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Decision Support Framework for Supply Chain Collaboration

Ana Cristina Barros

Instituto Superior Técnico, Universidade Técnica de Lisboa
Av. Rovisco Pais, 1049-101 Lisboa, Portugal
e-mail: anacbarros@ist.utl.pt
Phone: +351 21 8417729

Ana Paula Barbosa Póvoa

Instituto Superior Técnico, Universidade Técnica de Lisboa
Av. Rovisco Pais, 1049-101 Lisboa, Portugal
e-mail: apovoa@ist.utl.pt
Phone: +351 21 8417729

Alexandra Castro

Qimonda Portugal S.A.
Avenida 1º de Maio, 801, 4485-629, Vila do Conde, Portugal
E-mail: Alexandra.Castro@qimonda.com
Phone: +351 252 246310

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Abstract

Supply chain collaboration is recognized as a powerful way for industries to achieve competitive advantage. Still, literature reveals different strategies of collaboration in buyer-supplier relationships and adds that a one-fits-all solution for supply chain collaboration does not exist. Naturally, managers often raise the question "how can I determine the most suitable supply chain collaboration strategy for my raw materials?"

Motivated by this observation, we propose a decision support framework, which guides managers to the most adequate collaboration strategy, by analyzing the characteristics of both the raw materials and the suppliers. The framework results from (a) a comprehensive case study at an enterprise operating in a highly volatile market with long supplier lead times, (b) on interviews with managers of several industrial sectors, and (c) on the literature review of other relevant case studies.

Keywords: Supply Chain Collaboration, Relationship Management, Buyer-Supplier Relationships

1. Introduction

Most managers are aware of the recent supply chain collaborative strategies that have been introduced in the literature such as Vendor Managed Inventory (VMI), Collaborative Planning, Forecasting, and Replenishment (CPFR) and Continuous Replenishment (CR). Technology initiatives that support these collaboration strategies such as electronic data interchange (EDI), web-based integration systems, enterprise resource planning (ERP), and supply chain optimization (SCO) software are also reasonably well known. Although, successful stories of supply collaboration implementation have been reported in several contributions (Holmström, 1998, Toni and Zamolo, 2005;), there are also a number of reports about enterprises that did not find significant performance improvements following the implementation of their supply chain collaboration programs (Lee et. al, 2003, Dong et. al, 2006;). Thus it is only natural to raise the question “what is the most suitable supply collaboration strategy for the raw materials of an industrial enterprise?” Our framework, which was developed by means of action research in a semiconductor enterprise, provides an answer to this question. In action research, the scientist has the role of change agent inside the enterprise and through the access to empirical real-world data, theoretical results are generated, tested and possibly modified through action (Gummesson, 2000). In order to achieve a general framework, the action research was complemented with several interviews with managers of other industrial sectors, such as food, laminates, cork products and office supplies and with literature review on case studies about industries focused on automotive production (Hahn et. al, 2000; Valentini and Zavanella, 2003), household electrical appliances (Toni and Zamolo, 2005), footwear (Bertolini et. al, 2007), and consumer goods (McCarthy and Golicic, 2002; Småros, 2003), as well as chemical and apparel industries (McCarthy and Golicic, 2002).

The remainder of the paper is structured as follows. Section 2 reviews the literature related to the buyer-supplier collaboration concepts, as defined by Holweg et al. (2005), namely Traditional Supply Chain, Information Exchange, Vendor Managed Inventory, and Synchronized Supply. The decision support framework for supply chain collaboration is presented in section 3. Finally, section 4 concludes the paper and outlines an agenda for future research.

2. Literature Review

Several taxonomies of buyer-supplier relationships have been proposed in the literature as a mean to perform supplier segmentation and help companies establish their overall supply strategy (a classification review is presented in Saccani and Perona, 2007). Once the supply strategy is defined and the strategic and non-strategic partners are chosen, companies have to define how the collaboration with the suppliers will affect the replenishment and inventory management operations. Holweg et al. (2005) looked at implementations of collaboration projects in the supply chain across several industries and countries and proposed a simple classification of concepts for Supply Chain Collaboration, which structures collaboration concepts by their participation on two dimensions – the inventory replenishment collaboration and the forecasting collaboration – leading to four types of collaboration strategies (Figure 1).

Planning Collaboration	**Yes**	**Information Exchange** • Exchange of demand information • Alignment of forecast for capacity and long-term planning • Collaborative Forecasting	**Synchronized Supply** • Merges the replenishment decision with the production and materials planning of the supplier. • Supplier takes charge of customer's inventory replenishment and uses this visibility in planning his own supply operations
	No	**Traditional Supply Chain** • PO is the only information exchanged • Bullwhip problem • Excessive inventory investment to cope with demand uncertainty	**Vendor Managed Inventory** • Supplier takes responsibility for maintaining customer's inventory • Easier to manage short product life cycles • In shortage situations the supplier prioritizes customers for whom it is responsible for managing the inventory
		No	**Yes**
		Inventory Collaboration	

Figure 1. Supply Chain Configurations for Collaboration (adapted from Holweg et. al, 2005)

For supply chain collaboration there is not a one-fits-all solution and enterprises have to analyse the most appropriate strategies for each of their stock items and suppliers. Holweg et al, identified geographical dispersion, demand pattern and product characteristics as the key factors in determining the most suitable collaboration strategy. The present paper identifies further key factors and studies how their different values influence the collaboration strategy decision (see section 3.1). The following describes the characteristics of the four collaboration strategies.

Traditional Supply Chain (TS)

In a traditional supply chain, buyer and supplier operate in an arm's length environment, meaning that each of them is responsible for its own inventory control and production or distribution ordering activities. The only information exchanged between parties consists of purchase orders and, as explained by Lee et al. (1997), this behaviour leads to distortion of demand along supply chain members – a phenomenon called bullwhip effect. Demand amplification of orders, as one moves up the supply chain can cause many problems for the upstream partners including higher inventory, inefficient use of production and transportation capacities, and lower customer service level. Geary et al. (2006) provide a comprehensive historical review of the bullwhip effect in supply chains. They identify 10 published causes of bullwhip, which can be eliminated by re-engineering the supply chain. The activities necessary to counter the bullwhip effect include information sharing of point of sales data and inventory status data, synchronization and co-ordination of the supply chain, simplification of material flows, reduction of process times, and simplification of the pricing / promotional activities. All these activities require that trust emerges in supply chain relationships moving out from a traditional supply chain to a totally integrated information system. Chen et al. (2000) concluded though that the bullwhip effect can be reduced, but not completely eliminated, even when demand information is shared by all stages of the supply chain and all stages use the same forecasting techniques and inventory policies.

Although the benefits of the bullwhip reduction are well known, we still believe that the traditional supply chain might be the better option for certain supplier-buyer dyads as we will further discuss in section 3.

Information Exchange (IE)

Since information sharing has been identified as a key enabler in reducing the bullwhip effect in the supply chain, companies started exchanging demand information in the form of expected orders in the future. Some companies go further and share their raw data for material planning, such as the point of sales data in the case of retailers and consumption or requirements data in the case of manufactures. Although companies share this information in order to align forecasts for capacity and long-term planning, they still order independently (Holweg et al., 2005). Lee et al. (2000) analysed the benefit of information sharing for a two-level supply chain with non-stationary end demands and concluded that it could provide significant inventory reduction and cost savings to the manufacturer. Larger savings are expected when: (a) the demand correlation over time is high, (b) the demand variance within each time period is high, or (c) the lead times are long. A similar analysis has been performed by Cachon and Fisher (2000), who compared a traditional supply with no use of shared information with a supply that exploits shared information in the case of one supplier, N identical retailers, and stationary stochastic consumer demand. They concluded that the benefits are not directly due to the information sharing but to the impact of information exchange on lead time and batch size reduction, from which they did find substantial savings.

If we add the forecasting process to the information exchange process, then we arrive at collaborative forecasting. In 1998, the Voluntary Interindustry Commerce Standards (VICS) association published the guidelines for a new method called Collaborative Planning, Forecasting and Replenishment (CPFR), which they have updated in 2004 and described as “a business practice that combines the intelligence of multiple trading partners in the planning and fulfilment of customer demand.” (VICS, 2004) The benefits attributed to the CPFR are greater visibility of inventory, improved replenishment accuracy, out-of-stock and overstock reduction and better customer service level. VICS (2004) proposes four alternatives for CPRF, depending on who takes the lead in the three collaboration tasks: sales forecasting, order planning/forecasting, and order generation (Table 1). Chen et al. (2007) investigated the performance of these four alternatives by using simulation. As performance measures they used service level, fulfilment rate, order cycle time, and total system cost (holding, shortage, and order cost for both manufacturer and retailer). The simulation results showed that option B had the best score for all the performance measures.

Table 1. Collaboration Role Alternatives (VICS, 2004).

Alternatives	Sales Forecasting	Order Planning / Forecasting	Order Generation
Option A **(Conventional order management)**	Retailer	Retailer	Retailer
Option B **(Supplier-Managed Inventory)**	Retailer	Manufacturer	Manufacturer
Option C **(Co-Managed Inventory)**	Retailer	Retailer	Manufacturer
Option D **(Retail VMI)**	Manufacturer	Manufacturer	Manufacturer

McCarthy and Golicic (2002) started from a case study research in the US in order to propose an alternative approach for the implementation of inter-firm collaborative forecasting. Their approach does not require the substantial investment in human and technological resources required by CPFR and yield as well to substantial improvements in company and supply chain performance including increased responsiveness, product availability assurance, optimized inventory and associated costs, and increased revenues and earnings. Also Småros (2003) performed case study research within European retailers and concluded that the most important obstacle for the CPFR implementation in Europe is the retailers' lack of forecasting processes and resources. She presented examples of how forecasting accuracy can be improved through very streamlined co-operation processes and proposed different collaboration approaches for each phase of the product life cycle.

Vendor Managed Inventory (VMI)

In a Vendor Managed Inventory strategy the supplier is responsible for maintaining the buyer's inventory levels. Achabal et al. (2000) showed how the implementation of a VMI system between an apparel manufacturer and over 30 of its retail partners can improve customer service levels, often coupled with a significant improvement in inventory turnover. Another example in the retailing industry is given by Holmström (1998), who reports that it is possible to implement VMI using a simple and efficient solution in a standard systems environment (SAP R/3 and EDIFACT). Toni and Zamolo (2005) provide a case study of a VMI implementation in a manufacturing environment and in parallel to the benefits of higher customer service levels and stock reductions they observe also the following advantages: immediate response to customer's various requirements, error reduction through the elimination of paper documents, increased market visibility, improved planning and reduced re-planning, better management of risks and opportunities and greater sales.

Together with these practical examples, the literature on VMI strategy includes analytical models that aim to define the optimal conditions to run VMI and provide theoretical evidence of the implementation benefits. Dong and Xu (2002) for example concluded that the inventory related costs of buyer-supplier channel as a whole will be reduced with a VMI program. They evaluated the short-term and long-term impact of VMI on supply chain profitability and concluded that the buyer will always realize higher profits, weather these may be only visible for the supplier on the long-term. Also Yao, et al. (2007) show that benefits from inventory reductions due to VMI are not equally distributed between buyers and suppliers. Often the buyer receives all the benefits while the supplier bears additional costs. On the short-term of VMI implementation, inventories move upstream from buyers to suppliers, but on the long-term when a fully integrated supply chain is achieved, manufacturers can increase capacity utilization and achieve greater production smoothing (Waller et al., 1999). Disney and Towill (2003) used a simulation model to demonstrate that the bullwhip effect is reduced in VMI supply chains.

Modelling has also been used to investigate the impact of VMI implementation on transport operations. Disney et al. (2003) have shown that transport cost savings are achievable in a VMI supply chain when compared with a traditional supply chain. Wilson (2007) investigated the effect of a transportation disruption on supply chain performance and concluded that although a transportation disruption affects both the traditional and vendor managed supply chain, the impact when the VMI structure is used is much less pronounced.

Dong et al. (2006) studied, by means of a survey in industries focused on Industrial Machinery and Equipment, Electronic and Other Electrical Equipment, and Transportation Equipment, the determinants of adoption of VMI. Both the hypotheses of competitiveness in buyer's and supplier's market were analysed but the VMI adoption was only associated with increased competitiveness in the supplier's market. This study did not find a correlation between demand uncertainty and VMI adoption, which is in concordance with the results of Walter et al. back in 1999 (Walter et al, , 1999). VMI adoption decreases with higher levels of buyer operational uncertainty, yet increases with greater levels of buyer-supplier cooperation. Kuk (2004) has also surveyed companies in the electronics industry to analyse more insights on VMI implementation. The findings suggest that small rather large organisations expected and perceived higher returns from VMI and that high level of employee involvement and logistics integration are more likely to realize the potential values of VMI.

Synchronized Supply (SS)

In a synchronized supply, supplier uses the information from customer in order to plan his own supply and production activities (Holweg et al., 2005). This means that the supplier operates in a build-to-order strategy (Gunasekaran and Ngai, 2005). The information shared by the customer consists of orders, forecast data, consumption and stock level reports. As full transparency of information exists, the responsibility for the placement of the replenishment orders can belong to the supplier or the buyer. In case the supplier uses tailored raw material with long supply lead time to fulfil customer orders, the order period may be divided between "firmed order period" and "ready for production period". The "firmed order period" is the time supplier needs to produce/assemble the customer order and the "ready for production period" is the time supplier needs to order the raw materials. Figure 2 illustrates a delivery forecast with three time periods.

Figure 2. Delivery forecast with three time periods

To achieve synchronized supply, both supplier and buyer have to work together in order to define the common goal for the total supply chain. Kim (2006) defined three steps for process chain synchronization: (1) Aligning the supply chain strategy around the new business model, (2) Reengineering networks and processes for efficiency or responsiveness, (3) Synchronizing internal and external processes and systems with measurement.

The three strategies Information Exchange, Vendor Managed Inventory and Synchronized Supply require the exchange of information. Electronic data interchange is an enabler for the data sharing but not a requirement, since this information can also be exchange through other means such as email (Waller et. al, 1999; Lee et. al, 2000). As Lee et al. (2003) concluded, the achievement of significant performance improvement is only possible when the electronic network is used not only to exchange commercial documents but to create new forms of collaboration between channel partners. Williamson et al. (2004) analysed the development of inter-organisational information systems within Supply Chain Management and categorized it into four phases: paper-based documentation, development of EDI, integration of Enterprise Resource Planning systems and strategic partnerships enabled by the use of web development technologies such as XML and Java.

3. Decision Support Framework for Supply Chain Collaboration

Kraljic, P. (1983), Christopher and Jüttner (2000), Handfield (2006) and Kim (2006) provide good frameworks and roadmaps on how to develop strategic partnerships in the supply chain. These roadmaps start with the steps needed to define the company's relationship strategy with its suppliers and continue with the steps needed to implement the strategy. After establishing the Strategic, Preferred, Transactional, and Partner suppliers (Handfield, 2006), companies have to define which collaboration strategy is the most appropriate for each supplier. This is exactly the gap that the present work aims to fill.

In order to define the appropriate collaboration strategy to implement with each supplier, companies have first to measure the decision factors (section 3.1) and second to deduct the strategy using the framework in Figure 4 (section 3.2).

3.1 Decision Factors

The decision factors relevant for the deduction of the supplier collaboration strategy are: (1) Purchasing Volume, (2) Risk of Supply, (3) Demand Volatility, (4) Importance of Buyer to Supplier, (5) Lead Time, and (6) Shelf Life. These factors were identified through brainstorming sessions with enterprise managers. As first step for the strategy definition companies evaluate the decision factors for each commodity and supplier and rate them in a three value scale of high, medium and low. The following defines the decision factors and explains their influence to the decision of the collaboration strategy.

3.1.1 Purchasing Volume (PV)

The basis to identify the high, medium and low purchasing volume is a simple ABC-Analysis (Frazelle, 2002, Vollmann et al., 2004) performed per material group. Each material group includes several material items, which are the same material with different characteristics, such as design, dimensions or colour. In case of multiple sourcing, it will be necessary to perform a sequential analysis, first per material group and afterwards per supplier. If one supplier delivers items of several material groups, an independent analysis per supplier is performed as well. Figure 3 shows the various combinations between sourcing strategies and supplier diversity and the ABC-analysis recommended for each situation.

Sourcing Strategy	**Multiple**	**Several Suppliers for each Material Group** ABC-Analysis: Material Group and Supplier	**Several Suppliers for several Material Groups** ABC-Analysis Independent and Sequential Material Group and Supplier
	Single	**One Supplier for each Material Group** ABC-Analysis: Material Group or Supplier	**One Supplier for several Material Groups** ABC-Analysis: Material Group and Supplier
		Delivers one Material Group	**Delivers several Material Groups**
		Supplier Diversity	

Figure 3. ABC-Analysis for each sourcing strategy and supplier diversity

Alternatively, in order to purchase volume companies can use the consumption value, since this information might be easier to compile.

High purchasing volume means high importance to the buyer and therefore, depending on the values of other decision factors, IE, VMI or SS are recommended. On the contrary, low purchasing volume does not warrant the investment in synchronizing the supply and therefore only TS, IE or VMI apply.

3.1.2 Risk of Supply (RS)

The risk of supply considered in this paper is the potential delivery failure of the suppliers, which may be calculated by the analysis of the supplier delivery performance, quality, capacity, technology, financial situation, and response in case of accidents or natural disasters (Norrman and Jansson, 2004; Wu et al., 2006). The reader is referred to the work of Wu et al. (2006) for inbound risk classification, identification and calculation.

When both the purchasing value and risk of supply are high, then parties have to work together towards risk reduction by synchronizing their processes and improving supply chain performance. The risk of supply also reflects the level of trust the buyer has towards the supplier. VMI strategy requires high trust level, since the buyer fully confines the replenishment task to the supplier and therefore VMI is only suggested for risk of supply values from medium to low.

3.1.3 Demand Volatility (DV)

Demand Volatility refers to the change over time of the demand forecast. Forecast accuracy measures the deviation between the actual demand and forecasted demand (Frazelle, 2002), whereas demand volatility measures the deviation between the forecasted demand in two different periods. Similar to the forecast accuracy, it may be measured via the standard deviation of the change of the forecasted demand.

The demand volatility only influences the strategy definition when the purchasing value is high, since for purchasing value medium and low, high demand volatility may be compensated with the increase of safety stocks. For high demand volatility, the decision is dependent on the lead time value, because for high to medium values of lead time, it would be too risky to leave the replenishment task up to the supplier. Synchronized supply is therefore recommended.

3.1.4 Importance of Buyer to Supplier (IBS)

This parameter answers the buyer's question: "Are we strategic customers to our supplier?" The strategic relevance of the buyer to the supplier can be achieved through quantitative aspects, such as high supplier's sales volume to the buyer, and qualitative measures, such as R&D partnership, knowledge transfer or estimated future revenues. Another indicator of the importance of the buyer to the supplier is the level of customization of the delivered goods (Lampel and Mintzberg, 1996). When pure customized goods are exchanged, meaning that the products are designed and produced in accordance to customer's specifications, the importance is certainly higher than in the case of the exchange of standard products.

The implementation of strategies that require changes on supplier's processes are only viable when the buyer is an important customer to the supplier, otherwise the supplier motivation for the strategy implementation will be very low. Therefore, companies should only consider the implementation of Vendor Managed Inventory and Synchronized Supply with suppliers, to whom they are important customers.

3.1.5 Lead Time (LT)

Lead time is the time spent between order placement and material arrival at customer warehouse (Narahari et. al, 2000; Bertolini, et. al, 2007). Lead time higher than 6 weeks is considered to be high, between 2 and 6 weeks medium and lower than 2 weeks low.

Lead time reduction is an essential task for supply chains that aim to increase responsiveness and decrease inventory costs. Especially in industrial sectors with high demand volatility, the improvement of the demand information exchange alone will not prevent stock-outs and obsolete stock. Therefore, supply chain improvement projects should prioritize the lead time analysis through Business Process Re-engineering (BPR) techniques in order to bring the lead time to its minimum (Treville et. al, 2004; Bertolini et. al, 2007).

High to medium values of lead time require more information exchange and coordination in the supply chain than low lead times. Still, traditional supply is recommended for high to medium values of lead time in the case of medium to low values of purchasing value and risk of supply, low importance of buyer to supplier and medium to high values of shelf life, since in this case high lead time can be compensated with safety stock increase.

3.1.6 Shelf Life (SL)

Shelf life is the period through which supplier guaranties that the material will keep its characteristics as stated in the specification and certificates of conformance and analysis. Shelf life lower than 6 months is considered to be low, between 6 and 12 months medium and higher than 12 months high.

In the framework presented in this paper, shelf life is the last parameter companies have to look at in order to realize if some level of information exchange and coordination in the supply chain is necessary. For medium to low values of purchasing value and risk of supply, low importance of buyer to supplier and high to medium values of lead time, information exchange warrants in the case of low shelf life, because in this case there is a high risk of storing out of date materials.

3.2 Deduction of the Collaboration Strategy

After collecting the data companies can easily deduct the appropriate collaboration strategy for each supplier by following the paths in Figure 4. For simplicity reasons two classifications of the decision factors risk of supply, demand volatility, importance of buyer to supplier, lead time, and shelf life were combined (Flores and Whybark, 1987 in Vollmann et al., 2004).

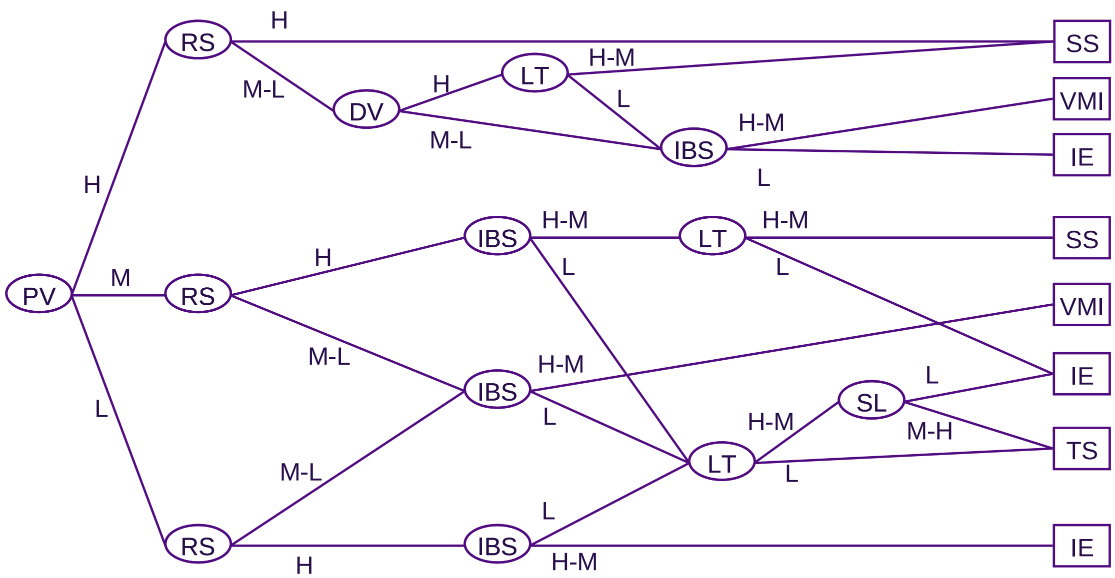

Figure 4. Decision Support Framework for Supply Chain Collaboration

The framework was constructed based on the principle that a one-fits-all solution for supplier collaboration does not exist and that the strategy benefits described during the literature review in section 2, will only apply for certain material and supplier characteristics. Also, the implementation of Information Exchange, Vendor Managed Inventory and Synchronized Supply strategies require great efforts for companies and therefore managers have to concentrate on the relationships that will bring the most benefits, without neglecting the ones with high inbound supply risk. Hence, the framework also identifies the situations where a Traditional Supply is recommended, because the volume of goods exchanged does not warrant the implementation of a collaboration strategy and the materials and suppliers do not represent a big impact for company operations.

In section 3.1 we discussed how the decision factors affect the strategy definition.

Figure **5** is another representation of the framework that gives an overview of the different paths leading to each collaboration strategy.

	Information Exchange									Synchronized Supply			
PV	H	H	M	M	M	L	L	L	PV	H	H	M	
RS	M-L	M-L	H	H	M-L	H	H	M-L	RS	H	M-L	H	
DV	H	M-L							DV		H		
IBS	L	L	H-M	L	L	H-M	L	L	IBS			H-M	
LT	L		L	H-M	H-M		H-M	H-M	LT		H-M	H-M	
SL				L	L		L	L	SL				
	Traditional Supply									Vendor Managed Invent.			
PV	M	M	M	M	L	L	L	L	PV	H	H	M	L
RS	H	H	M-L	M-L	H	H	M-L	M-L	RS	M-L	M-L	M-L	M-L
DV									DV	H	M-L		
IBS	L	L	L	L	L	L	L	L	IBS	H-M	H-M	H-M	H-M
LT	H-M	L	H-M	L	H-M	L	H-M	L	LT	L			
SL	M-H		M-H		M-H		M-H		SL				

Figure 5. Selection Scenarios for each Collaboration Strategy

The framework recommends synchronizing the supply when the values of purchasing value, supply risk, demand volatility, and lead time are high. These are the most critical materials and most relevant suppliers for the company and most probably the ones where the company faces more stock-outs and high inventories. Here the synchronization of processes and the elimination of non-value activities are very important in order to reduce the lead time. Vendor Managed Inventory is appropriated for materials and suppliers with medium to low risk of supply and high to medium importance of buyer to supplier. VMI is the strategy that requires the highest levels of trust and therefore only applicable for low values of supply risk. Also, companies should assure that they represent an important customer for their suppliers so that suppliers will prioritize the management of their stock over other customers. Information Exchange is recommended when Vendor Managed Inventory or Synchronized Supply are not possible because either the buyer is not very important to the supplier or the risk of supply is high, but still some level of information should be exchanged because either the demand volatility is high, or purchasing volume is high, or importance of buyer to supplier is high, or lead time is high and shelf life low. Finally, Traditional Supply should apply in all situations in which the buyer is not very important to the supplier and the materials and suppliers do not represent a big impact on company's operations, namely when the purchasing volume is medium to low, the lead time is low, and when the lead time is high but the shelf life is high as well.

The next step after the deduction of the supplier collaboration strategy is the comparison of the deducted strategies with the ones in place and the establishment of an action plan. Prior to implementation, companies have to investigate if their suppliers have the necessary competencies to implement the deducted strategies, such as information systems and inventory management competencies in the case of VMI.

4. Conclusion and Future Research Agenda

In the past supply chain uncertainty and risk have been reduced through the increase of control over the entire supply chain by means of internal growth or vertical integration. Over the time managers realized that internal and external expansions are too expensive and too inflexible and therefore, today companies aim to achieve the same control over the supply chain through the development of collaborative relationships with their supply chain partners. The collaboration begins with the settlement of common goals for the total supply chain and, through relationship management, partners build up trust in order to achieve these common goals. Previous literature has brought essential tools to help managers define their sourcing strategy and important taxonomies to define the various collaboration strategies for the supply chain. The framework presented in this paper aims to be part of the sourcing strategy of companies by defining the appropriate collaboration strategy between supply chain partners for effective replenishment and inventory management. By the analysis of the decision factors Purchasing Volume, Risk of Supply, Demand Volatility, Importance of Buyer to Supplier, Lead Time, and Shelf Life, the framework guides managers to the appropriate collaboration strategy among Traditional Supply Chain, Information Exchange, Vendor Managed Inventory, and Synchronized Supply.

Future research should validate empirically the positive impact of the deducted strategies on the performance of the firm. In order to maintain the general approach of the framework, its positive impact on performance should be confirmed in enterprises of several industrial sectors, by means of comparative multiple case studies (Dubois and Araujo, 2007).

5. References

Achabal, D.; McIntyre, S.; Smith, S.; Kalyanam, K. (2000). A Decision Support System for Vendor Managed Inventory. Journal of Retailing, Vol. 76, No. 4.

Bertolini, M., Bottani, E., Rizzi, A., Bevilacqua, M. (2007). Lead time reduction through ICT application in the footwear industry: A case study. Int. J. Production Economics, 110, 198–212.

Cachon, G.P., Fisher, M. (2000). Supply Chain Inventory Management and the Value of Shared Information. Management Science, 46, 8, 1032-1048.

Chen, F., Drezner, Z., Ryan, J.K., Simchi-Levi, D. (2000). Quantifying the Bullwhip Effect in a Simple Supply Chain: The Impact of Forecasting, Lead Times, and Information. Management Science, 46, 3, 436–443.

Chen, M.-C., Yang, T., Li, H.-C. (2007). Evaluating the supply chain performance of IT-based inter-enterprise collaboration. Information & Management 44, 524–534.

Christopher, M., Jüttner, U. (2000). Developing strategic partnerships in the supply chain: a practitioner perspective. European Journal of Purchasing & Supply Management, 6, 117-127.

Disney, S.M., Potter, A.T., Gardner, B.M. (2003). The impact of vendor managed inventory on transport operations. Transportation Research Part E, 39, 363–380.

Disney, S.M., Towill, D.R. (2003). The effect of vendor managed inventory (VMI) dynamics on the Bullwhip Effect in supply chains. Int. J. Production Economics, 85, 199–215.

Dong, Y., Xu, K., Dresner, M. (2002). A supply chain model of vendor managed inventory. Transportation Research Part E, 38, 75–95.

Dong, Y., Xu, K., Dresner, M. (2006). Environmental determinants of VMI adoption: An exploratory analysis. Transportation Research Part E, doi:10.1016/j.tre.2006.01.004.

Dubois, A., Araujo, L. (2007). Case research in purchasing and supply management: Opportunities and challenges. Journal of Purchasing & Supply Management, 13, 170–181.

Frazelle, E. (2002). Supply Chain Strategy. McGraw-Hill.

Geary, S., Disney, S.M., Towill, D.R. (2006). On bullwhip in supply chains—historical review, present practice and expected future impact. Int. J. Production Economics, 101, 2–18.

Gummesson, E. (2000). Qualitative Methods in Management Research. Sage Publications, Inc., London.

Gunasekaran, A., Ngai, E.W.T. (2005). Build-to-order supply chain management: a literature review and framework for development. Journal of Operations Management, 23, 423–451.

Hahn C.,K., Duplaga E.A. , Hartley, J.L. (2000). Supply-chain synchronization: Lessons from Hyundai Motor Company. Interfaces, 30, 4, 32.

Handfield, R. (2006). Supply Market Intelligence: A Managerial Handbook for Building Sourcing Strategies, Auerbach Publications, New York.

Holmström, J. (1998). Business process innovation in the supply chain a case study of implementing vendor managed inventory. European Journal of Purchasing & Supply Management, 4, 127-131.

Holweg, M., Disney, S., Holmström, J., Småros, J. (2005). Supply Chain Collaboration: Making Sense of the Strategy Continuum. European Management Journal, 23, 2, 170–181.

Kim, D. (2006). Process chain: A new paradigm of collaborative commerce and synchronized supply chain. Business Horizons, 49, 359—367.

Kraljic, P. (1983). Purchasing must become Supply Management. Harvard Business Review, 61, 5, 109-117.

Lampel, J., Mintzberg, H. (1996): Customizing Customization. Sloan management review, 38, 1, 21-30.

Lee, H. L., Padmanabhan, V., Whang, S. (1997). Information Distortion in a Supply Chain: The Bullwhip Effect. Management Science, 43, 4, 546-558.

Lee, H.L., So, K.C., Tang, C.S. (2000). The Value of Information Sharing in a Two-Level Supply Chain. Management Science, 46, 5, 626-643.

Lee, S. C., Pak, B. Y., Lee, H. G. (2003). Business value of B2B electronic commerce: the critical role of inter-firm collaboration. Electronic Commerce Research and Applications, 2, 350–361.

McCarthy, T.M., Golicic, S.L. (2002). Implementing collaborative forecasting to improve supply chain performance. International Journal of Physical Distribution & Logistics Management, 32, 6, 431 - 454.

Narahari, Y., Viswanadham, N., Bhattacharya, R. (2000). Proceedings of the 2000 IEEE International Conference on Robotics & Automation San Francisco, CA, April 2000.

Norrman, A., Jansson, U. (2004). Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident. International Journal of Physical Distribution & Logistics Management, 34, 5, 434-456.

Saccani, N. , Perona, M. (2007). Shaping buyer–supplier relationships in manufacturing contexts: Design and test of a contingency model. Journal of Purchasing & Supply Management, 13, 26–41.

Småros, J. (2003). Collaborative forecasting: a selection of practical approaches. International Journal of Logistics Research and Applications, 6:4, 245 - 258.

Toni, A. F., Zamolo, E. (2005). From a traditional replenishment system to vendor-managed inventory: A case study from the household electrical appliances sector. Int. J. Production Economics, 96, 63–79.

Treville S., Shapiro, R. D., Hameri, A.-P. (2004). From supply chain to demand chain: the role of lead time reduction in improving demand chain performance. Journal of Operations Management, 21, 613–627.

Valentini, G., Zavanella, L. (2003). The consignment stock of inventories: industrial case and performance analysis. Int. J. Production Economics, 81–82, 215–224.

Vollmann, T., Berry, W., Whybark, D., Jacobs, F. (2004). Manufacturing, Planning, and Control Systems for Supply Chain Management: The Definitive Guide for Professionals. McGraw Hill Professional, 5th Edition.

Voluntary Interindustry Commerce Standards (VICS) (2004), Collaborative Planning, Forecasting and Replenishment (CPFR®),

http://www.vics.org/committees/cpfr/CPFR_Overview_US-A4.pdf.

Yao Y., Evers P. T., Dresner M. E. (2007), Supply chain integration in vendor-managed inventory, Decision Support Systems, Decision Support Systems, 43, 663– 674.

Waller, M., Johnson, M., Davis, T. (1999). Vendor managed inventory in the retail supply chain. Journal of Business Logistics, 20, 1, 183-203.

Williamson, E., Harrison, D., Jordan, M. (2004). Information systems development within supply chain management. International Journal of Information Management, 24, 375–385.

Wilson M. (2007), The impact of transportation disruptions on supply chain performance. Transportation Research Part E: Logistics and Transportation Review, 43, 4, 295-320.

Wu, T., Blackhurst, J., Chidambaram, V. (2006). A model for inbound supply risk analysis. Computers in Industry, 57, 350–365.