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VENDOR MANAGED INVENTORY, FROM CONCEPT TO PROCESSES, FOR AN UNIFIED VIEW

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Abstract: In a supplier-customer relationship, Vendor Managed Inventory (VMI) is currently used to monitor the customer's inventory replenishment. However the integration of VMI implies consequences on the collaboration process that links the different planning processes of each partner. This paper proposes a unified view of the VMI: beyond the short term pull system inventory replenishment, partners have to share their vision of the demand, their requirements and their constraints to fix middle/long term common objectives for each article concerned by VMI. There are many ways to specify these links between VMI and partner's planning processes.

Keywords: *Vendor Managed Inventory, Supply chain management, Collaboration, Simulation*

1 Introduction

Using supply chain collaboration more strategically has become crucial in today's increasingly demanding business process to create new revenue opportunities, efficiencies and customer loyalty (Ireland and Crum 2005).

Lack of demand visibility has been identified as an important challenge for the supply chain management resulting in inefficient capacity utilization, poor product availability and high stock levels for each partner (Smaros *et al.*, 2003). According to this, increasing the demand visibility on production and inventory control was a first step to improve this collaboration between members of the supply chain. In this view, Quick Response (QR) was born in the beginning of the 80s in order to reduce delay needed to serve the customer in the textile industry. The supplier receives a point of sale data from the customer and uses this information to synchronize its production. In the beginning of the 90s the Continuous Replenishment Policy (CRP) was developed: based on consumer demand, the CRP pull system replaces the historical push systems. Gradually, the sphere of decision of the suppliers is growing until the VMI transfers the totality of the customer's inventory replenishment responsibility to the supplier (Tyan and Wee, 2002).

To describe the supply chain management, Brindley and Ritchie (2004) emphasize the difference between the notions of logistics, as the physical and tangible activities, and the relationship building and management as the behavioral and intangible dimension. Therefore, beyond the tangible short term replenishment dimension of the VMI, what does implement VMI mean in terms of relationship and tactic or strategic exchanges?

Furthermore, it clearly appears that the implementation of the process is limited to particular situations. For example, today VMI is quasi-exclusively synonymous with distribution context. So the way to extend Distribution-VMI notions to the relationship between industrial partners must be focused on.

The purpose of this paper is first to clarify the VMI concepts (what clearly is VMI and how can VMI be concretely implemented in the supply chain) and secondly to deal with the integration of VMI inside the industrial actor's planning processes. Thus, the first part presents a state of art of the VMI, which enables to propose a global VMI process in a second part. In a third part we propose an integration of the VMI processes inside actors' planning processes. In a last part, we will present conclusion and future researches.

2 Literature review

2.1 Literature overview

As Disney and Towill (2002) argue, moving to a VMI scenario alters the fundamental structure of the supply chain ordering. But details of this transformation are not clear. In order to measure the impact of different Information and Communication Technologies on supply chain dynamics, Disney *et al.* (2002) have implemented VMI (and other scenarios) in the Beer Game. The debriefing of the game clearly underlines the player's difficulty to implement the VMI concept and they need for clarification.

In the literature, three main types of contribution can be found: general, case studies and models. General papers give a general definition of the VMI and the main benefits of its application. Industrial case studies delimit the scope of the VMI application, its benefits and limits. Finally, modeling papers propose mathematical models that underline key parameters, called "determinants", that impact the VMI performance.

We first analyzed how the term VMI is qualified in the literature. We are interested in the introductive and descriptive parts of the different papers. It can be noticed that authors use more than four different words or expressions to qualify VMI in a same article. We found twenty-four expressions used to qualify VMI (Table 1 in appendix A) that can be organized around five families:

- *Concept*: these are expressions used in a very large and generic sense.
- *Process*: these expressions show a functional, a process oriented approach of VMI.
- *Cooperation*: these expressions emphasize the relationship between partners.
- *Cooperative process*: this family inherits *process* and *cooperation* families.
- *Technology*: a focus on technologies that support VMI.

After building these families, Appendix A quantifies the use of each expression. For a given article, figures in percentage associated to a particular expression represent the frequency of apparition of this expression in proportion to the totality of the expressions used in this article.

Globally, all authors introduce the VMI with general terms, which belong to the *concept* family. The *process* terms are used in a majority of papers, but are less developed. The *cooperation* and *technology* sides are treated in case studies. Modeling papers broach the *cooperative process*, but each author develops a particular way to build the cooperative process.

To conclude, the overview of the literature underlines that a general consensus exists around the concept and the main expectations associated to the VMI. However, authors make their own interpretation of the integration of the cooperative process.

2.2 Objectives of VMI

Expressions extracted to concept and process families give all the necessary elements to identify the objectives of VMI. According to Tang (2006), the customer's target is to insure higher *consumer service level* with lower *inventory costs*. Supplier's is to reduce *production, inventory and transportation costs*. However, we can identify common objectives, which permit to build up a better collaboration between the partners and so to reach the main objectives: tensing the different flows, *speeding up the supply chain* (Holveg *et al.* 2005) and *reducing the bullwhip effect* (Disney and Towill 2003, Holveg *et al.* 2005, Achabal *et al.* 2000, Cetinkaya and Lee 2000).

2.3 Determinants of VMI

Many authors focus their analysis on one or on a limited number of the links between one objective and the associated determinants. VMI implementation is mostly translated into a *backing up of stocks from the customer to the supplier warehouse* (Blatherwick 1998). The supplier has to maintain the customer's inventory level within certain pre-specified limits (Tang 2006) based on a *minimum and maximum range* (ODETTE 2004).

Moreover most authors agree to explain the interest of transfer of customer's *inventory responsibility* from customer to supplier (Dong *et al.* 2007, Holveg *et al.* 2005, Kaipia and Tanskanen 2003, Tang 2006, Kuk 2004). With VMI, the customer delegates the ordering and replenishment planning decisions to the supplier (Tang, 2006).

The supplier bases replenishment decisions on the same information than the one the customer previously used to make its purchase decisions (Holveg *et al.* 2005). So, when VMI is implemented, the supplier has a *better vision of the customer's demand* (Kaipia and Tanskanen 2003). It results in more accurate sales forecasting methods and more effective distribution of inventory in the supply chain (Achabal *et al*. 2000). Production, logistics and transportation costs can be reduced due to coordinated production and replenishment plans for all customers (Tang 2006). Thanks to a better visibility, the supplier is able to smooth the peaks and the valleys in the flow of goods (Kaipia and Tanskanen 2003). In other terms, it *reduces the bullwhip effect*. Disney and Towill (2003) have demonstrated that VMI can reduce this effect by 50 % mainly thanks to the *visibility of the demand* through the in transit and customer's inventory levels. Yao and Dresner (2007) show that information sharing reduces the supplier safety stock, thereby reducing the average inventory level.

Furthermore, implementing VMI leads the supplier to higher *replenishment frequency* with smaller replenishment quantity (Yao *et al*. 2007, Dong *et al*. 2007) and so to greater inventory cost saving (Cetinkaya and Lee 2000). The supplier obtains a new degree of freedom, making decisions on quantity and timing of replenishment (Rusdiansyah and Tsao 2005). The delivery frequency appears like a performance lever for the supplier. The effects of transportation disruption impact are less severe when VMI is used (Wilson 2007).

Figure 1 summarizes the different objectives of the VMI differentiating individual and collaborative (supply chain) objectives. The link between one determinant and the objective, which appears just on top, is not exclusive. Each objective inherits all the determinants below.

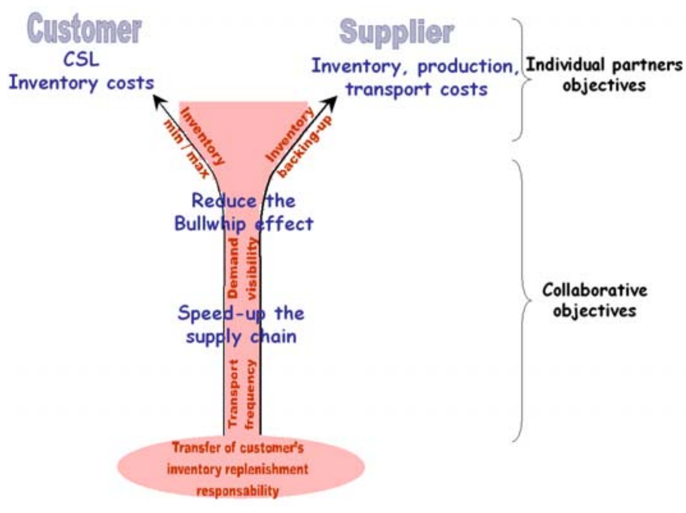

Figure 1: Objectives and associated determinants of the VMI

2.4 Scope of application

VMI has been widely adopted by many industries for years. The classical success story for VMI implementation is the partnership between Wal-Mart and Procter & Gamble. Some studies show the difficulties to implement VMI successfully (Tyan and Wee 2002).

Tyan and Wee (2002) particularly study the adoption of VMI by the Taiwanese grocery industry. This adoption is slow in comparison with western countries. According to the authors, the confidentiality of information sharing, the risk of loss of control by the customer or the increase of supplier's administrative costs cause the failure of more than one out of two attempts of implementation. The reasons are attributed to business culture, complicated logistics flows and complex distribution channels. First, the Taiwanese grocery industry represents a protective environment with minimal competition from foreign companies. In that sense, they agree with Dong *et al.* (2007) who underline the weight of the market competitiveness in VMI adoption. Secondly, the supply chain is complex (characterized by a large number of actors and intermediaries for a multi channel retail market).

De Toni and Zamolo (2005) present key characteristics of VMI as short replenishment lead times and frequent and punctual deliveries that optimize production and transport planning. Furthermore, according to them, the middle/long term collaboration allows to proportion supplier's production capacity and to determinate the minimum and maximum customer's inventory level. Holveg *et al*. (2005) explain that if a supplier does not integrate several information at a tactical planning level, the impact of VMI is negative. For example, the Bullwhip effect, which theoretically considerably decreases, increases. Dong *et al.* (2007) conclude that existing collaborations between the two actors would certainly facilitate the adoption of the VMI. ODETTE (2004), which presents VMI as a concept and process, defines the specifications of an Information System to support VMI processes.

The study of literature shows that almost all authors quasi-exclusively apply VMI to the Distributor-Supplier relationship. De Toni and Zamolo (2004) present a case study about VMI implementation. They explain that this implementation started with the distributor, but that it could be successfully developed to the other echelons of the supply chain. Gentine (2002) gives general perspectives about this VMI application to an industrial-industrial relationship. In particular, he cites the reduction of levels of stocks and the possibility to reduce transport cost thanks to the new degrees of freedom given to the supplier.

3 Our vision of the VMI process

From the literature review, it is possible to have a global idea about what VMI is, but a number of questions remain when we seek to implement it. We define the VMI concept as followed:

- a replenishment pull system.
- Where the supplier is responsible for the customer's inventory replenishment.
- Inside a collaborative pre-established middle/long term scope.

We can characterize the transition from the classic push supplier-customer relationship to a pull relationship thanks to two main transformations:

- there is no longer a purchase order from middle term processes of the customer, but a short term information about the consumption of the inventory.
- The Material Requirement Planning (MRP) of the supplier no longer releases a work order, but only a target level for the supplier's inventory.

However, VMI represents more than this pull version of the classical supplier-customer relationship. According to the concept, it may lead to a collaboration situation between the partners. VMI has to introduce information sharing and common decision-making processes. The integration of the VMI in the planning and scheduling process of partners results in a new collaboration protocol. We define three levels in this protocol. The **Partnering Agreement**, specifies the integration of the planning processes of the partners into a "VMI replenishment planning process". The **Logistical Agreement** fixes the parameters, which regulate the management of each article (minimum maximum inventory level, minimum delivery quantity, transport schedule…) (Gröning and Holma, 2007). The **Production and Dispatch process** monitors pull short-term decisions as production dispatch and transport.

The following **Figure 2** represents the links between the three main processes of the VMI. We find the different levels of decision. First, the PA synchronizes VMI with the partners' planning processes. It specifies the constraints to the Logistical Agreement and Production and Dispatch processes when integrating its into a global collaboration protocol.

Secondly, inside a fixed collaboration protocol, the LA allows to confront constraints and requirements of each actor. The objective is to converge on logistical parameters, which define and constraint the short term decisions in the Production and Dispatch process. **Figure 2** distinguishes two short term implementations depending on whether Production and Dispatch decisions are integrated or not:

- *Dispatch-VMI*: most papers consider that the degree of freedom is only used for the dispatching decision. Therefore, the suppliers' finished product inventory is replenished according to classical push or pull production approaches. Here, delivery possibilities are limited by the inventory level of product that the production has fixed.
- *Integrated-VMI*: some papers consider that the degree of freedom also directly impacts the supplier's production, and its work in progress. In this case, we consider that dispatch and production decisions are taken simultaneously. The target is to optimize the entire process. Some optimization methods could be used to reach a global optimum.

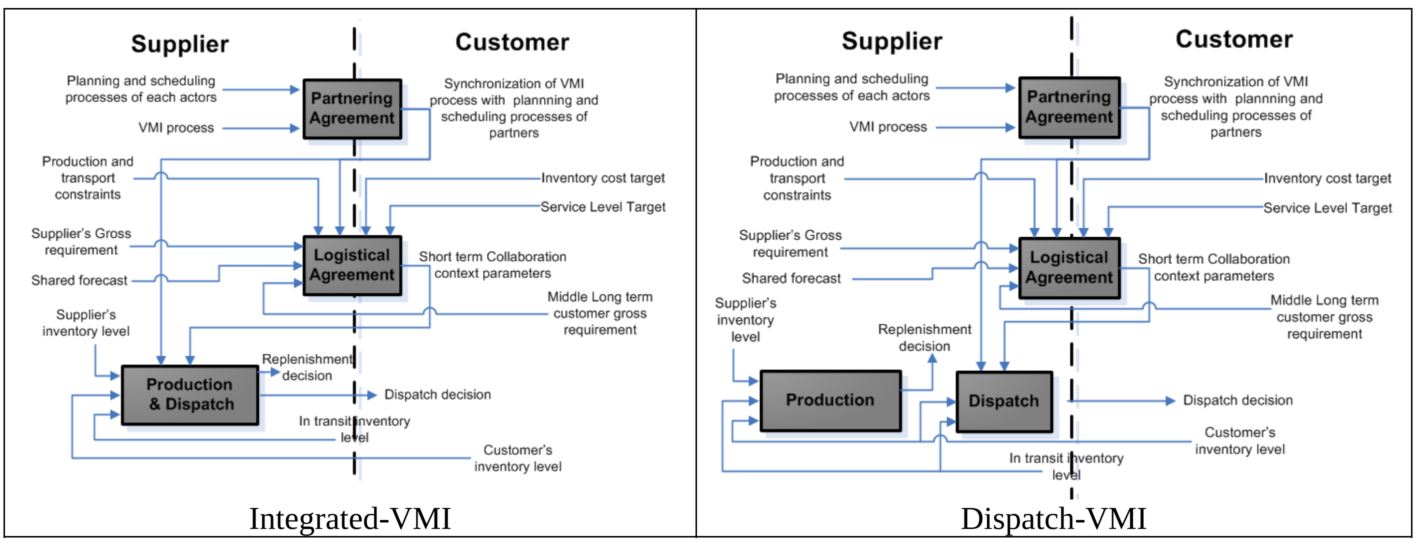

Figure 2: VMI macro-processes

Beyond this distinction in the short term processes, a global reflection about the integration of these VMI processes with the actors' planning processes is necessary.

4 Integration of MRPII and VMI processes

In this part, we propose an integration of the VMI processes with the usual internal planning processes of the supply chain actors.

4.1 MRPII processes

In this study we refer to the Manufacturing Resource Planning (MRPII) to illustrate the implementation of the VMI into the actor's planning processes.

The Sales and Operations Planning (SOP) Process: details the various decisions, which are taken throughout the long term planning. Its most important outputs are the production capacities (production

SOP) and long term forecast of supplying requirement (supply SOP) (see Figure 3). This model includes the forecast calculation, the interpretation behaviours the decision-maker exhibits when examining the forecasts received from his customers, the transmission behaviours when a decision-maker sends his forecasts to his supplier. If no demand transmission is forecast, the SOP process computes its forecasts internally. According to the demand forecasts, the workload can be computed and smoothed over several time periods. The resulting workload defines a capacity plan that must be validated by the SOP management.

The Master Production Scheduling (MPS) process computes the estimated production release of final products. Then the *Material Requirement Plan (MRP)* computes, the raw materials demand (push strategy) to send to the suppliers, or objective stock levels (pull strategy). As in the SOP process, the demand forecasts are updated either internally or aggregated from the demand forecast information received from the customers.

In terms of short term processes, i.e. Execution and Control Operations , we differentiate, two levels: *the Short Term Planning (STP) and the Launching Inventory Management (L&IM)* processes both detail the various short term decisions. The *Short Term Planning* process takes into account the actor's own constraints (*i.e.* breakdowns…), the calculation of the possible production release and, in case of a pull strategy, the demand to send to the suppliers.

The *Launching & Inventory Management* process is responsible for taking into account the other actors' constraints (*i.e.* insufficient delivery…), the products inventories update, the calculation of the real production release, and finally the calculation of the quantities to be delivered to each customer.

These four planning processes are considered according to two points of view: internal (production), to express one's own production decisions, and external (supply or dispatch), to express the material requirement to the supplier or the delivery decisions. The Figure 3 illustrates this model.

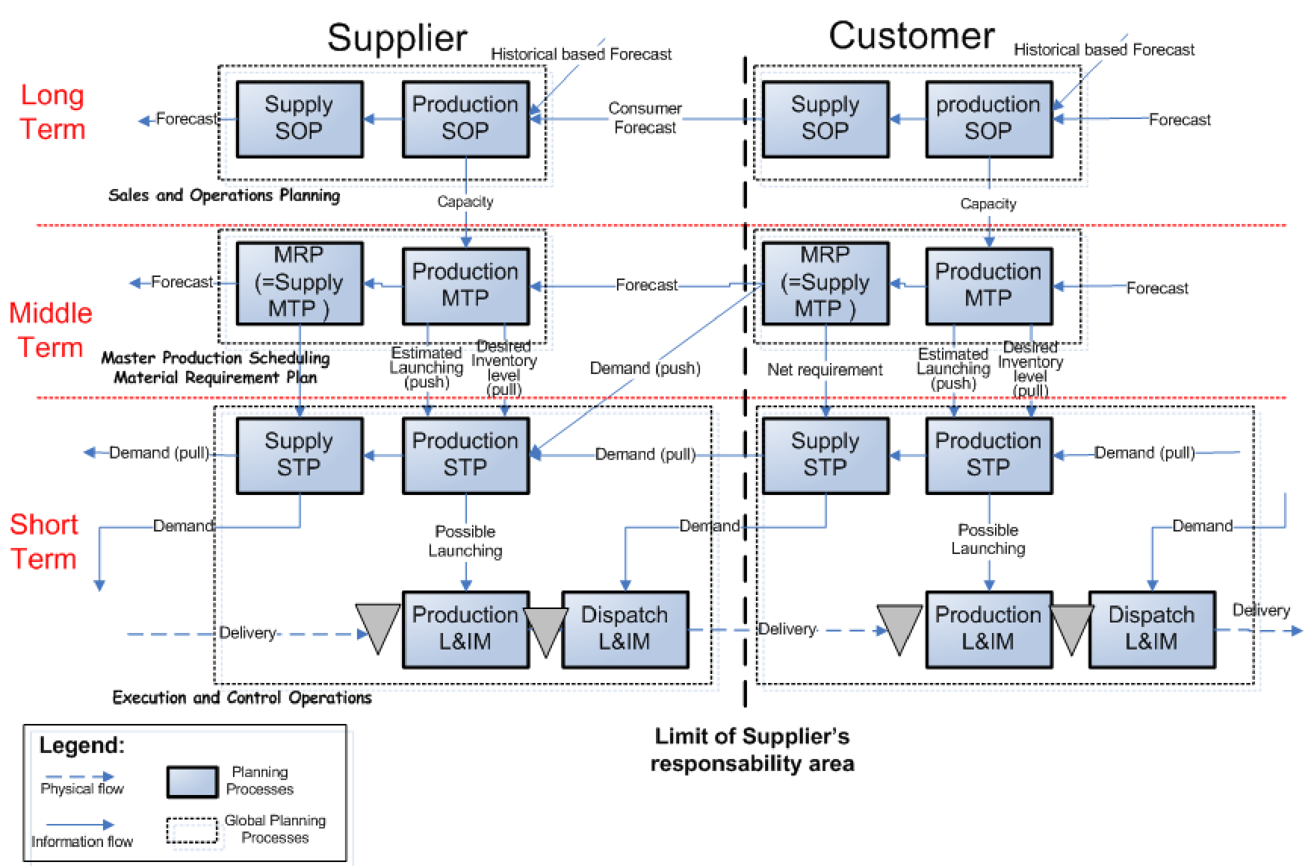

Figure 3: The generic representation of the supply chain actor's processes

4.2 VMI processes

4.2.1 Production and Dispatch processes

The difference between the two ways we have identified to implement the VMI (Integrated and Dispatch VMI) relies on the propagation of the demand uncertainty in the supply chain.

First, the supplier inherits of the short term decisions of the customer short term supply decision. Therefore, the customer's STP Supply process is replaced by a Supplier's STP Dispatch process (see **Figure 4**).

The two short term implementations of VMI differ on the propagation of the demand uncertainty through the supply chain. Without VMI, the customer demand is a fixed real quantity. With VMI, the customer gross requirements. The supplier monitors replenishment of customer's inventory thanks to the level of this inventory and the minimum and maximum level established. Finally, the STP dispatch process computes the net requirement expressed as an interval between a minimal ($\underline{D}_A^C$) and a maximal ($\overline{D}_A^C$) for each customer C.

With the Integrated VMI, the uncertainty is transmitted all over the chain, first in the STP dispatch process then in the STP replenishment process. The output of the supplier's STP dispatch process is the union of these intervals: $\left[\underline{D}_A;\overline{D}_A\right]=\bigcup_C\left[\underline{D}_A^C;\overline{D}_A^C\right]$. A global replenishment choice is made inside the STP production by the supplier. Thanks to this decision, the input of the Production L&IM process remains a scalar desired production. It is not affected by the VMI.

With the Dispatch-VMI, the impact is less severe in terms of modifications. The choice is made inside the STP dispatch process. The interval is transformed in a scalar at this time independently of the production constraints. No uncertainty is transmitted to other processes.

VMI also impacts the L&IM dispatch process. However, the quantity of finished products in the supplier's inventory and the decisions previously taken in production limit the possibilities in terms of dispatching.

In terms of deliveries, what is available (what was made) is compared to what was required. When the production is inferior to the net requirement, a solution is to dispatch the production according to the particular weight of each customer. With VMI, the demand is an interval, [$\underline{D}_A^C$; $\overline{D}_A^C$]. So the value of what is dispatched belongs to the interval [$\underline{DL}_A^C$; $\overline{DL}_A^C$]. Then the supplier has to adopt a VMI behaviour inside the defined interval.

On the other hand, the L&IM dispatch is affected by the Dispatch VMI just like in the Integrated-VMI. This is due to the fact that the process takes into account the customer's requirements in order to make the decision and the requirements are expressed in terms of interval.

In a nutshell, the transition between the two versions of VMI takes place in the STP dispatch process of the supplier. Either this process is neutral, it transmits the uncertainty to the STP production, or it makes a decision inside the interval and transmits a scalar (**Figure 4**).

4.2.2 Logistical Agreement (LA)

The LA is particular to one article. There are as many LA as there are articles in VMI context. It is part of the middle/long term decision-making processes. Both supplier and customer transmit their own constraints. On the one hand, the customer has to insure a minimum consumer service level and wants to minimize inventories holding costs according to its own Master Production Schedule (MPS). On the other hand, the supplier has constraints in terms of MPS, production lead time and transport possibilities (lead time, frequency, lot size…). They have to mutually agree on objectives and constraints of the short term replenishment and dispatch decision-making. Finally, they fix minimum and maximum customer inventory level and transport characteristics for a pre-determined period.

Both supplier and customer can have different planning processes frequencies. Ideally, their MPS processes are perfectly synchronized. So, it is possible to keep the MPS frequency to realize the LA.

However, in many industrial contexts, production and product constraints create a gap between supplier's and customer's horizons. In this case, they have to determine a particular frequency for the LA.

Another important choice concerns the expression of the targeted minimum and maximum customer's inventory levels. In the literature, we find two different situations: this target is expressed in pieces or in days of stock. The choice is made according to the global industrial context and the product characteristics (demand visibility, variability, nature of the product…)

Most of the authors agree on the mutual character of the agreement. Yet, it could be possible to find authors who describe agreement led by the customer.

The actors have to organize a shared and common plan which will be used to parameter the customer's inventory min/max level. This common plan is built around exchanges between the partners. The customer expresses its components requirement plan. The supplier gives a delivery plan. Each actor includes its constraints in this plan. Two situations must be distinguished:

- either, one of the actors, usually the customer, dominates the partnership. In this case, he imposes its constraints. As a consequence, minimum and maximum are the direct expression of these constraints. For example, Disney and Towill (2002a) explain that the customer calculates the re-order point then passes it to the supplier.
- Or, in the well-balanced partnership case, the negotiation is defined by an exchange of point of views. It is true collaboration in terms of plan building. Dudek and Standtler (2006) propose an exchanges process helping to the convergence of the point of views of each actor.

4.2.3 Partnering Agreement (PA)

With VMI, the supplier has a vision of the customer's inventory, so that the supplier's tactical decisions in terms of planned production or planned inventory can be affected. The exchanges between partners have to be adapted. According to this, the PA defines the whole collaboration process. It synchronizes the VMI process with planning and scheduling processes of each partner. When modeling the relationship, many unknowns remain in terms of link's specifications. The links are created, but we have to clearly define them. The following Table 1 summarizes the different questions that have to be answered in order to integrate the VMI process inside a given collaboration process.

Link	Associated question(s) / choice(s)
Type of VMI	- Dispatch VMI or Integrated VMI?
Periodicity of the LA	- Which horizon? - Which period of validity of the parameters defined by the LA?
Gross requirement expression	Are the supplier's and customer's planning process synchronized? And so where are the shared gross requirement defined?
Shared Forecast	- What is shared? - On which horizon? - When? (period)
Min/Max customer's inventory level	How is it expressed: in pieces, in days?
Stock information	- How is it expressed: in levels, in consumption? - Periodicity: real time, hour, day, week…
Agreed minimal Transport characteristic	What is defined: minimal lot size, minimal delivery frequency?

Table 1: Examples of link specifications at the partnering processes

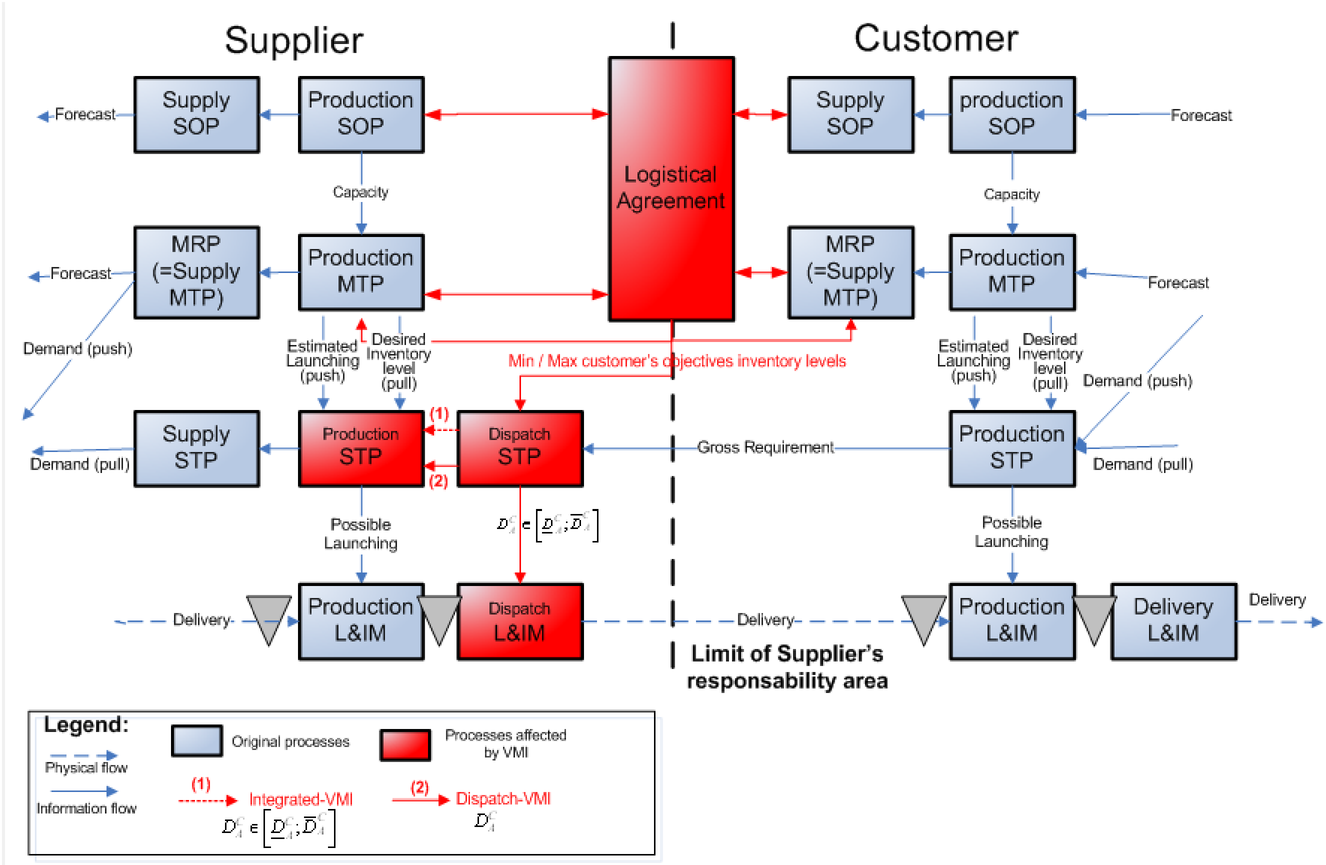

Figure 4: Implementation of VMI in the actors' planning processes

5 Conclusions and future researches

Our study began with the widespread assumption that we knew what VMI was, or at least that the VMI was perfectly described in the literature. According to this certainty, the initial target was to implement and then simulate VMI in a simulation tool called LogiRisk. However, if there was no doubt about the real implementation of VMI in industry, it appears that a consensus about a global definition is missing. What clearly is VMI and how can it be concretely implemented in the supply chain is not obvious. It is not clear if VMI is a model, a process, a strategy, a relationship, a link…

As a consequence, first of all we have identified all the concepts which surround VMI through the literature. Thus, the first part allowed the objectives and the considered decision levers to be presented. This enables to propose an unified view of the process of VMI and its implementation inside actors' planning processes. We emphasize the degrees of freedom obtained by the supplier. According to the expression of these degrees of freedom, we distinguish two types of VMI: the Dispatch-VMI, only centered on the deliveries decision and the Integrated-VMI, integrating both production and deliveries decision.

The Vendor Managed Inventory (VMI) belongs to these collaboration policies which are today currently implemented in the industry. To define a collaboration policy, managers have to integrate different sources of uncertainties: evolution of the context or market, partners' local behaviors, exchange processes,… Therefore, we plan to use the decision tool exposed by Mahmoudi (2006) for the simulation of collaboration policies (LogiRisk) to analyze the VMI implementation effect. In this tool, a collaboration policy is the gathering of:

- a collaboration protocol, VMI for example, that defines the decisional processes between the partners;
- the union of the decisional behaviors of the partners during their decisional activities. In a future upgrade, we will thus adapt the LogiRisk prototype to implement the VMI collaboration policy.

Therefore, the next step of this study is to implement VMI into concerned algorithms (STP production, L&IM dispatch) and to create the Logistical Agreement. According to this, it could be interesting to adapt the cooperative planning of Dudek and Stadler (2006), but also to explore other solutions. The final objective is to simulate the VMI choice in a supply chain and to compare its effects with traditional collaboration policies. It could allow us to understand the positive and negative impacts of the VMI and to identify favorable contexts.

6 References

Achabal D., Mcintyre S., Smith S. and Kalyanam K., 2000. A Decision Support System for Vendor Managed Inventory. Journal of Retailing, 76 (4), p. 430-454.

Blatherwick A., 1998. Vendor Managed Inventory fashion fad important supply chain strategy. Supply Chain An International Journal, 3(1), p.10-11.

Cetinkaya S. and Lee C., 2000. Stock Replenishment and Shipment Scheduling for Vendor Managed Inventory Systems. Management Science, 46 (2), p. 217-232.

De Toni A. and Zamolo E., 2005. From a traditional replenishment system to vendor managed inventory: a case study from the household electrical appliances sector. International Journal of Production Economics, 96, p. 63-79.

Disney S.M., Towill D.R., 2002a. A procedure for the optimization of dynamic response of Vendor Managed Inventory system. Computers and Industrial Engineering, 43, p. 27-58.

Disney S.M., Towill D.R., 2002b. A discrete transfer function model to determine the dynamic stability of vendor managed inventory supply chain. International Journal of Production Research, 40, p. 179-204.

Disney S.M., Towill D.R., 2003. The effect of vendor managed inventory (VMI) dynamics on the Bullwhip Effect in supply chains. International Journal of Production Economics, 85 (2), p. 199-215.

Disney S.M., Naim M.M. and Potter A., 2002. Assessing the impact of e-business on supply chain dynamics. International Journal of Production Economics, 89 (2), p. 109-118.

Dong Y. and Xu K., 2002. A supply chain model of vendor managed inventory. Transportation research Part E, 38, p. 75-95.

Dong Y., Xu K. and Dresner M., 2007. Environmental determinants of VMI adoption: An exploratory analysis. Transportation research Part E, 43, p. 355-369.

Dudek G. and Stadtler H., 2005. Negociation based collaborative planning between supply chains partners. European Journal of Operational Research, 163, p. 668-687.

Gentine P., 2002. La gestion partagée des approvisionnements peut-elle être créatrice de valeur ? Accenture.

Gröning A. and Holma H., 2007. Vendor Managed Inventory, preparation for an implementation of a pilot project guidance for an upcoming evaluation at Volvo. Master's thesis. Lulea University of technology.

Hennington E. and Linden T., 2005. Vendor Managed Inventory, enlightening benefits and negative effects of VMI for Ikea and its supplier. Master's thesis. Lulea University of technology.

Holmström J., 1998. Business process innovation in the supply chain – a case study of implementing vendor managed inventory. European Journal of Purchasing & Supply Management, 7, p. 127-131.

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

Ireland R. K. and Crum C., 2005. Supply chain collaboration, how to implement CPFR and other best collaborative practices. J. Ross publishing and APICS. 206 pages.

Kaipia R. and Tanskanen K., 2003. Vendor managed category management – an outsourcing solution in retailing. Journal of Purchasing & Supply Management, 9, 165-175.

Kuk G., 2004. Effectiveness of vendor managed inventory in the electronics industry: determinants and outcomes. Information & Management, 41, p. 645-654.

Lamothe J., Mahmoudi J., Thierry C., Cooperation to reduce risk in a telecom supply chain, special issue Managing Supply Chain Risk. Supply Chain Forum: An International Journal. To appear vol 8-2 2007.

Mahmoudi J., 2006. Simulation et gestion des risques en planification distribuée de chaînes logistiques : application au secteur de l'électronique et des télécommunications. PhD.

Mishra B. and Raghunathan S., 2004. Retailer- vs. Vendor Managed Inventory and Brand Competition. Management Science, 50 (4), p. 445-457.

Nachiappan S.P. and Jawahar N., 2007. A genetic algorithm for optimal operating parameters of VMI system in a two echelon supply chain. European Journal of Operational Research, 182, p. 1433-1452.

Nachiappan S.P., Gunasekaran A. and Jawahar N., 2007. Knowledge management system for operating parameters in two echelon VMI supply chain. International Journal of Production Research, 45 (11), p. 2479-2505.

ODETTE, 2004. Vendor Managed Inventory (VMI) (version 1.0).

Rusdiansyah A. and Tsao D., 2005. Coordinating Deliveries and Inventories for Supply Chain under Vendor Managed Inventory System. JSME International Journal, 48 (2), p. 85-90.

Smaros J., Lethonen JM., Appelqvist P. and Holmstrom J., 2003. The impact increasing demand visibility production inventory control efficiency. International Journal of physical distribution and Logistics management, 33(4), 336-354.

Tang C., 2006. Perspectives in supply chain risk management. International Journal of Production Economics, 103, p. 451-488.

Tyan J. and Wee H., 2002. Vendor managed inventory: a survey of the Taiwanese grocery industry. Journal of Purchasing & Supply Management, 9(1), p.11-18.

Yao Y. and Dresner M., 2007. *The inventory value of information sharing, continuous replenishment, and vendor-managed inventory*. Transportation Research Part E: Logistics and Transportation Review, In Press, Corrected Proof, Available online 9 April 2007.

Yao Y., Evers P. and Dresner M., 2007. Supply chain integration in vendor-managed inventory. Decision Support Systems, 43 (2), p. 663-674.

Wilson M., 2007. The impact of transportation disruptions on supply chain performance. Transportation research Part E, 43, p. 295-320.

Appendix A: Utilization rate of expressions to qualify VMI in the Literature

	Papers / Words used to introduce VMI	Gröning and Holma (2007)	De Toni and Zamolo (2005)	Tyan and Wee (2002)	Kaipia et al (2002)	Holmström (1998)	Henningsson and Linden (2005)	Dong et al (2007)	Kuk (2004)	Odette (2004)	Holweg et al (2005)	Kaipia and Tanskanen (2003)	Tang (2008)	Blatherwick (1998)	Smaros et al (2003)	Disney and Towill (2003)	Dong et al (2007)	Yao and Dresner (2007)	Disneyand Towill (2002a)	Disney et al (2002))	Nachiappan et al (2007)	Nachiappan et al (2007)	Yao and Dresner (2007)	Wilson (2007)	Rusdiansyah and Tsao (2005)	Achabal et al (2000)	Disney andTowill (2002b)	Mishra and Raghunathan (2004)	Cetinkaya and Lee (2000)
Concept	system	27%		47%	23%	8%		9%		5%	14%		9%			38%	12%	27%	61%		14%	9%	50%	25%	80%	94%	86%	67%	86%
Concept	program	7%		32%			1%	41%	31%						40%		63%	27%					20%						
Concept	supply chain structure															6%								67%					
Concept	concept						1%		6%	25%	43%	25%		33%	10%		2%		4%										
Concept	initiative	7%						6%	25%		29%		82%					27%					30%						
Concept	Sheme			3%									9%												7%				
Concept	approach		8%		8%					5%	14%				20%														
Concept	method		8%							10%																			
Process	process		31%		23%	31%	1%	9%		50%		13%																	
Process	model		15%		8%					5%		25%			10%	6%					7%	18%		8%	13%				
Process	scenario															19%			25%	38%									
Process	strategy			5%			6%	3%						67%		19%	7%		4%	38%	7%						14%		
Process	replenishment practice	13%	15%	3%	23%	15%									10%														
Cooperation	partnership	33%		11%		23%	90%	13%	6%			38%				13%	14%		4%	13%								33%	
Cooperation	Arrangement							3%	13%								2%												
Cooperation	Agreement														10%											3%			
Cooperation	collaboration	7%																7%											
Cooperative process	mode of operations																				71%								
Cooperative process	mode of coordination							3%										7%				73%				3%			14%
Cooperative process	protocol																			13%									
Technology	tool								6%																				
Technology	technology	7%						13%	13%																				
Technology	solution				15%	23%																							
Technology	technique		23%																										
	Number of citations	15	13	38	13	13	81	32	16	20	7	8	11	3	10	16	43	15	23	8	14	11	10	24	15	36	7	3	7
	Number of words used	7	6	6	6	5	5	9	7	6	4	4	3	2	6	6	6	5	5	4	4	3	3	3	3	3	2	2	2
	Average	4,5																											