Vendor-Managed Inventory as a Knowledge-intensive Service in Procurement Logistics in the Automotive Industry

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The delivery concept Vendor-Managed-Inventory (VMI) is a good example of a service requiring close cooperation and sharing of information between customer and supplier. Originating in the retail goods industry, VMI is nowadays also being used in other industries, e. g. automotive. In large-scale application, VMI is not feasible without IT support, but also certain features of the product, the supplier and the relationship between supplier and customer need to be fulfilled in order for VMI to be suitable. In this paper, we present a model to help companies decide whether VMI is suitable in a given context and to identify the information that needs to be shared. The model is being explained and its use is demonstrated using Blaupunkt as an example from the automotive industry.

Keywords: procurement logistics, EDI, vendor-managed-inventory, VMI, e-Kanban

1 Introduction

In 1988 the UN published its first global standard for electronic data interchange [UN/EDIFACT 2007]. Since then the field of logistics has been exposed to continuous changes. On one hand, the Toyota production system has become a paradigm for the automotive industry, replacing existing push-based systems with pull-based systems with a strong focus on stock reductions. This resulted in a demand for additional and partially different data to be shared between members of the supply chain. On the other hand, suppliers were pressured to offer better and more logistic services. Additionally, a lot of research has been done on the bull-whip effect, revealing that a poor flow of information is one of the causes that lead to unnecessarily increasing stocks [Lee et al. 1997]. A key to extended services lies in additional information flows from the customer to the supplier in order to enable the supplier to take over processes that were previously performed by the customer. Due to large volumes of data and often vast geographical distances in complex supply chains, IT takes the role as an enabler.

Sections 2 and 3 will give some detail about commonly used delivery concepts in industrial logistics and possible IT-based implementations. Section 4 will relate criteria of products/suppliers and delivery concepts to IT implementations. We use decision tables to provide recommendations for selection of a delivery concept and required data based on given characteristics of products and suppliers. Section 5 demonstrates (with an example) how the decision tables are practically used in a real business context at our industrial partner Blaupunkt GmbH (Bosch group). The conclusion in section 6 summarizes the paper.

2 Delivery Concepts

2.1 Delivery Schedule

Delivery schedules are widely used in the automotive industry to satisfy recurring demands for certain products. An outline agreement is signed by supplier and customer to define prices, estimated quantities and terms and conditions. After that, delivery schedules with our without demand forecasts can be sent to the supplier (via EDI, e-mail, fax …) instead of issuing purchase orders and invoices. The demand levels are usually directly taken from ERP systems.

2.2 VMI

Vendor-Managed-Inventory is a concept that is fundamentally based on the cooperation of supplier and customer regarding inventory management and the connected delivery concept. Basically, the supplier takes over the inventory management as an additional service while taking into account mutual agreements concerning the minimum and maximum stock levels. In order to manage the stock, required information and rights are given to the supplier. Because of the cooperative nature VMI can be assigned to the so-called Efficient Replenishment [Benkherouf & Mahmoud 1996], again being a component of the strategic concept Efficient Customer Response (ECR) and Collaborative Planning Forecasting and Replenishment (CPFR) respectively [Seifert 2004]. CPFR builds upon ECR and intersectoral initiatives that improve the supplier-customer relationship by mutual planning processes and shared information [Seifert 2004]. Both these concepts and VMI were developed in the retail and consumer goods industry. VMI was first used by Wal-Mart and its supplier Proctor & Gamble in the US at the end of the 80s. Soon this concept was also applied successfully in Europe [Waller et al. 1999]. The automotive industry started to use VMI in the mid 90s [Hammer & Champy 1996]. Since responsibility for inventory management is being shifted from the subsequent tier to the previous one, a greater transparency of the supply chain, reduced stock levels and administrative expenses are expected for both companies.

Of course it is still advisable that stock levels are also monitored by the customer while the actual management is performed exclusively by the supplier. For VMI it is irrelevant if stocks are owned by the customer or not (consignment), because regardless of the ownership, the stock levels have to be revealed to the supplier. In retail branches like supermarkets VMI can be implemented relatively easily with shelves and racks defining min. and max. inventory stocks [Baudin 2004]. For a manufacturing company raw material stocks cannot be visualised as easily. Additionally, fixed values for min. and max. stock levels might not be suitable because of changing production schedules and fluctuating demands. Dynamic min./max. levels can solve these problems and help to replenish only the amount of material needed. Demand forecast data should be shared with the supplier for more precise planning, meaning that the customer has to indirectly share the knowledge about own orders received as well as the production schedule.

2.3 Kanban

The Kanban principle, which was developed by Taiichi Ohno for the Toyota Corporation, is now a worldwide known method to implement Just-in-time (JIT) deliveries [Ohno 1988]. Using Kanban, every tier in a value chain only produces or provides just as much as is needed for the next tier in a defined period of time [Spearman 1992]. I.e., the push principle was replaced by the pull principle. A Kanban (jap. = card/container) can be used as a signal to control the production, leading to minimised use of resources and consequent elimination of waste [Takeda 2006]. The Kanban itself contains all the information necessary for an order. Usually these are paper cards attached to the container of the respective part [Ohno 1988]. Initially Kanban was used only for internal production control. However, in the context of supply chain management it can be a great benefit to extend the use of Kanban beyond the company's borders in order to reduce stock or even eliminate whole warehouses. The information stored on Kanbans can also be transmitted electronically via EDI (so called e-Kanban).

Without a doubt, Kanban has the highest potential for stock reductions and also cost reduction. But there are restrictions for the usage of Kanban with suppliers (see section 4.1).

3 Implementations of the Concepts Using IT

3.1 Classical EDI

EDI is a possibility for intercorporate communications where business and technical data can be exchanged via electronic transmissions [Seifert 2004, Hansen & Hill 1989]. Especially for data with high volumes and frequent transmissions it is advisable to use EDI [Massetti & Zmud 1996]. In order to set up EDI, the two business partners need to agree on a data format and to link their systems accordingly [Hill & Ferguson]. The connection itself can be implemented via a point-to-point method where servers are communication using a protocol (e.g. OFTP) or via a clearing system. Important advantages of EDI are time savings and elimination of error-prone manual data input compared to paper-based solutions like FAX [UN/EDIFACT 2007]. Furthermore EDI is a prerequisite for concepts like VMI in many industries (cf. section 2.2). For small and medium-sized companies EDI might be associated with relatively high total cost of ownership (TCO) because of the need for trained EDI specialists and specific hard- and software [Massetti & Zmud 1996]. The necessary data conversions between in-house formats and standard formats like EDIFACT or VDA are an additional challenge. Not surprisingly, these services are likely to be outsourced especially by smaller companies.

3.2 Message Types

In this paper, we focus on the use of EDIFACT standard formats because of their global and industry-independent usage. The current UN/EDIFACT directory covers about 200 different syntax-based message types. They consist of a character set (ISO 7372) and a syntax (ISO 9735) [Joint Syntax Working Group 2007]. Structures and descriptions can be obtained at the web sites of UNECE (United Nations Economic Commission for Europe) [CEFACT]. EDIFACT messages carry a six capital letter abbreviation as title (e.g. DELFOR = delivery forecast). Messages have roughly the same content as their related paper version (c.f. the UN/EDIFACT directory for further details about the messages used in following chapters [CEFACT]).

3.3 Alternatives

Since they were directly derived from paper forms, classical EDI messages are not intentionally designed to support new processes like VMI. Therefore the current standards might only provide limited usability in such scenarios. An even stronger argument against classical EDI is that it is hardly used by small and medium-sized companies [v. Westarp et al. 1999]. Serious effort is made by organizations like UN/CEFACT with OASIS or ROSETTANET to replace the current standards with XML based formats [Oasis 2006, Rosettanet 2007. Advantages of XML are better readability and usability especially in internet related applications. Still, XML has not yet become very successful as replacement for EDI yet, because there is no globally established semantic XML standard currently available.

WebEDI understood as a visualization of EDI messages in a web front end is very useful for small companies that want to fulfil their customers' request for EDI transmissions. However, if that company uses an ERP-system, this will lead to additional workload due to duplicated processes in both EDI-web front end and ERP system. Overall, the usability of WebEDI is limited, but it can be attractive to integrate WebEDI functionality into a B2B portal that also supports preceding processes like sourcing or performance measurement (e. g. on-time-delivery ratings as part of Supplier Relationship Management).

4 Decision Model

As outlined, improved coordination and communication along supply chains is an important business goal nowadays. Among others, this can lead to reduced procurement logistics costs. Several delivery concepts can be used to attain these cost savings, with Kanban being the most promising one. Additionally, there are several possible IT implementations for these concepts, leading to a large total number of options. Unfortunately, the decision for one of these options depends of a number of factors, as we will demonstrate in this section. To support the decision-making process, we have developed a decision model [Cardenas 1977, Kubicek 1975] using the well-known concept of decision tables [Humby 1973].

In the primary decision table, the most suitable delivery concept is selected. In this step, only the logistic problem regardless of the flow of information is considered. In the secondary decision tables, the delivery principle is the basic condition, leading to possible actions for the design of the information flows. The complete model provides several variations of information flow designs for each delivery concept. Due to space constraints, the description of model is limited to the applicability check for VMI and the selection of a variation for the information flow design in this paper.

4.1 Basic Conditions

First of all, an analysis is necessary, which conditions for the information flow design and the choice of delivery concept exist and are relevant. Furthermore, the conditions need to be analysed with regard to whether they can be influenced or not. The following categories of features exist for the conditions:

- features of the supplied product
- features of the supplier
- features of supplier AND the product.

One result of these categories of features is that different products with different features will lead to different recommendations even if these products are

Features of the Supplied Product	
ABC and XYZ Analysis	A common method in material management is the ABC / XYZ analysis which classifies products according to their value percentage and characteristic consumption (e. g. A products with high value and X products with constant consumption). We will also use this method to test for process improvements.[Hansen & Hill 1989; Flores & Whybark 1986] Therefore, concepts with stock reduction purposes will primarily target A parts while the XYZ analysis indicates possible restrictions because it can be difficult or impossible to reduce stock levels for products with fluctuating demand (see figure 1). Taking this into account, VMI can be seen as a compromise between JIT concepts like Kanban without any stocks and the classical delivery schedule with stocks.
Series Production, Direct Demand	Another characteristic is the reason for the demand. In case of recurrent demands (direct demands) the consumption of the part is predictable. On the contrary we have the more or less unpredictable consumption for MRO products (Maintenance, Repair, Operations) [Life Cycle Engineering 2007]. If consumption is unpredictable, a demand forecast – which is highly recommended for VMI – is impossible.
Life Cycle Phase	The phase of a product in its life cycle is also influences the demand significantly. A product being phased in or out is difficult to classify according to XYZ. However, in those cases, VMI can be still applicable using dynamic min. / max. levels.

Table 1a: Basic Conditions – Features of the Supplied Product

Table 1b: Basic Conditions – Features of the Supplier

Features of the Supplier	
Since a supply chain does not only consist of one actor, we also need to cover the characteristics of the supplier. A good point to start with is the sourcing-toolbox (figure 2) which describes a sourcing strategy by choosing the partial strategies L, O, A, Z, S and W. [Arnold 1997] It is quite possible that a manufacturer only has a sole supplier. We are not including this case because in that case a very specific and individual solution for the flow of information would be the best solution.	
Transportation Time	The geographical distance in categories local, domestic and global affects the design of information flow only indirectly. The transportation time is a better indicator because it shows the possibility of JIT and importance of ASN (advanced shipping notes). In real life, the transportation time will mostly depend on the geographical distance unless fast transport like airfreight is used. The decision table will use the categories short, medium, long for the transportation time. In case of long transportation times it might be good to convert the estimated time of arrival (ETA) at the customer plant for the delivery schedules into the estimated time of departure (ETD) at the supplier's plant. This will make it easier for the supplier to deliver on time. Normally only the shipping agent (third party logistics provider) will be able to do this conversion because he possesses the most precise information about his own schedules. Therefore he needs to be included as a third party for providing this service when exchanging delivery schedules and advanced shipping notices.
Intensity of Collaboration	The extent of cooperation between two business partners is difficult to measure. Thus, just a simple differentiation into either a close or minor collaboration is made. In a minor cooperation where business relations might be stopped at any time it will be harder to establish the sharing of knowledge and information in a VMI process.
EDI Availability/Support of Gross Demand Data in ERP System	Concerning the choice of technology for the data exchange it must be tested if both sides can support EDI. In the positive case the exchanged format needs to be agreed before the connection can be set up. XML and WebEDI are the alternatives if a classical EDI solution is not available. Even though an EDI connection can be established the whole process might fail when the data cannot be processed correctly. For example, many ERP systems that are currently in use do not support the processing of gross demand data that is needed for VMI.

provided by the same supplier. Implementing different delivery concepts for use with the same supplier is in many cases not cost-effective, therefore in that case one concept should be implemented for all products provided by the same supplier.

4.2 Possibilities for Changes of the Initial Situation

The defined basic conditions help to describe the initial situation. Once this is done, an analysis, which of the conditions can be altered in order to reach an improved position, needs to be performed.

Again the sourcing strategy is our starting point because it determines the supplier selection. It would be possible to choose a supplier that is most suitable for a smooth information flow. However, price, quality, delivery performance and upkeep of autonomy will be the main factors influencing the selection [Swamidass 1993]. Although the information flow has a more supporting role it should definitely be considered for the strategic supplier selection as a potential cost saving criterion and performance boost. Basically the partial strategies of the sourcing tool box can be seen as fixed parameters. Partial strategy Z is an exception because the supply time is directly connected with the delivery concept.

4.3 Actions and Impacts

4.3.1 Decision Tables

As already mentioned, the decision tables will be used in two steps. The primary table is used to determine if VMI is suitable, the secondary to define the appropriate information flow variation for VMI. Due to space constraints, the use of the model for delivery schedule, JIT and purchase orders will not be described here.

Table 1c: Basic Conditions – Features of Products and Suppliers

Features of Supplier and Product	
Quality Risks	Quality risks will automatically lead to increased stock levels be-cause a safety stock has to be built up in order to stabilize the mate-rial flow. Additionally, cycle times will be longer due to quality inspections. In case of high quality risks, there will be very little potential for stock reductions. Interrelated with these risks is the dual and multiple-sourcing strat-egy for a product. Specific custom parts can only be purchased economically from a single supplier. The same is of course true for a monopoly supplier. Reasons for dual and multiple-sourcing are increased independency and minimization of supply shortfalls and risks. Contradicting reasons can be found in the literature where supply shortfalls are more seen as a problem for multiple sourcing because the cooperation will be weaker hence quality inspections will slow down the supplies[25]. Finally, this will always be a very product and supplier specific decision that cannot be incorporated as a sourcing feature for this model. But multiple-sourcing will gener-ally make overall logistics more complicated, also complicating the design of information flow[25]. If an identical product is sourced from suppliers with different characteristics, the decision table might recommend different designs. The whole VMI process itself will also be affected because several suppliers will manage the inventory together. Any rule violations will affect the others suppli-ers' planning. Therefore the rules must be followed strictly and be monitored by the customer.

In the VMI table (Table 3), each column represents one variation (numbered V1 to V30). There are intersections of the combination possibilities of the characteristics (so called rules) that are essential in order to cover all combinations completely. Rules can be consolidated when the resulting variant is the same. In that case the concerning rule will be indicated with the prevarication symbol "–" [Humby 1973]. This is done to improve the overview, otherwise the VMI table would need to display 26 * 32 = 576 variations.

4.3.2 Design of Information Flows for VMI

The main characteristic of VMI is the additional service provided by the supplier. In order to be able to manage the inventory, the current stock level must be known. Without VMI the current stock data is only given to consignment suppliers, because they have the right to know about the parts since they still own them. The inventory report (INVRPT) usually needed for consignment stocks can easily be used for VMI. This message might already be sent to the supplier. The stock with its agreed min./max. and/or signal limits trigger the stock level alerts. Alerts can provide important information when the stock reaches a too high, too low or even critical level. No standard EDI message is known for this kind of information, so any system or VMI tool that monitors the level should send out warning e-mails. If forecast data is available, it should be shared with the supplier as well. This will enable the supplier to plan more precisely and adjust his own production, especially for parts with a fluctuating demand. Unlike the forecast in classical delivery schedules, the data will not show dates with their predicted delivery but instead the predicted demand of goods taken from the warehouse into production. Because these demands are directly based on the production schedule, they show more detailed data compared to the predicted deliveries. For that reason we distinguish between net demand (delivery schedule) and gross demand (VMI). Based on this data the supplier will calculate his own delivery schedule which might be advantageous compared to schedule deter-

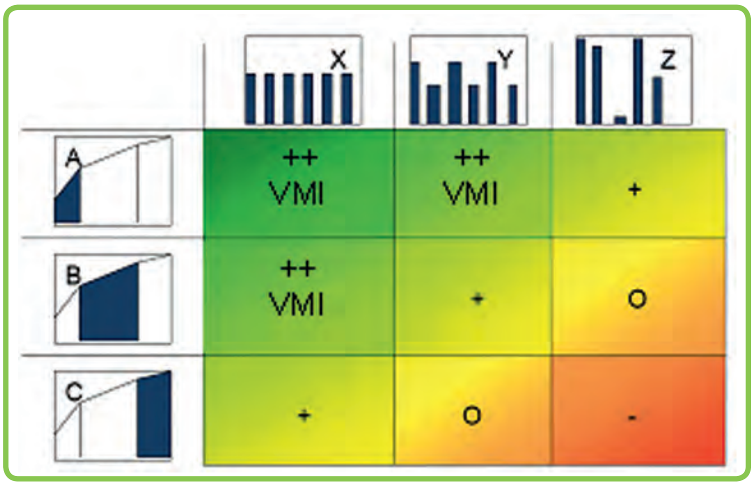

Figure 1: ABC/XYZ-Analysis Including Applicability of VMI [Bosch (a) 2006]

Figure 2:
Sourcing Tool Box
[Arnold 1997]

supplier (L)	sole	single	dual	multiple
object (O)	unit	modular	system	
area (A)	local	domestic	global	
frequency (Z)	stock	demand tailored	just-in-time	
subject (S)	individual		cooperative	
location (W)	external		internal	

mined by the customer. Simulated alerts can indicate upcoming critical stock levels. Being different but still related, the message delivery forecast (DELFOR) can also be used to send gross demands. Fields for min./max. levels are not supported in DELFOR. These values need either to be locally defined in each company's system or centrally administrated in a VMI tool that is accessible to both parties. A web interface can support this functionality. If such a VMI tool is used, it is necessary to key in or transmit the planned deliveries and deliveries in transit. Otherwise the simulation and alerts will not work correctly. The order response (ORDRSP) can be used to avoid manual input of planned deliveries when the supplier is using his own ERP system (cf. variations V1 – V12 in Table 3). For suppliers using an ERP system without gross demand capability, planning can be done in the tool and a standard DELFOR can be generated and send to the supplier's system. A despatch advice (DESADV) is used to exchange information about deliveries in transit. After receiving the goods successfully, the customer should issue this notification in order to close the shipment and increase the stock levels. ASN alerts can also be used to indicate overdue shipments or deviations. Alerts should also be used for performance measurement purposes because a standard OTD measurement cannot be used any more due to the lack of a customer generated delivery schedule.

5 Usage of the Model at Blaupunkt GmbH

5.1 Company Profile and Initial State

Blaupunkt GmbH is a wholly-owned subsidiary of the Bosch group with approximately 9000 employees working at sites in Germany, Portugal, Malaysia, Tunesia, Hungary and China. Blaupunkt is Europe's biggest supplier for car radios [Bosch (b)]. Therefore it clearly belongs to the automotive industry. At the same time, it also belongs to the electronics industry, since the product portfolio covers display units, loudspeakers, cockpit electronics and navigation and driver assistance systems. This is important since the electronics industry – especially multimedia electronics – is of great significance in Far Eastern countries like Japan [Harwit 1996]. For that reason many suppliers manufacture their products in Asia, leading to longer transportation times. Just-in-time methods might not be applicable while VMI is a new and attractive way to reduce stocks and offer better services.

Blaupunkt like other Bosch divisions uses a customized SAP R/3 as ERP system. SAP Inventory Collaboration Hub is used as VMI tool and maintained and supported by SupplyOn AG a module in their web-based electronic marketplace. EDI servers for direct connections with suppliers and SupplyOn (one of the leading online marketplaces in the automotive industry) are centrally administrated by a Bosch department.

5.2 Example for Using the Decision Tables

At first the tables have to be adjusted for the company. The usage of the VMI tool is mandatory for suppliers of Bosch when doing VMI. This decision was made to provide a neutral view for all actors in the supply chain. For that reason the recommended action "WebEDI" will be fixed as mandatory. In case of unavailable actions, it is advisable to indicate (e. g. by greying out) instead of removing them from a table. This might give us ideas for future development of our processes and IT systems.

As an example we take a product with direct but fluctuating demands (Y) caused by series production. It is in the stable life cycle phase and weekly deliveries are stored in a consignment warehouse. Currently, the supplier gets a delivery schedule (updated weekly) with a forecast for one year. This data is further used in the supplier's ERP-System which is capable of processing gross demand data. The supplier, with headquarters in Japan and manufacturing in Malaysia maintains a sales office and a warehouse in Germany. The products are shipped from Malaysia to the German sales office from where they are delivered to the Blaupunkt plant in Hildesheim. In the past years there were only minimal quality issues concerning the A and B parts. However there is no close cooperation between the two companies.

When we check these features in the primary decision table, the results are variations A4 or

Conditions	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23
series production	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
direct demand	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	-	N
life phase: phase in, phase out?	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	-	Y	N
high runner / short delivery time?	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N	-	-	-	-	-
high quality risk	N	N	N	-	-	-	-	-	-	-	-	-	Y	Y	Y	-	-	-	-	-	-	-	-
tight collaboration	Y	Y	Y	-	-	Y	-	Y	-	N	N	N	-	-	-	-	-	-	N	N	-	-	-
ABC-analysis	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	C	B	-	-	-
XYZ-analysis	X	X	X	Y	Y	Y	Z	Z	Z	X	X	X	X	X	X	X	X	X	Y	Z	-	-	-
Delivery concept																							
delivery schedule	+	+	+	+	+	++	+	++	++	+	+	+	+	+	+	+	+	+	+	+		++*	++*
VMI	++	+++	+	++	++	+	++	+	+	+++	+++	++	+++	+++	++	+++	+++	++					
KANBAN / JIT	+++	+++	++																				
purchase order																					++	++	++

legend:

-	=	not relevant
Y	=	Yes
N	=	No
A B C	=	see ABC-analysis
X Y Z	=	see XYZ-analysis
+	=	possible
++	=	recommended
+++	=	priority
++*	=	only when having frame contract

Table 2: Decision Table for Delivery Concept

Conditions	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20	V21	V22	V23	V24	V25	V26	V27	V28	V29	V30
Consignment warehouse?	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N
transport time (long/medium/short)?	L	L	M	M	S	S	L	L	M	M	S	S	L	M	S	L	M	S	L	L	M	M	S	S	L	L	M	M	S	S
EDI availablity (classic)	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	-	-	-	-	-	-	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
ERP system with gross demand capability?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	-	-	-	-	-	-	-	-	-	-	-	-
direct demand?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
data to be transmitted																														
inventory	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++
delivery schedule from supplier (ETA)	+	+					+	+					+	++	++	+	++	++												
delivery schedule from supplier (ETD)	+	+					+	+					++			++														
demand forecast (gros)	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++												
advanced shipping notification	++	++	++	++	+	+	++	++	++	++	+	+	++	++	+	++	++	+	++	++	++	++	+	+	++	++	++	++	+	+
receipt advice	++	++	++	++	+	+	++	++	++	++	+	+	++	++	+	++	++	+	+	+	+	+	+	+	+	+	+	+	+	+
invoice / self-bill	++	++	++	++	++	++	+	+	+	+	+	+	++	++	++	+	+	+	++	++	++	++	++	++	+	+	+	+	+	+
planned receipts	++	++	++	++	++	++	++	++	++	++	++	++																		
projected stock alerts	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++												
out-of-stock alerts	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++
signal level alerts																			++	++	++	++	++	++	++	++	++	++	++	++
advanced shipping notification alerts	++	++	++	++	+	+	++	++	++	++	+	+	++	++	+	++	++	+	++	++	++	++	+	+	++	++	+	++	++	+
technology (alternatively)																														
EDI	++		++		++		++		++		++								++		++		++		++		++		++	
WebEDI		++		++		++		++		++		++	++	++	++	++	++	++		++		++		++		++		++		++
XML	++	++	++	++	++	++	++	++	++	++	++	++	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

legend:

-	=	not relevant
Y	=	Yes
N	=	No
L	=	long transport time
M	=	medium transport time
S	=	short transport time
+	=	optional
++	=	requested

Table 3: Decision Table for VMI

A5. That means VMI is the recommended preference. Now the secondary table needs to be used. With a short or medium transportation time the recommended VMI variations are V3 or V5.

6 Conclusion and Outlook

The model presented here simplifies decision-making with regard to delivery concepts for a multi-national company. For specific business set-ups with special prerequisites tables can easily be enhanced by inserting additional conditions or actions.

However, in case of extensive amendments and when the decision is not narrowed down to VMI only, more tables will be needed. As already mentioned in 5.5 decision tables can also help to indicate those cases where the preferred solution is not available and give us hints for potential improvement. It should also be applicable for other manufacturing industries, even though we haven't validated it outside of Blaupunkt. Additionally, the model could also be adapted towards other new IT-based services like VMI that expose procurement logistics to the fast, dynamic and IT-driven environment of e-business [Lefebvre et al. 2003].

Irrespective of the model, several practical challenges to widespread adoption of VMI exist. Since classical EDI is quite cost-intensive, huge importance lies on development and establishment of new EDI formats and semantic standards based on XML: these could drastically reduce costs for small and medium-sized companies Also, support for VMI (esp. gros demand levels) in ERP systems needs to become more prevalent. And while the technical requirements can be fulfilled rather easily by large and small companies (making widespread adoption possible), the sharing of information necessary for VMI to be successful could fail because of psychological and political reasons, lack of trust possibly being the most significant.

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