Peter D. Franke

Vendor-managed Inventory for High Value Parts

Results from a survey among leading international manufacturing firms

Imprint

Berlin Institute of Technology
Scientific Series on Logistics
Special Edition 3
January 2010

Peter D. Franke

Vendor-Managed Inventory for High Value Parts –
Results from a survey among leading international firms

Edited by: Prof. Dr.-Ing. Frank Straube
Berlin Institute of Technology
Strasse des 17. Juni 135
10623 Berlin
Germany

Publisher: Universitätsverlag der TU Berlin
Universitätsbibliothek
Fasanenstrasse 88
10623 Berlin
Germany
Tel.: +49 (0)30-314-76131
Fax.: +49(0)30-314-76133
publikationen@ub.tu-berlin.de
http://www.ub.tu-berlin.de

Printed by: docupoint GmbH Magdeburg

ISBN 978-3-7983-2211-0 (print version)

ISBN 978-3-7983-2210-3 (online version)

The Logistics Division at Berlin Institute of Technology

For more than 30 years the Logistics Division in the Department of Technology and Management at Berlin Institute of Technology (TU Berlin) has been renowned for excellence in research, teaching, and professional training. The department is one of the largest of its kind in Europe, with seven professors, more than 40 members of staff and some 250 students attending its classes.

About the Editor

Professor Frank Straube is Managing Director of the Department of Technology and Management at TU Berlin and holds the Chair for Logistics. He is a board member of the European Logistics Association (ELA) and was vice chairman of the German Logistics Association (BVL) from 1997 until 2009. In addition, he is a member in supervisory and advisory boards of a number of logistics firms. As an active member of the European logistics community, he publishes extensively on the subject of logistics and is a renowned speaker in national and international conferences.

About the Author

Peter D. Franke holds degrees in Economics and Political Economics from the London School of Economics. He spent the first years of his career as a logistics consultant working mainly for manufacturing firms. Later he became purchasing manager for Rolls-Royce, the Aero Engine manufacturer. Today, he works as researcher at Berlin Institute of Technology, focussing on logistics challenges in small volume manufacturing firms and on strategic topics related to the logistics service industry.

Acknowledgements

This publication is the result of a survey among SCM professionals from manufacturing firms. We would like to thank all survey participants for their valuable inputs, which made this publication possible. The survey built on the fruitful discussions we had in the workshops for practitioners organised by our “Small and Medium Batch” research group. We therefore also thank all workshop participants for their continued support.

In the preparation of the survey and in the preparation of this report we received strong support from Christian Paratsch, Stefan Scheuffelen and Oliver Wirths who worked on this topic as part of their diploma theses. Finally, Marcus Lindenau deserves thanks for his help in making the document ready for publication.

Table of Contents

1 Introduction

The “Small & Medium Batch” research group at the Centre for Logistics at Berlin Institute of Technology started its work in February 2009. The group has been studying the specifics of supply chain management in firms producing small and medium size batches of usually technical complex products, like aerospace, heavy industry and railway manufacturers. As part of the research, a series of workshops was organised, taking place in different production sites.

A major challenge for the participating firms is the cost of inventories. Combined with often limited space in historical manufacturing sites, with products much bigger than they used to be years ago (e.g. power turbines) and a general trend towards shifting responsibilities to suppliers it leads to new thinking with regards to inventory management and holding strategies. Vendor-managed inventory (VMI) has become an option not only to C-class parts but also to high-value items, which are critical in the production process.

In September 2009, the "Small & Medium Batch" research group invited around 70 international manufacturing firms to participate in a study on VMI for high-value parts. We were delighted to find that there was great interest in the study. We received back 11 questionnaires from firms practicing VMI for high-value parts. Many of the other firms invited let us know that they did not yet have any experience in VMI for high-value parts and thus would not be able to fill in the questionnaire, but were beginning to implement programmes and hence would be interested in receiving the results. This reflects that the issue is highly topical and it encouraged us to publish our findings despite the rather small number of replies.

The questionnaire comprised 28 questions, formulated to yield information about the driving forces behind high-value VMI and success-factors for implementation. The results of our analysis and of the accompanying research are presented in this report. We hope that the report will:

- allow you to learn from firms who have implemented VMI successfully with many suppliers
- help to understand the alternative models available for implementing VMI from the strategic level down to physical processes
- provide strong arguments to convince partners and internal stakeholders of the benefits of VMI

Berlin, January 2010

Peter D. Franke

Berlin Institute of Technology

2 The Background

An Introduction to High Value VMI

Vendor-managed inventory implies shifting the responsibility for management of inventory at the buyer's premises from buyer to the vendor (Figure 1). The vendor makes forecasts, replenishment decisions and, in some cases accepts inventory ownership until consumption of the stock (consignment stock arrangement). The buyer's role switches from active inventory management to a more passive task of providing timely and accurate information regarding consumption and inventory levels (cf. Kuk, 2004; Simchi-Levi et al., 2008).

	Inventory Management Model		
Inventory Process	**Buyer Managed Inventory**	**Vendor Managed Inventory**	**Consignment/ Vendor Owned Inventory**
Inventory Forecast & Planning	**Buyer**	**Buyer**	**Buyer**
Inventory Management	**Buyer**	**Buyer**	**Vendor**
Inventory Ownership	**Buyer**	**Vendor**	**Vendor**

Figure 1: Inventory Management Models according to Supply Chain Digest (2009)

The origins of VMI lie in the consumer goods and retail industry. Companies such as Wal-Mart and Proctor & Gamble have developed VMI in the late 1980's. The following example highlights the reason for adopting the practice:

A retailer offers a wide range of products with different characteristics and demands. It is difficult for him to forecast demand for this diversity of products and avoid stock-outs. However, to him this is not so harmful: He knows that if the consumer comes into a store to buy a specific brand chocolate bar and a detergent and does not find the chocolate bar he wanted, he will in many cases buy the detergent and choose a different chocolate bar instead of the desired one.

For the supplier of the originally desired chocolate bar the situation is different. He has a great incentive to keep the shelves well replenished to make the sale and he knows best the demand for his product. This explains why in a retail/ consumer goods environment the suppliers are usually in the driver's seat.

Actually, some retailers today purposefully risk certain products to be occasionally out of stock because they have found the cost of a never-out-of-stock logistics policy to be higher than the losses due to out of stock situations. We can expect this behaviour to motivate even more suppliers to accept the ownership of inventory.

VMI in the retail environment has positive effects for the buyer and the vendor. For the buyer the administrative burden is reduced and he can expect higher sales. He has to watch his inventory though since the supplier has an incentive to raise levels of inventory. This problem can be dealt with by transferring inventory ownership to the supplier. The supplier benefits from the better sales and inventory information he receives. He can sell more and still reduce his inventory. Better planning ability also allows him to improve the planning process and reduce production and transportation costs (cf. Lee et al. 1997; Gümüs et al., 2008; Disney et al., 2003).

In the low to medium volume industries, which are the focus of this study, the situation is different: First, like in all manufacturing industries, the supplier does usually not have better information about demand for final products than the buyer does (This may be different with respect to spares). Second, demand for parts is often volatile, influenced by intentional or unintentional changes in production plans. Moreover, unlike in retail and consumer goods, many of the purchased items are designed and manufactured to specification. The supplier cannot pool the demands from several customers to even out fluctuations. Third, the buyer has a strong incentive to avoid stock-out situations, as any stock-out will disturb production.

So, why are VMI practices adopted in this environment? Clearly, it would have to be driven by the buyers and not by the suppliers.

One well-known form of VMI in manufacturing industries is quite common also in low to medium volume firms: C-Class parts management organised by a service provider (often a wholesaler of C-Class parts) who manages the stocks of these parts usually through a paperless ordering system (e.g. Two-Bin Kanban), thereby drastically reducing the administrative burden for the customer. The buyer usually only pays for the parts aw they are consumed giving an incentive to the supplier to keep inventory down and the price of items usually comprises a handling fee for the service provider.

With respect to high-value parts, however, the situation is more complicated. Quantities required are smaller than for C-Class parts, demand volatility is even higher and most likely the parts are made to specifications.

These considerations suggest that the issue of high-value VMI in low to medium volume industries is worth to take a closer look. They were the starting point of our interest in the organisational set-ups and incentives in High-Value VMI.

Structural framework

To analyze High-Value VMI we first designed a structural framework, which presents the options available to firms when implementing VMI. VMI can be designed in many ways to adapt the needs of the company. Through intensive desk research, fourteen key characteristics of VMI systems have been identified and are presented in the framework together with corresponding implementation alternatives (cf. Blackhurst et al., 2006; Sarpola, 2007).

Our VMI framework (Figure 2) is divided into three major sections: The commercial arrangement, the flow of information and the flow of goods. The commercial arrangement is the foundation of the VMI system. In this section the options available mainly relate to the question

Who has responsibility for which parts of the process?

In the section regarding the flow of information the overall question to be answered is

What information is to be transferred **when** and **how**?

Finally, the third section deals with the physical flow questions and defines options relating to the question

Where is stock held and in **which form**?

This framework provided the structure and content for our survey questionnaire the results of which are presented in the following chapters.

Commercial Arrangement					
VMI Partner	Vendor	3PL	Combination/ Other		
Parts delivered	Single parts	Kits	Batches		
Point of change of ownership	Pick-up of part	Delivery	Consumption into shop floor	Payment received from final customer	
Point of custodial ownership	Pick-up of part	Delivery	Consumption into shop floor	Delivery of final product	
Compensation in case of production delay	None	Compensation fee	Parts paid latest X days after delivery	Other	
Flow of Information					
Replenishment Technique	Kanban	Fixed Min/Max levels	Reorder Point/ Quantity	Other	
Information shared	Shipping Orders	Demand Forecast	Items in Stock	Stock Consumption Signal	Customer Orders
Signal capturing	Scanner	RFID	Webcam	Physical Kanban signal	Manual
Signal transfer	Manual (mail, phone, fax)	Automatic Email	1-Way web-based platform	2-Way web-based platform	Connected MRP systems
Transfer frequency	Realtime	Daily	X times per week	Weekly	
Shipping authorisation necessary	yes	No			
Flow of Goods					
Inventory held at	Vendor	External Warehouse	On-site warehouse	Shop-floor buffer	
Partitioning of warehouse	No partitioning	Separate on part level	Separate area for each vendor	Separate area for all VMI	
Location of shop floor preparation	Vendor	External Warehouse	Onsite Warehouse	Assemby Line	

Figure 2: Structural framework of VMI

3 Survey Methodology

Hypotheses

From the framework described above, we derived a number of hypotheses bringing together the options in the framework and our expectations regarding the choices made in the low to medium volume environment. These hypotheses are highlighted in the section outlining the results from the survey below. Not all our hypotheses could be verified. We were surprised with some of our findings. The findings relating to the hypotheses are also highlighted in the text.

Survey Technique

The questionnaire consisted of an Adobe©-Form which contained 28 questions. After filling in the respondents could send back the data by pressing a "submit" button in the form. This allowed us to load the data into a spreadsheet program for evaluation automatically.

In subsequent telephone interviews critical questions where discussed with the participants. This also gave us the opportunity to obtain further background information, which was valuable for us in the overall interpretation of the survey results.

Structure of the report

In the following section, we describe and interpret the findings from the survey. The structure roughly follows the logic of our VMI framework. We start by giving general information about the participating firms and the scope of their VMI systems (chapter 4). We then look at the commercial issues in VMI. This begins with selection criteria for parts and suppliers and the question whether to involve a 3PL in the arrangement (chapter 5), followed by a chapter on the incentives and problem areas (chapter 6) and finally a discussion of the combination of VMI with consignment stocks (chapter 7).

The next chapters are devoted to information and physical flows (chapters 8 and 9). We discovered that the physical processes are highly dependent on the specific circumstances of a particular enterprise. In Chapter 9 we therefore attempt to combine the physical process view with other findings from the survey in three models of VMI applied in the surveyed companies. Chapter 10 gives recommendations for the implementation of VMI, again following our framework.

4 Scope of VMI

This section contains some general information about the firms participating in our study. All further results will have to be seen in the light of the years of experience, which the firms have, and the extent to which they apply VMI.

Firms in the Survey

Low volume manufacturing makes up an often-underestimated portion of industry. Single item and low volume manufacturing are the most applied method of production in the machinery industry, 58% of all production belongs in this category in Germany (cf. Som, 2007). The importance of low volume production is growing with lean manufacturing methods and rapid manufacturing technologies being increasingly applied.

The participants in the survey were all logistics professionals from firms producing small to medium batches of technology products, mainly firms from the aerospace, rail, robotics and machinery industries. The participants in the study represent firms with average revenues of US$ 30 billion, all large multinationals. Participants are from Germany and the United States.

The scope of high-value VMI

The most experienced companies in the sample have been practicing VMI for 10 years as is shown in

Figure 3. Among the companies polled, we defined a group of more experienced VMI-practitioners. 5 out of 11 companies have been running a VMI-system for high-value parts for 4 years and longer. This group of firms has been looked at more closely in all further analyses.

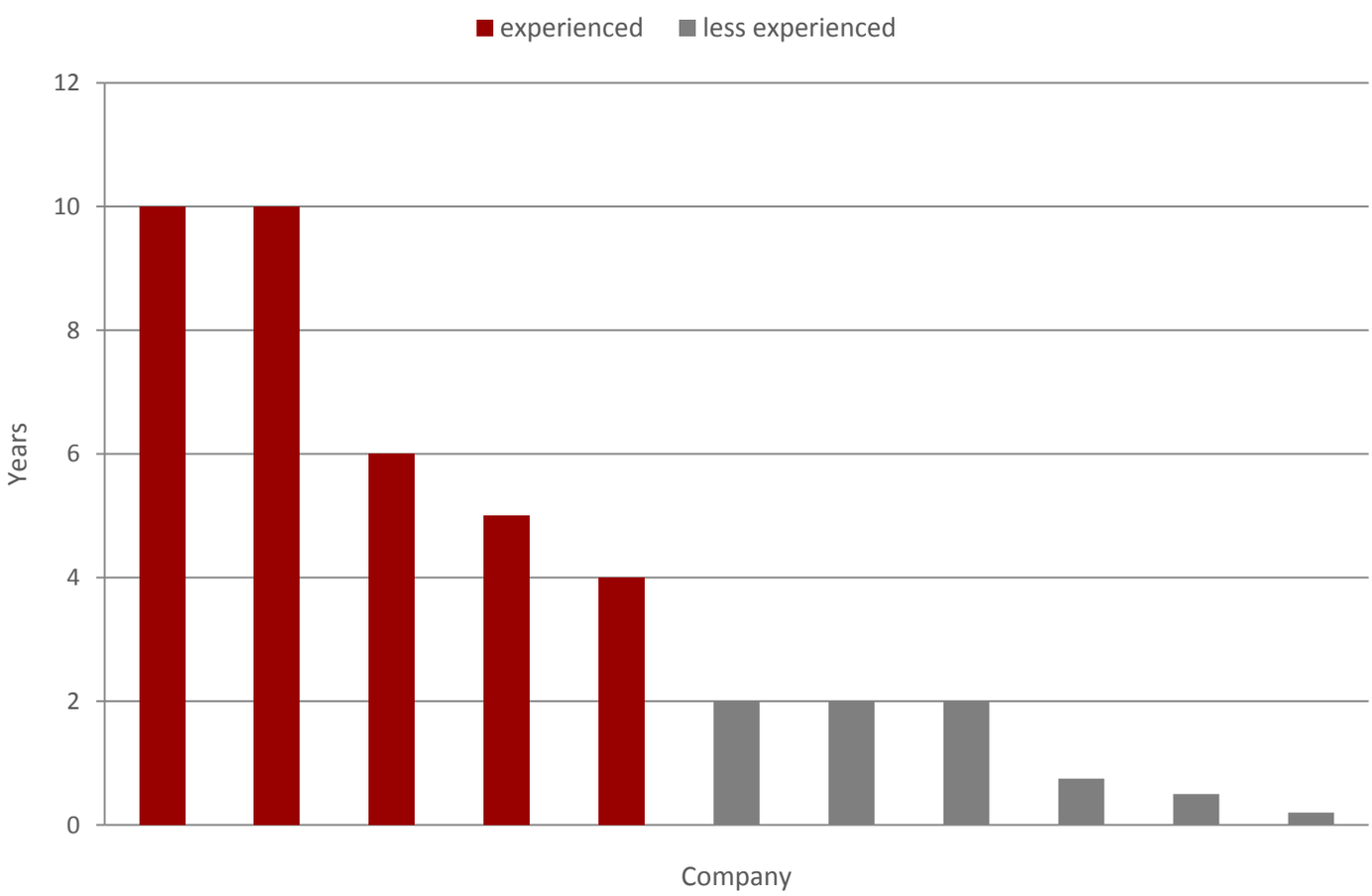

Figure 3: Years of experience in VMI

VMI is applied for very different numbers of parts depending on their special circumstances but the clear majority of firms are planning to extend the schemes (Figure 4). This proves that VMI is in fact an issue in the industries in focus. 7 out of 11 companies, including some of the most experienced, are currently planning to expand their VMI-programmes, a proof of success. It is quite common to introduce VMI for *all* high-value parts. Although, most companies do not plan to let their vendors manage all of those parts, most companies have planned to include more parts. Half of the companies have involved more than 10 suppliers and have managed to remove a considerable administrative burden and inventory management responsibility (see Figure 5). Each supplier who manages inventory for the buyer implies a smaller number of ordering relationships, which the buyer has to manage actively.

Key findings

VMI is successfully employed in small volume production environments – Most firms are planning to expand their VMI-programmes

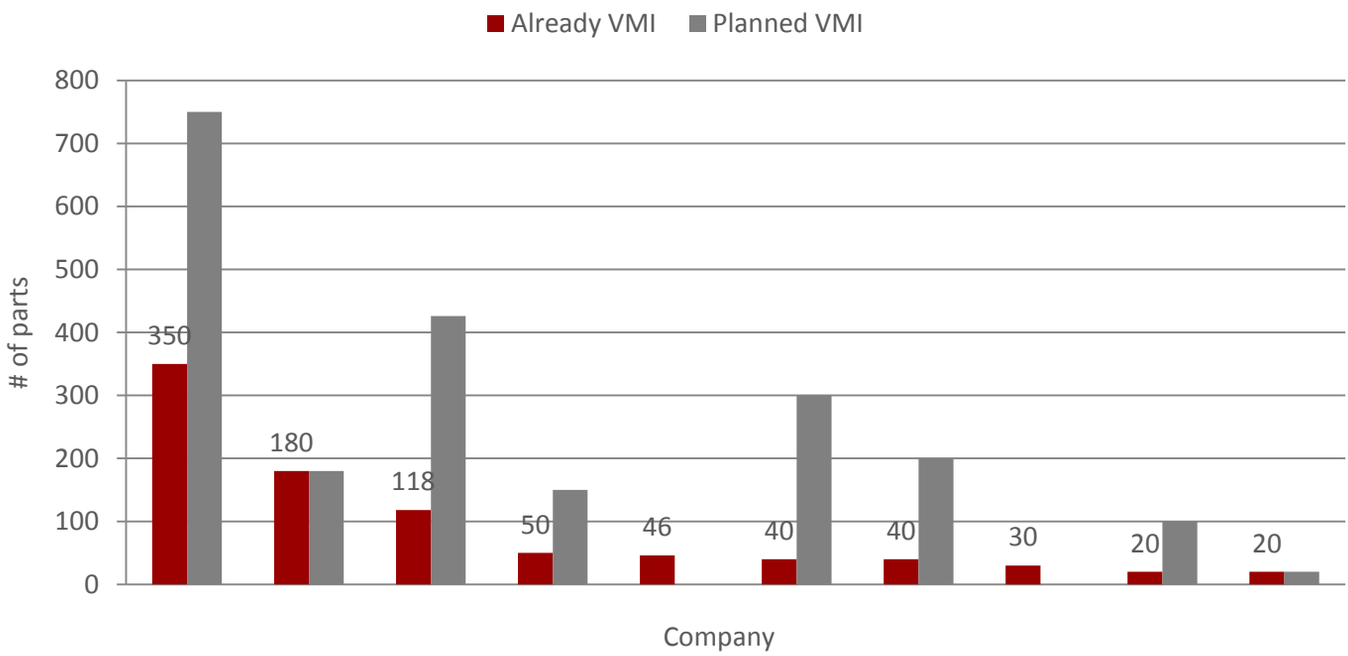

Figure 4: Progress of implementation

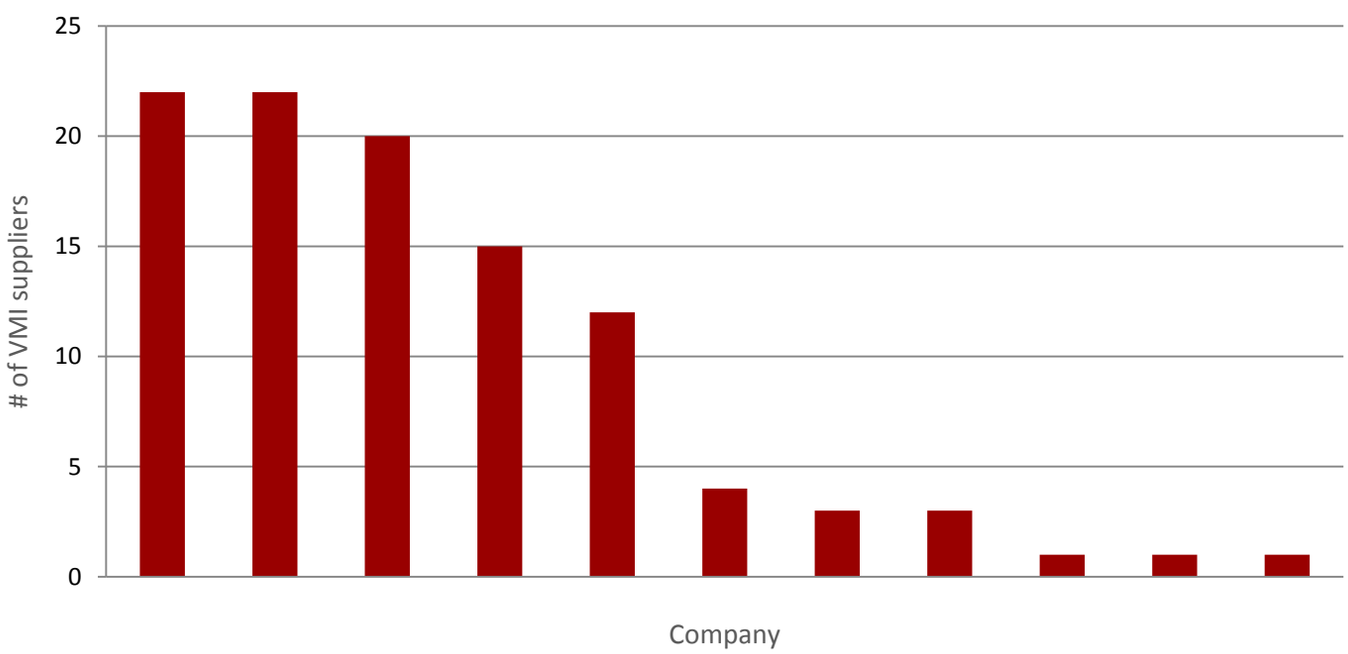

Figure 5: VMI-suppliers

5 Parts and Supplier Selection

As explained in the introduction, in consumer goods and retail, VMI is usually driven by the vendors who seek to deliver an as big portion of their items if not all in this form. In contrast, in industrial VMI, driven by the buyers, the buying firm will need to select suitable vendors and items; it is highly unlikely that all suppliers can deliver all their parts in a VMI process at once.

Parts Selection

When asked how they select parts, 9 out of 11 companies answered they select parts on the basis of their value – not surprising, since we explicitly focused on high-value items in the survey (Figure 6); In addition, the physical size of parts turned out to be an important aspect for selection. Several companies mentioned a further important factor in subsequent interviews: Demand stability. Again not surprising since unstable demand makes it more difficult for the supplier to manage the inventory, although in a stable Pull production system, VMI should be able to survive unstable demand. While the question whether a part belongs to a specific module seems to play a subordinate role in part selection, we did find that experienced practitioners of VMI include Kits in their VMI system. Kits contribute up to 70% of VMI items (see Figure 7).

This underlines that VMI is an instrument of empowering suppliers, allowing the buying company to focus on production and distribution. The best suppliers supply kits of parts, coordinating sub-tier or even same-tier suppliers and take over far reaching responsibilities for the delivery of these kits including the management of inventory. An additional advantage for the buying companies is that they can reduce the number of suppliers with whom they have an active relationship.

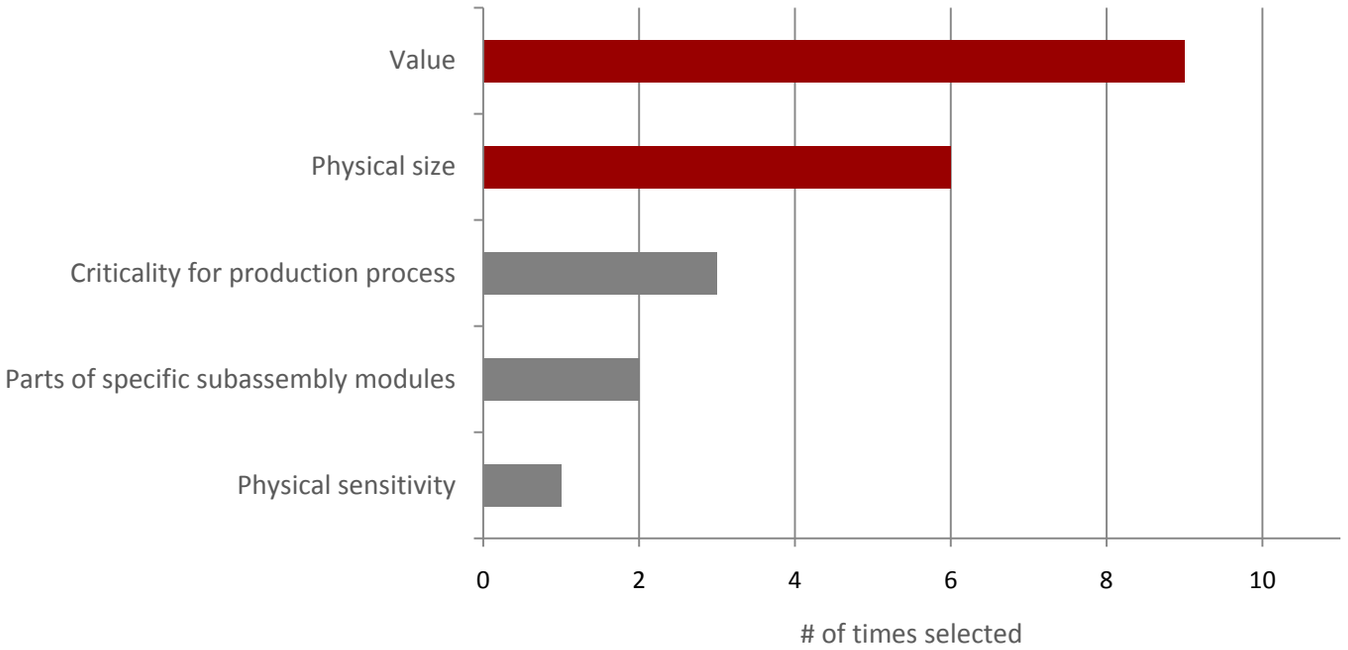

Figure 6: VMI-parts selection criteria

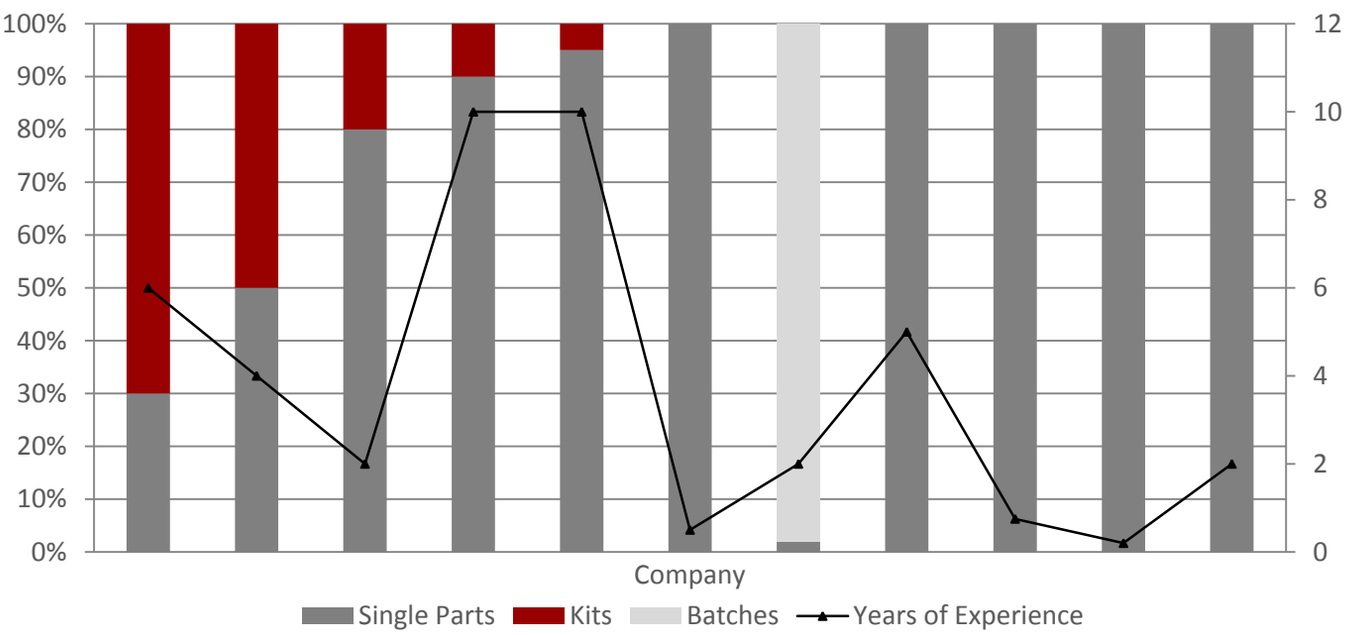

Figure 7: Part Characteristics and years of experience

Vendor Selection

Among the criteria for vendor selection, the characteristics of parts delivered by the supplier and the duration of the business relationship with the supplier are the major reasons to include a supplier in the VMI-programme (Figure 8). In contrast to what might appear practical, the compatibility of the vendor's infrastructure does not seem to be a relevant aspect at all.

It is quite common with C-Parts to let a logistics service provider (LSP) manage the inventory through a Kanban system. The VMI Partner is thus not the supplier of the parts but the LSP who usually obtains a service fee for his service, which is still efficient because the logistics processes for parts with a low value can be streamlined and the buyer has to deal only with one partner instead of many suppliers. In addition, there are a number of scenarios, especially in the electronics industry, where 3PL are taking the role of a VMI partner (cf. Eitelwein et al.; 2008).

Concerning high value parts, however, we expected the majority of the companies to deal directly with the vendors and not with a 3PL. The reason for this lies within the nature of high value parts: Only a few vendors with a small range of high-value parts have to be involved. It seems feasible to manage this without a 3PL who would usually charge a fixed percentage mark-up to cover the cost of his services.

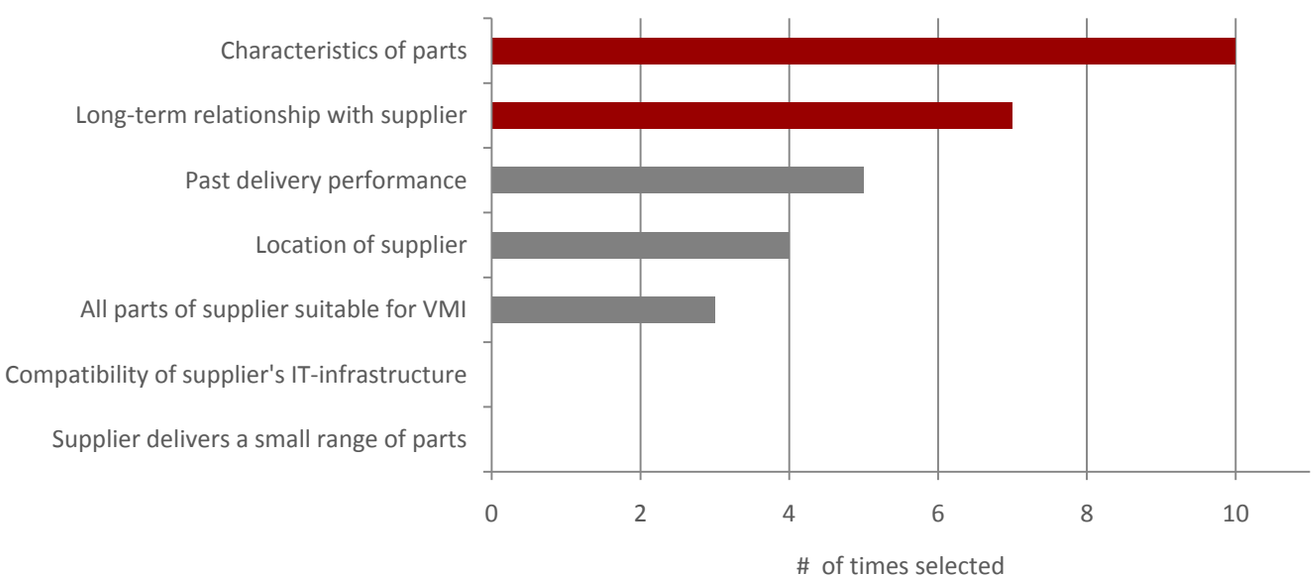

Figure 8: VMI-supplier selection criteria

Hypothesis

Companies do not employ a 3PL for VMI when the quantity of parts and vendors involved are small.

Our expectation was correct: 9 out of 11 companies have established a VMI-model where they deal directly with the vendors and omit handling by a 3PL. One company has parallel models in place, one employing a 3PL and one where they deal directly with the vendors.

If we take a closer look at the two companies, which have mandated a 3PL, we can observe that those two have included a considerable number of suppliers in their VMI-programme, i.e. more than 10 (Figure 9).

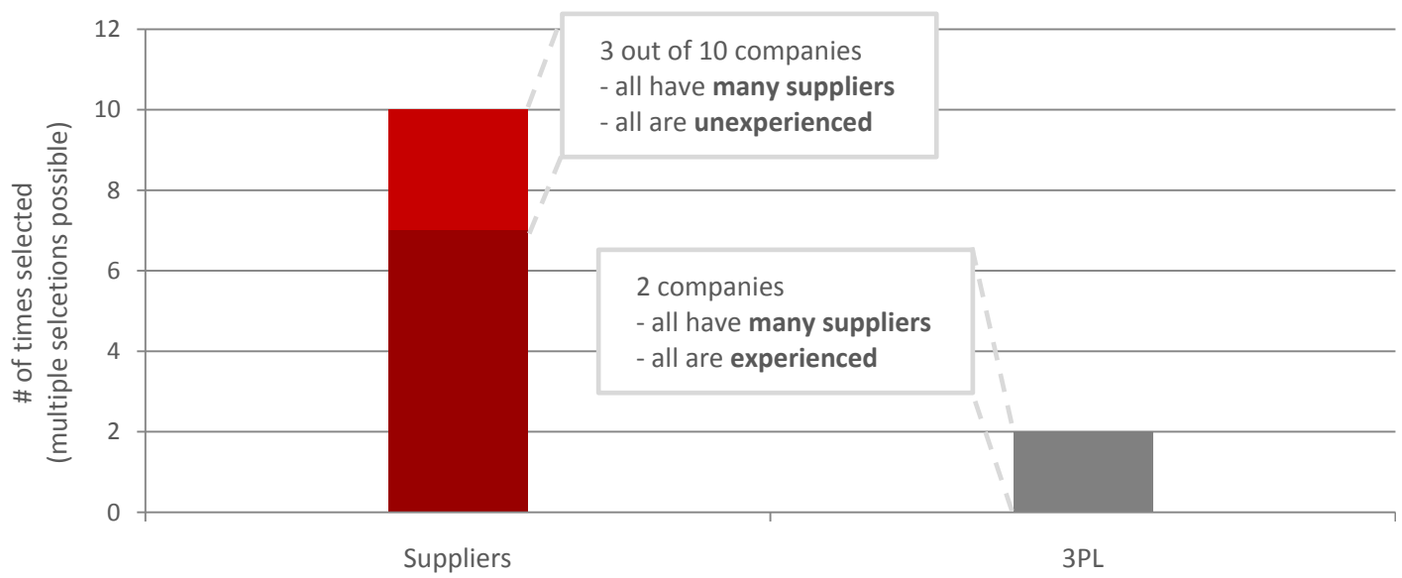

Figure 9: VMI-partner

However, in the group of companies not cooperating with a 3PL we could also identify three companies with more than 10 suppliers (Figure 9). Further investigation showed that these were rather inexperienced practitioners of VMI. It seems that more experienced companies counteract the complexity of having many VMI Partners by engaging a 3PL.

Key findings

- The most important criteria for parts selection are value and physical size.
- The most important criteria for supplier selection are characteristics of parts delivered and long-term relationship with suppliers.
- Experienced companies implement VMI for kits of different parts.
- Experienced companies with many VMI-suppliers employ a 3PL even for their high-value VMI parts.

6 Incentives and Challenges

As VMI implies a significant change in the responsibilities of buyer and seller, the question what the incentives are to accept this change comes natural. In this section, we look at benefits of VMI to buyers and suppliers as well as at problem areas in VMI and ways to overcome these.

Benefits

Asking buyers of VMI parts which benefits from VMI they experienced was a straightforward exercise. However, since the suppliers of VMI were not included in the survey, our analysis of incentives to suppliers has to rely on the information we received from the buyers.

Benefits to the Buyer

We asked firms to rate in what intensity benefits occurred (Figure 10). Most of the benefits are concerning a reduction of complexity through process improvements (e.g. less administrative effort, reduction of transactions) and increase of delivery reliability (e.g. improved service levels, reduction of safety stocks). We can see that the average scores of all benefit areas are positive. Less administrative effort was mentioned most often, followed by less transactions, higher service level, lower safety stock and faster information with regard to real demand. All this is no big surprise; one would expect administrative efforts to be reduced especially in procurement because the replenishment administration is transferred to the supplier.

This generally positive picture is reinforced by the fact that nearly all companies plan to expand their VMI-programme further.

Benefits to the supplier

To bring some light into the suppliers' situation, we asked the buyers of VMI parts what benefits the suppliers have, in their view (Figure 11). Possible benefits can be divided into

two categories: Process benefits and commercial benefits. We expected that suppliers like buyers would benefit primarily from improved processes. As will be discussed in the next chapter we would only expect buyers to make some commercial concessions where VMI is combined with consignment stocks, in order to compensate the supplier for increase in inventory to be financed.

Hypothesis

Vendors are motivated by process improvements rather than by commercial concessions to participate in a VMI-program.

The hypothesis has proven to be true: system-based benefits are named much more often than commercial concessions. The responses as well as several comments showed clearly that suppliers were very open-minded towards the introduction of VMI. It does certainly not appear that partners are forced to manage the inventory. This would not also seem unlikely with the power structures in the industries in question. Respondents stated that their suppliers had great interest in real time information and that none had opposed to the system. The underlying reason may be that in low to medium volume industries suppliers are used to being exposed to an extreme requirement for flexibility. With VMI, the suppliers are getting a lot more transparency of what is actually required and the need for flexibility may be reduced.

Key findings

- Buyer companies benefit from VMI predominantly through process improvements and increased delivery reliability.
- Suppliers strongly benefit from the process improvements through VMI

Figure 10: Benefits to the buyer company

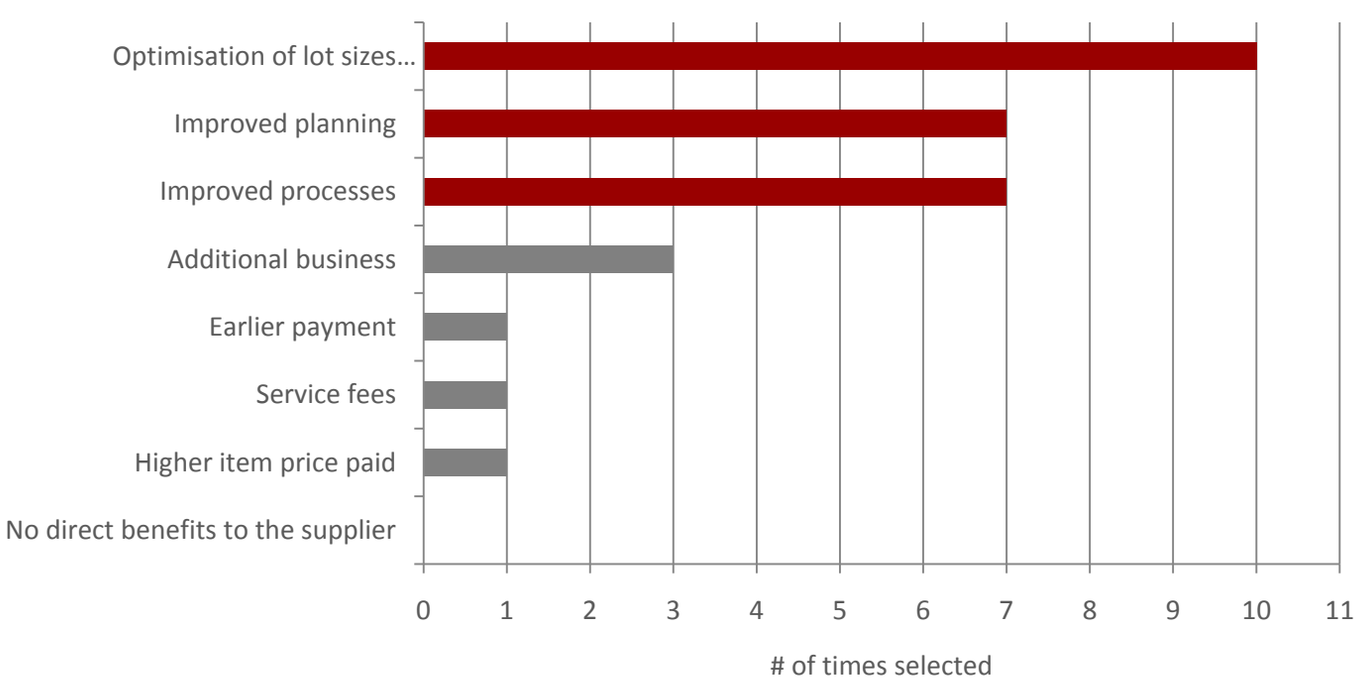

Figure 11: Benefits to the suppliers

Problem areas

The main problems in a VMI-system arise from two different areas. On the one hand, there may be problems to maintain optimal stock levels (stock-outs, excessive stock, inability to cope with demand fluctuation), and on the other hand, there may be conflicts with suppliers regarding inventory ownership, payment and trust issues (Figure 12). Overall, the respondents seem to experience rather few problems. The biggest problem area is around supplier conflicts. Process quality seems to be a lesser problem.

There may be many ways to cope with conflicts over inventory issues. We expected to find, as already mentioned above, some form of compensation scheme in the case of production delays at the buyer's site. This would be of particular importance when VMI is combined with consignment stocks (see chapter 7) but we are also looking at companies without consignment stock arrangements. While a consumption stop is especially harmful to companies delivering consigned parts, it also means a cash flow stop to other suppliers when the maximum inventory level is reached and no more parts can be replenished.

Hypothesis

Buyer companies establish up front standardised regulations to limit negative cash flow effects to their suppliers in case of production delays.

The survey shows that 6 of the 11 companies compensate their suppliers in such situations (Figure 13). While four of them buy the parts after a certain period, none pays a compensation fee.

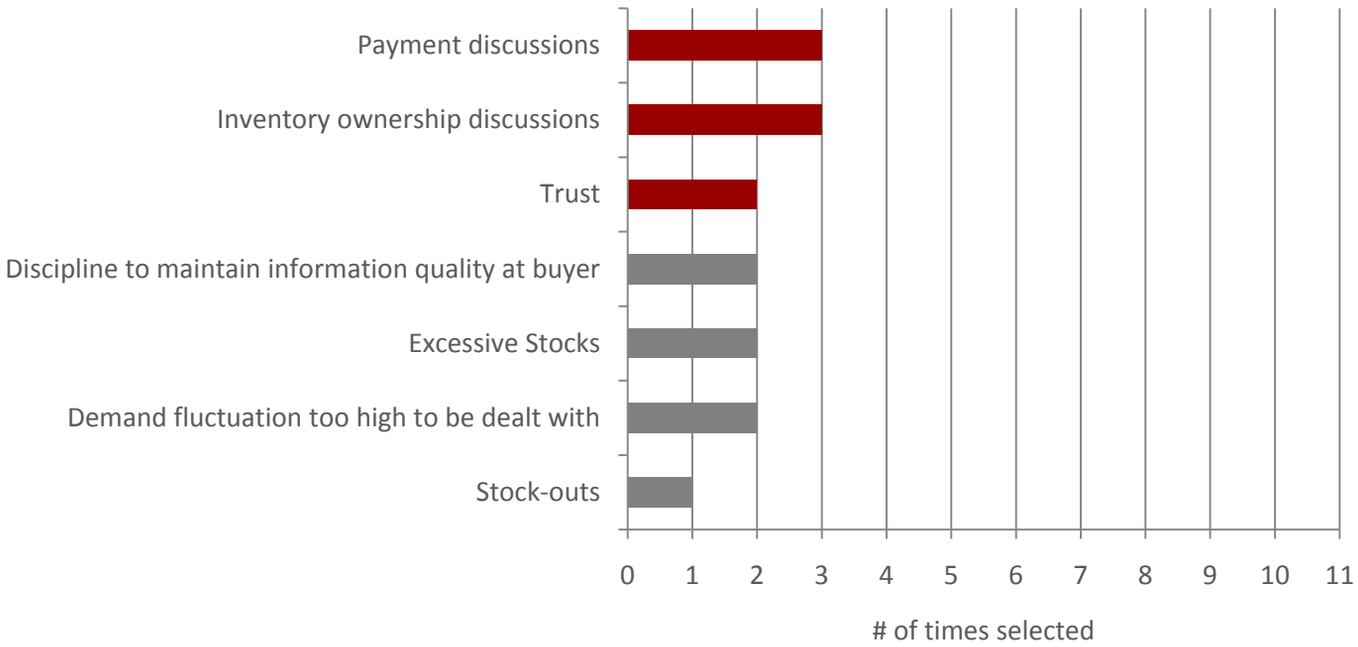

Figure 12: Problem areas

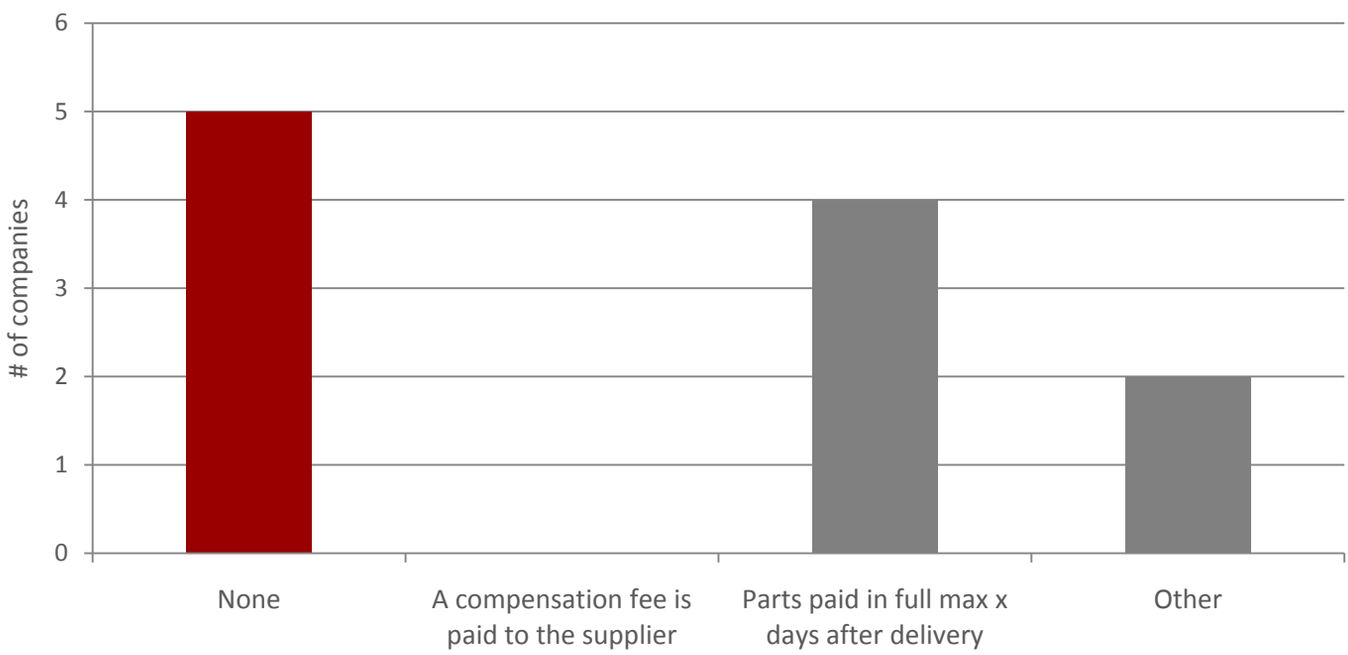

Figure 13: Compensation schemes for production delays

A closer look at the two companies, which ticked “other”, is necessary here. These companies stated that they have mutually agreed with their VMI-partner to solve such issues depending on the situation. They do not to have any upfront regulations but rather deal with such situations ad hoc. Hence, 7 out of 11 companies do not have a standard procedure to deal with production delays – our assumption was wrong.

Hypothesis

Separation of VMI-parts from regular parts in the warehouse helps to reduce process complexitiy.

A further way to avoid conflicts can be to separate VMI parts from other parts. In total, only four of the 11 companies assign designated spaces in their warehouse to VMI-parts (for each part, each supplier or a general VMI-area) (see Figure 14). Some of the other companies, which do not partition their warehouse, tag their VMI-parts visually to differentiate them from other parts. Although, apparently, this cannot be related to the implementation of consignment stock, there should be a reason for the companies to take the effort and space to clearly separate the VMI-parts from ordinary parts to create transparency in the warehousing processes. This higher transparency could help to cope with the complexity of the new processes.

This can be measured by a reduction of administrative effort, in-store process times and transactions. If we now compare the average score on these particular benefits between the companies which do assign designated VMI-spaces in the warehouse and those who do not, we find that the former, indeed, reach a significantly higher average score (Figure 15).

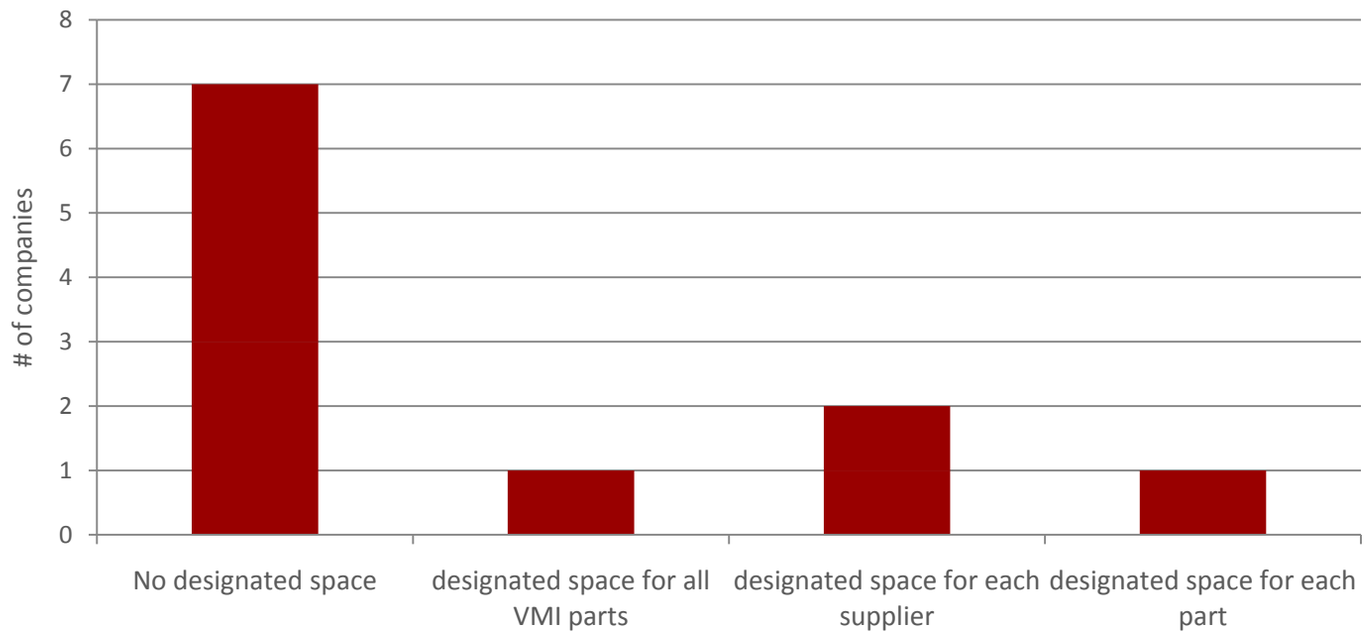

Figure 14: Separation of VMI parts in warehouse

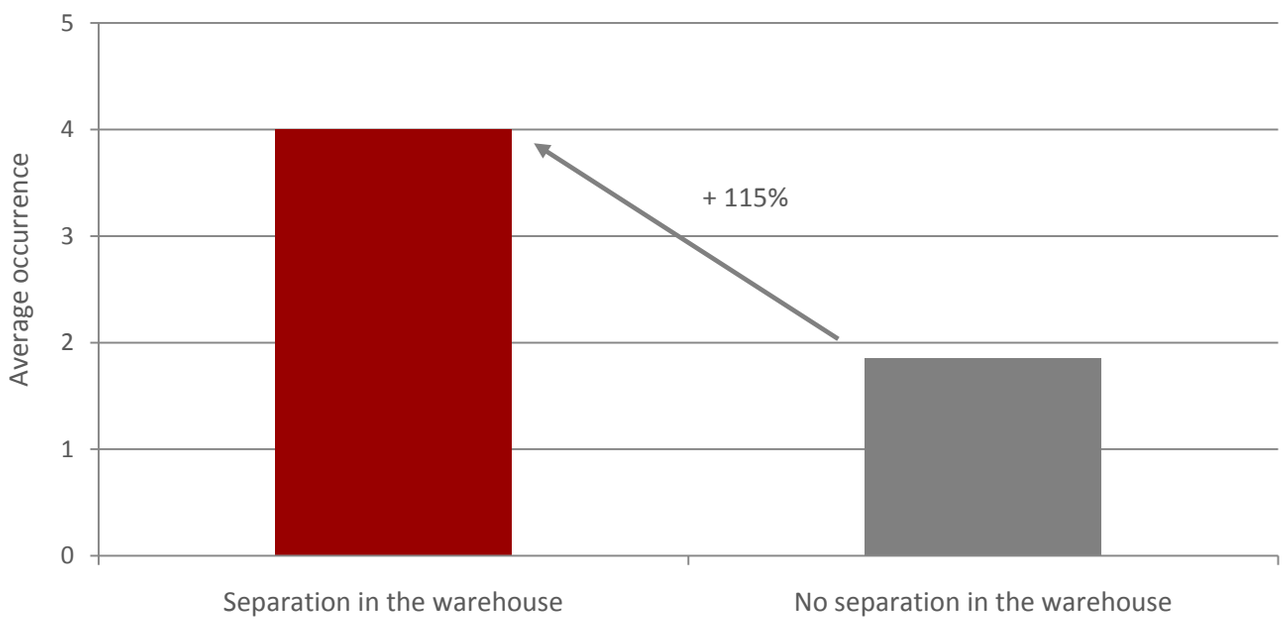

Figure 15: Average reduction of complexity depending on warehouse setup

Trying to find out what else companies do to avoid conflicts with suppliers, we looked again at the selection process. A large group of the companies select their VMI-suppliers based on the length of their relationship. We expect that those companies, which prefer to do VMI with suppliers they had long-term relationships with, experience fewer conflicts in the course of the VMI-partnership.

Hypothesis

Companies, which use long-term relationships as selection criterion to choose their VMI-suppliers, experience fewer conflicts over inventory ownership, payments and trust issues.

In fact, this hypothesis could be verified (Figure 16). It turned out that companies, which did not select suppliers accordingly, experienced far more conflicts. This may not be surprising, but it emphasizes the importance of mutual trust and respect, built up over past relationships, for a collaborative handling of new systems and processes.

Overall, it was anticipated that benefits would outweigh problems from the point of view of the buyer. What surprised us is that more experienced firms tend to see more problems than the less experienced. The reason for this must be that in a longer time problems are more likely to come up, or that in the years after implementation, VMI is more in the focus and performance more closely monitored.

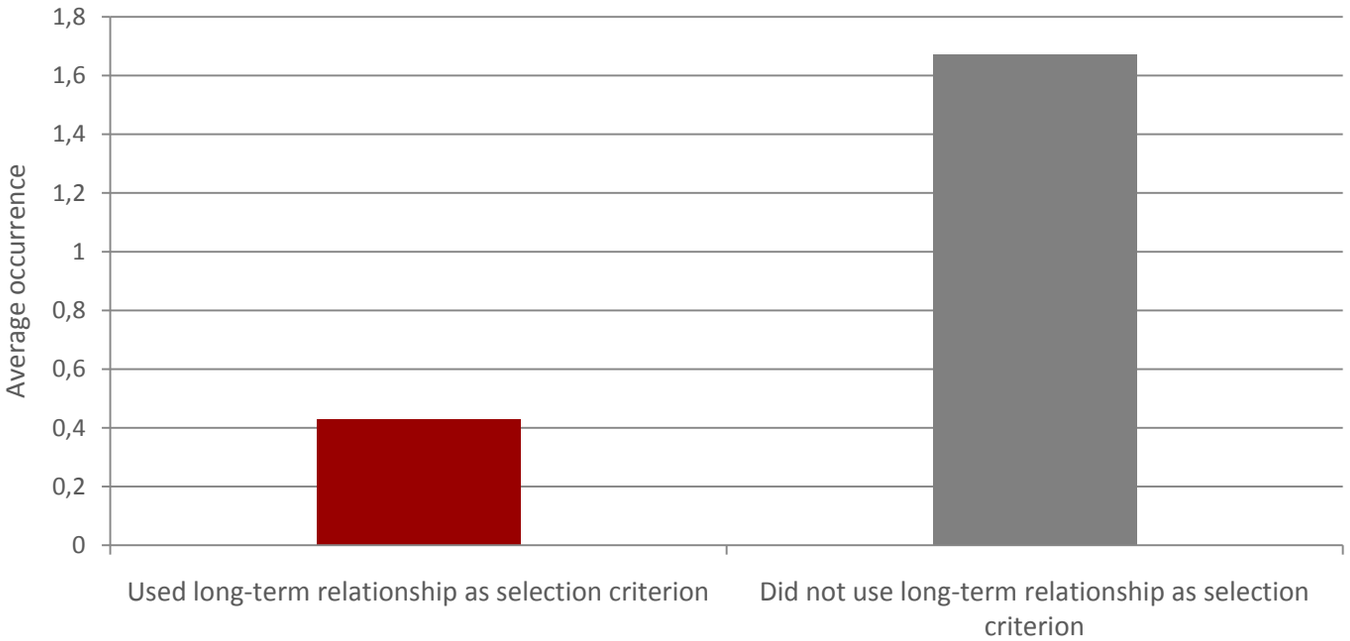

Figure 16: Supplier conflicts depending on supplier selection criteria

Key findings

- The most common problems are conflicts over inventory ownership and payments.
- Companies that chose long-term relationships as criterion for supplier selection experience fewer conflicts.
- The majority of companies do not implement up front compensation regulations to limit negative cash flow effects to suppliers in case of production delays.
- Separating VMI-parts from regular parts help to achieve better process quality

7 VMI and Consignment Stocks

As was explained in the introductory section on VMI, the ownership of VMI often remains with the vendor to give him a clear incentive to keep inventory down. However, as was also explained, the driver in industrial VMI, unlike in the retail environment, is the buyer of the goods in question. We were therefore interested to find out if, in the low volume – high value environment, which is in focus here, consignment stocks play a big role or if being able to concentrate on customers is a sufficient incentive for the buyers to organise VMI systems.

Hypothesis

In the small volume environment, VMI is rarely combined with consignment stocks

It turned out that 6 of the 11 companies implemented consignment stock arrangements in their VMI-programme. Four of them have their entire high-value VMI-parts on consigned condition (Figure 17).

Interestingly, fewer of the experienced companies include consignment stock into their VMI-model. Apparently, this is not a significant attribute of mature models and hence not necessarily the incentive to organise VMI for high-value parts.

In those cases where VMI is combined with consignment stocks the question was what the incentives would be for the VMI partner to accept this. For the companies, which do have consignment stock, we expected to find a higher occurrence of commercial concessions made to the VMI-partners, such as service fees or higher item prices.

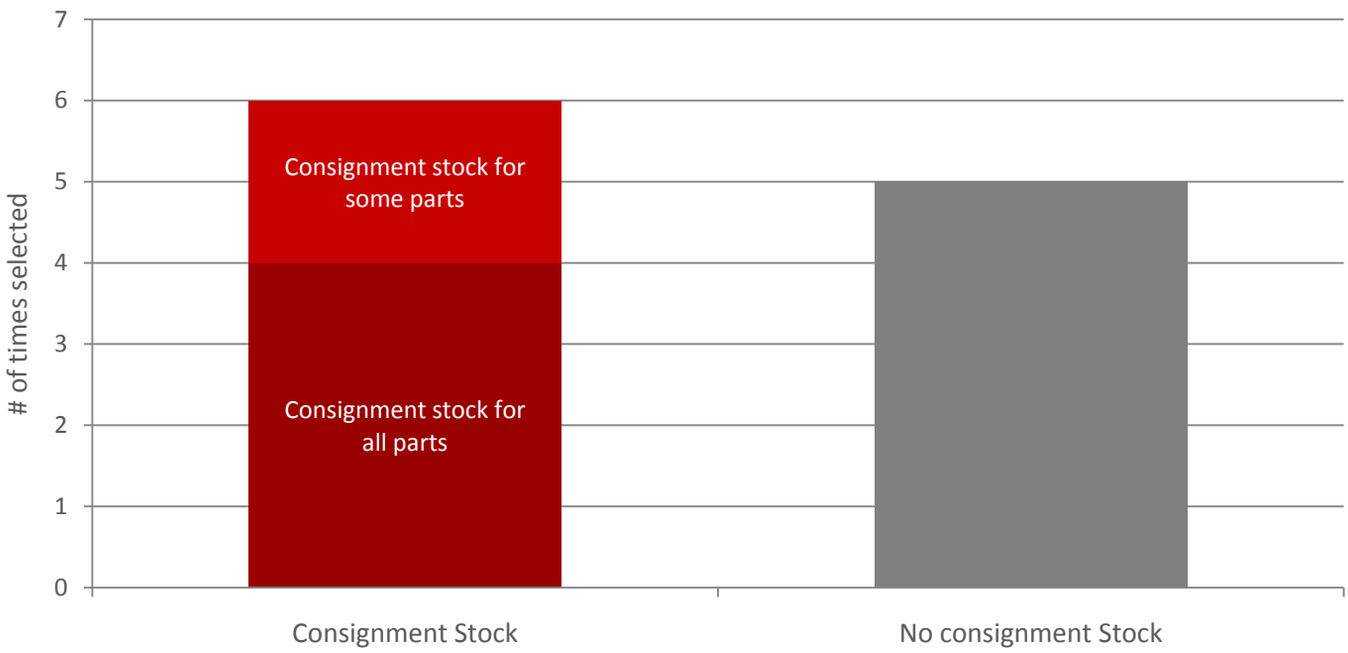

Figure 17: Number of companies running consignment stock arrangements

In addition, we expected to see more conflicts between the buyer company and the VMI-partners over inventory ownership and payments. Two specific problem areas arising from consignment stocks are anticipated:

Production Delays

In the case of production delays no material would be consumed and hence, the VMI-partner would be cut off from cash flow without own fault. As a way to ease the situation for the VMI partner, we expected the companies that use consignment stock arrangements to implement some form of compensation scheme in the case of production delays.

Damage during handling

Another field of conflict could be the handling of the consigned goods in the warehouse. In many cases, the buyer company or a third party handles stock belonging to the vendor. Therefore, we expected the companies contractually to set a separate point of transfer of custodial ownership (i.e. the risk of damages), where the buyer starts handling the goods (in most cases this is the pick-up or delivery of parts) irrespective of the transfer of commercial ownership. Another possibility to work around this issue is to separate the consigned VMI-parts in the warehouse from the regular parts to make sure these are handled with the appropriate caution. Therefore, we expected to find a clear separation of VMI-parts in the warehouse, with separate areas either for each VMI-supplier or at least for VMI-parts in general.

Hypothesis

Companies which combine VMI with consignment stock

- experience more conflicts with suppliers
- make more commercial concessions to suppliers
- implement compensation schemes for production delays
- separate VMI-parts from the rest of the parts in the warehouse
- set custodial ownership to coincide with handling responsibility

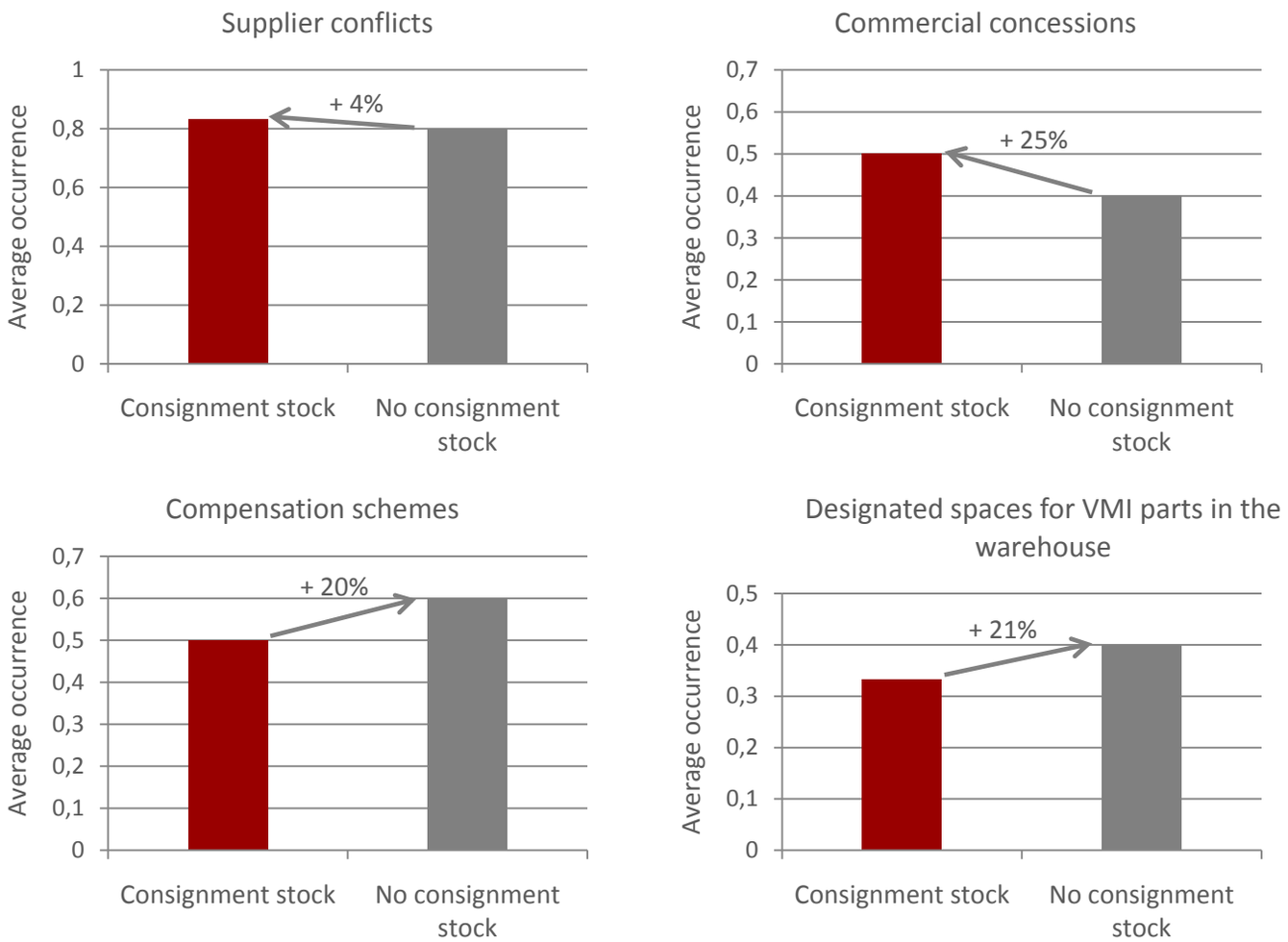

Figure 18: Average occurrence of supplier conflicts, commercial concessions, compensation schemes and warehouse setup for models with or without consignment stock

Surprisingly, none but one of these expectations could be verified in the survey! Among the group of companies, which include consignment stock in their VMI-model, there was no significantly higher occurrence of either commercial concessions made to the VMI-partners, conflicts over inventory ownership, payment or trust, compensations schemes in case of production delays or designated VMI-areas in the warehouses. Moreover, the companies practicing consignment stocks did not report more conflicts than the others did! The differences in the distribution were no higher than 25%, which cannot be regarded as significant for a sample of this size (Figure 18).

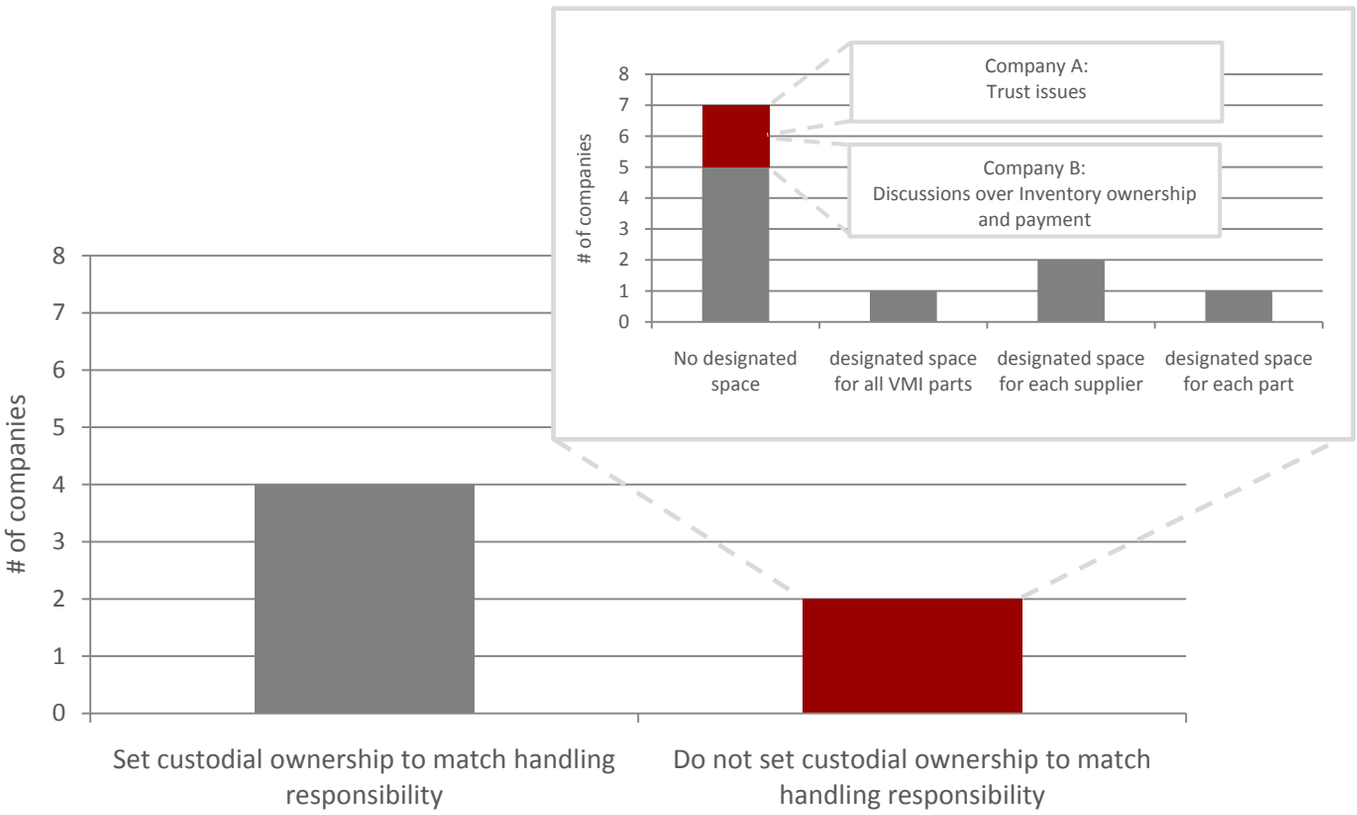

Figure 19: Ownership and handling responsibility

Only our expectations regarding the regulation of custodial ownership could be verified for 4 of the 6 companies using consignment stock models. Obviously, we would have liked to analyse, if this arrangement helped firms to avoid conflicts but, unfortunately, our sample is not large enough to make a rigorous statistical analysis. However, we decided to take a closer look at those companies who do not separate custodial and commercial ownership and found an interesting picture (Figure 19).

These 2 out of the 6 companies who have implemented consignment stocks, which do not set the custodial ownership to coincide with the handling responsibility, also do not separate the VMI-parts from the rest in the warehouse. We would expect both to help avoid conflicts arising from said discrepancy of commercial and custodial ownership. It turns out that one of these companies is 1 out of 2 companies, which mentioned trust problems, and the other is 1 out of 3 companies, which mentioned inventory ownership and payment problems (Figure 19). As pointed out above, this cannot be proven a statistically significant correlation, but it may be a hint on the possible nature of the relationship between these aspects.

Key findings

It is rather common to combine VMI with consignment stock.

- Companies which combine VMI and consignment stock, do not make more commercial concession or have more conflicts with suppliers.
- But they do arrange custodial ownership to coincide with handling responsibility of goods.

8 Information Flows

Data shared

To map the flow of information, we asked which data is provided to the VMI-partner, how it is captured, how it is transmitted and what the VMI-partner is doing with it.

We expected the companies to transmit all the information necessary for the replenishment process. This comprises data on demand forecasts for planning, as well as information regarding inventory levels. This information can either contain items in stock and/or a signal when parts are consumed.

Hypothesis

All companies will provide a demand forecast and information regarding their inventory level.

If we look at the information transferred to the VMI-partner, we see that all the companies provide demand forecasts, 9 of them also transfer the number of items in stock and 5 send a signal when parts are consumed (Figure 20).

Looking at the answers of each individual company reveals that all but one transfer the number of items in stock or a signal when parts are consumed from the warehouse (allowing the calculation of stock levels) or both. One company, which does not transfer inventory data, turned out to employ a 3PL-based model where the 3PL collects the data himself. Therefore, we can conclude that in all cases the VMI-partners receive demand forecasts and information on stock levels. Our hypothesis is true. Demand forecast and stock levels are vital for any VMI-system.

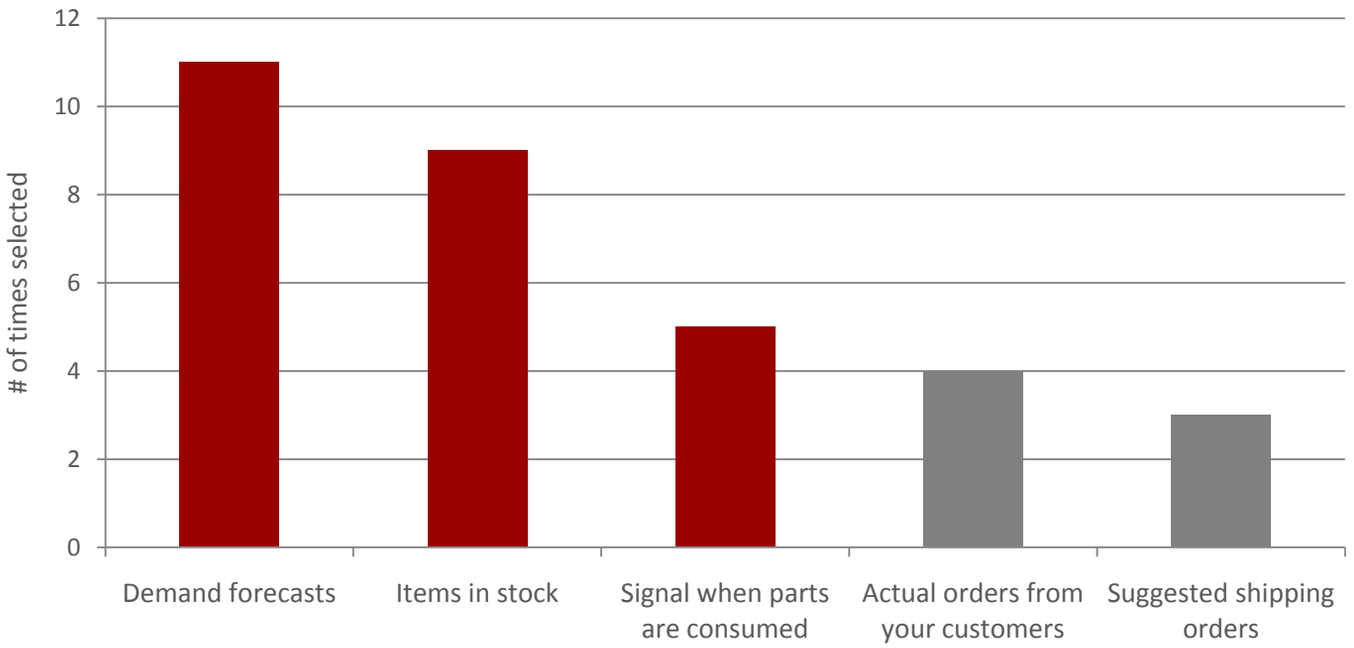

Figure 20: Information transferred to the VMI-partner

Technologies applied

We also asked which technologies are used to capture the inventory data and stock movements. Due to the importance of high value parts and their likely criticality for the production process, we expected that companies would put high effort into the proper monitoring of processes and stocks and to use the best technology available (like RFID) to avoid any mistake stock information.

Hypothesis

The most advanced companies use RFID technology to capture inventory data and stock movements.

The survey revealed a different picture (Figure 21): 9 of the 11 companies used conventional scanners to capture the data. Not a single company used RFID or other novel devices, such as webcams that let the suppliers literally look at stock levels.

Apparently, the advantages of RFID technology, such as traceability of items throughout the warehouse and the ability to scan items in bulk, seem not to be relevant or at least not to outweigh the costs in low to medium volume industries where quantities of parts and shipments are low compared to other industry sectors. The absence of high tech data capture solutions also suggests that there is a high level of trust between the VMI partners that stock information will be accurate. We will come back to the issue of trust in a later chapter. This trust is of particular importance when VMI is combined with consignment stocks (see section 6).

As to the transfer of data to the supplier, we expected the companies to communicate in a way that can easily be adapted to different companies' IT systems, where data can be accessed by both the vendor and the buyer and where some form of automation is possible, making fax or email communication unnecessary for day-to-day operations. While a direct connection of MRP-systems requires a high level of trust, a web-based platform, with either one- or two-way communication seems to be the perfect candidate for this task.

Hypothesis

Many companies use a web-based platform to communicate their data to the vendors.

This hypothesis is true (Figure 22): 10 out of 11 companies base their data transfer on an either one- or two-way web platform. These modules, that allow a rather customised way to grant a ubiquitous access to the relevant data, appear to be industry standard. Only two companies have their MRP-system connected to the VMI-partner's infrastructure. To the vast majority of the companies this represents a too critical intrusion into their network. This explains why the compatibility of IT infrastructures is not at all a relevant criterion for supplier selection to the companies, since the web platforms are totally platform independent.

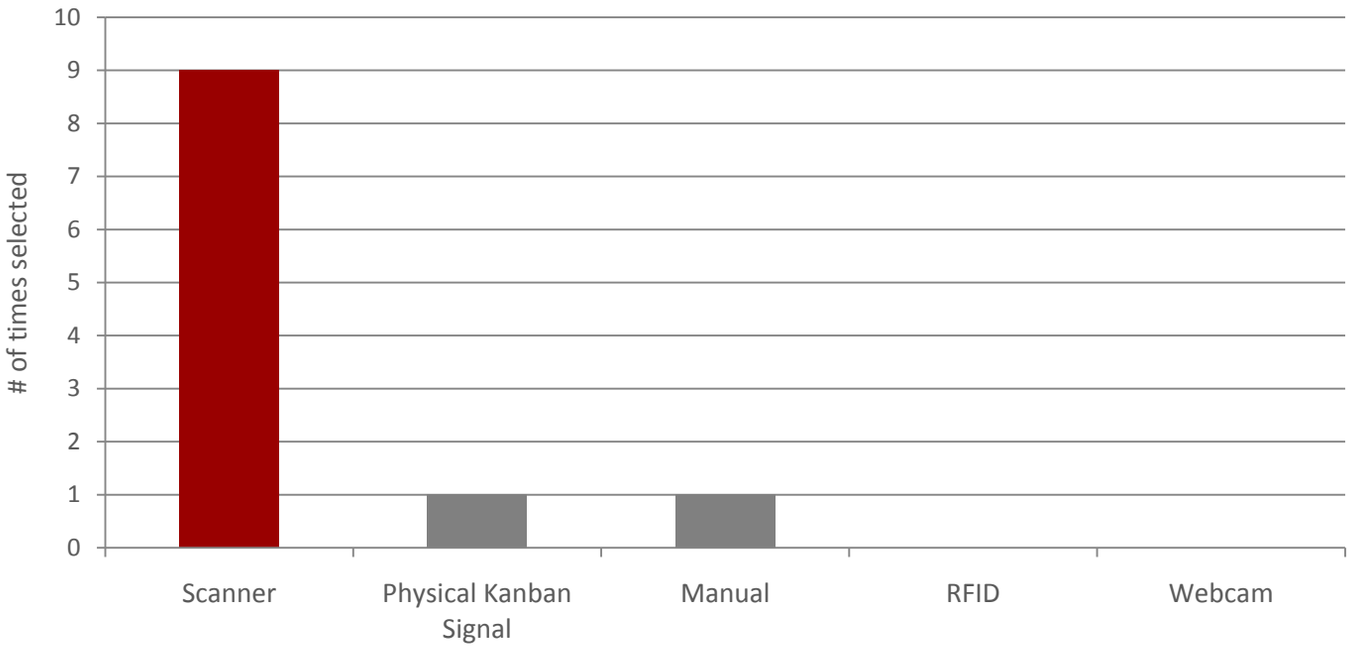

Figure 21: Technology used to capture inventory data and stock movements

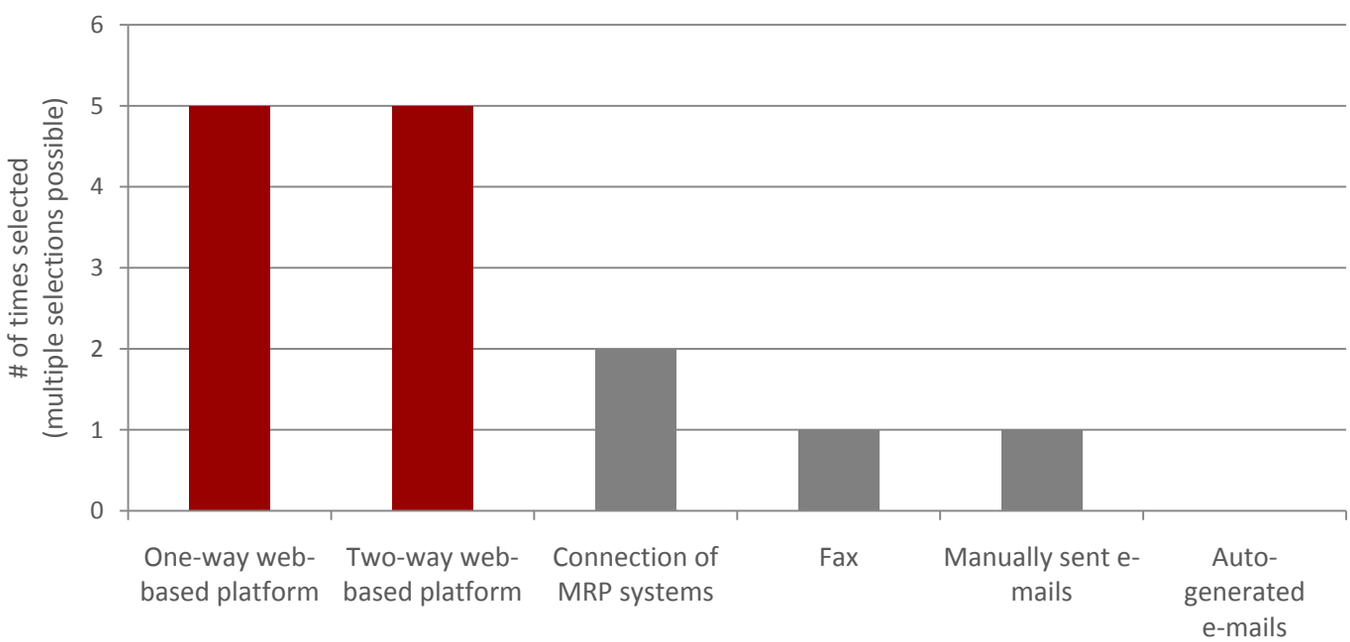

Figure 22: Systems of data transfer

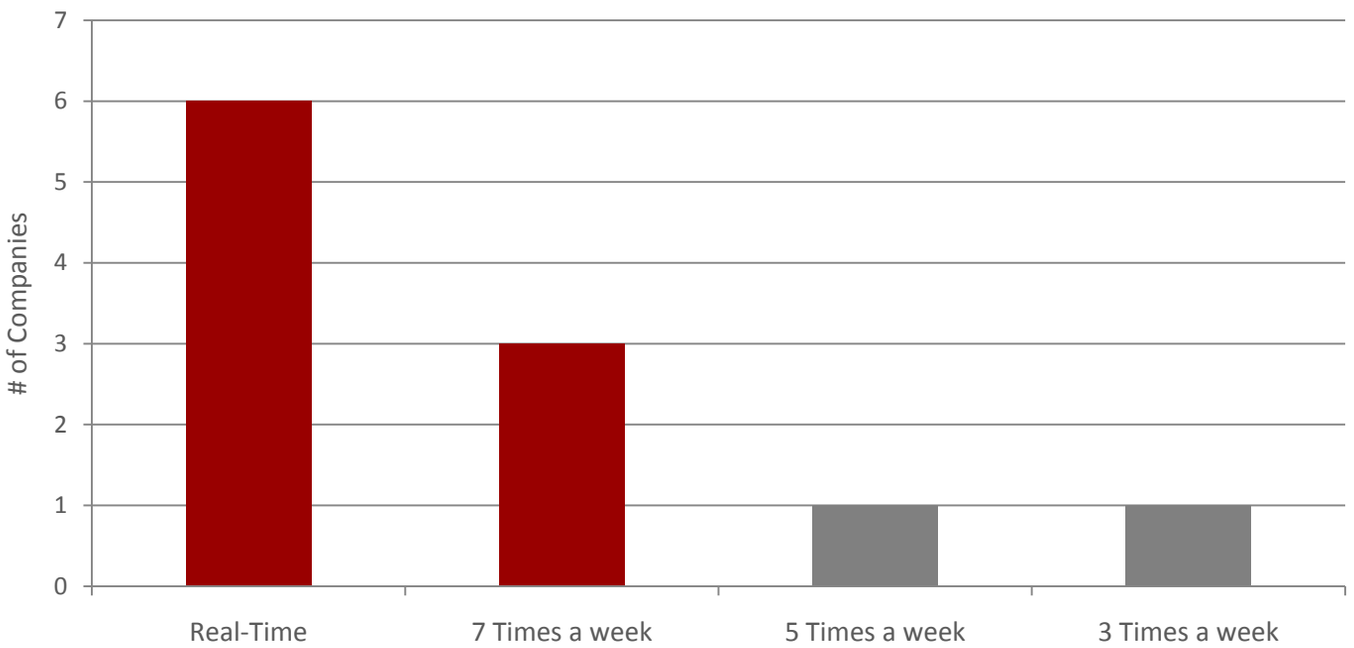

Figure 23: Frequency of data transfer

Update Frequency

Another aspect to the transferral of data is the refresh period, since the responsiveness of the system depends on data being up-to-date. Therefore, we expected most of the companies to transfer or refresh the data at least on a daily basis.

Hypothesis

The majority of companies refresh requirements data at least once a day.

The survey shows that 9 of the 11 companies refresh the data at least every day, 6 of them provide even real-time data.

Replenishment Decision

The final step in the information flow is the replenishment technique employed. Vendor-managed inventory does not necessarily give great flexibility to the supplier. Depending on the circumstances and the object for which the model is used, the buyer and the vendor can agree upon a more rigid or a more flexible model according to their needs. While Kanban and re-order point/re-order quantity techniques represent rather rigid frameworks where replenishment actions must be taken upon specific signals, Min/Max-level arrangements just provide boundaries between which the VMI-partner needs to keep the stock-levels and, thus, leave him a lot more autonomy and flexibility. Therefore, we expect a majority of companies to apply Min/Max-level arrangements in their VMI-model. Obviously, in every VMI system but especially in those without consignment stock arrangement the partners will agree some fixed maximum inventory level to avoid oversupply.

Hypothesis

Most companies apply a Min/Max-level replenishment technique in their VMI-system.

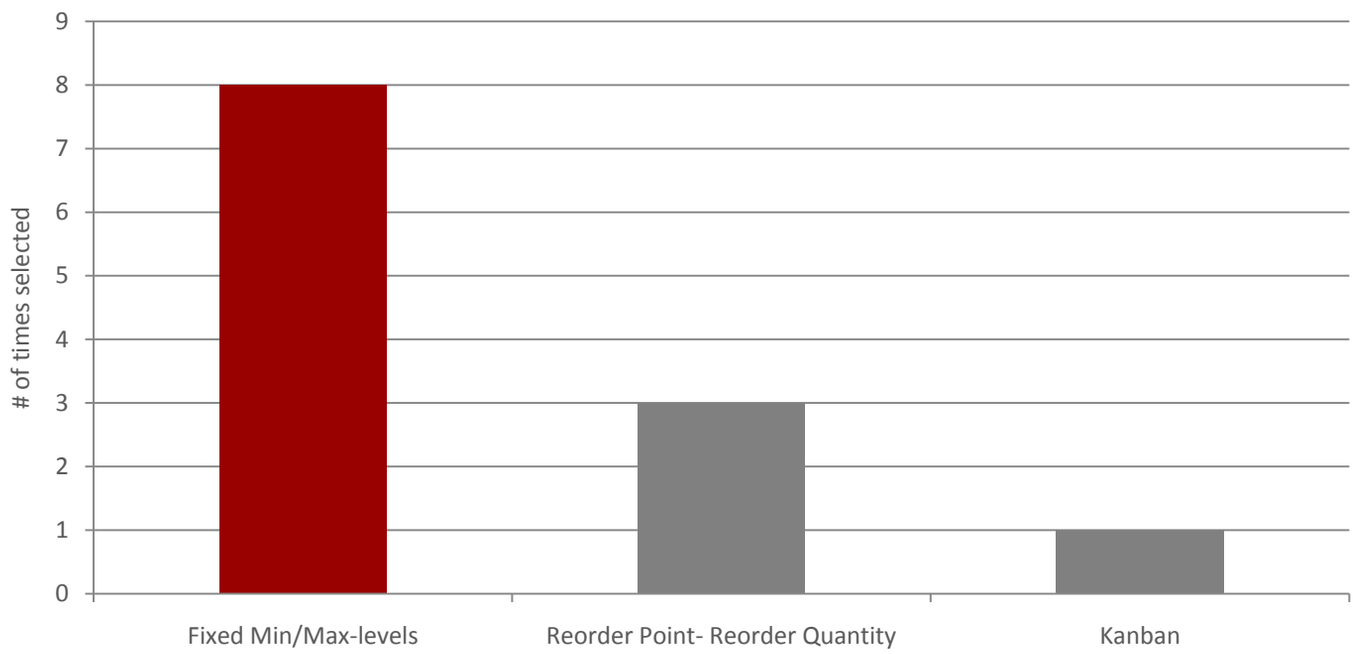

Figure 24: Replenishment techniques

It turned out that this hypothesis was true (Figure 24): 8 out of the 11 companies use Min/Max-levels as their replenishment technique. One firm is combining Min/Max with Reorder Point replenishment. The company that installed the Kanban system applies a special model: The supplier rents a warehouse on the buyer's premises, which he can replenish according to his needs and where he handles the flow of goods. The Kanban system is only responsible for the replenishment between this warehouse and the buyer's production. In this example, the buyer transfers not only the inventory management but also the warehouse management to the supplier.

It appears that the majority of companies prefer to grant the VMI-partners a wider autonomy in the replenishment process. This allows them to optimise their logistics and thereby achieve some benefits from the system (see section 6). The number of companies, which let their VMI-partners ship parts without further authorisation, also shows the importance of the autonomy of the VMI-partner. Since Vendor-managed inventory implies the vendor to assume the responsibility of inventory management, we expected a very high number of companies to allow the VMI partner to ship parts without further authorisation.

Hypothesis

The majority of companies allow their VMI partner to ship parts without further authorization.

Ten out of 11 companies indeed do not require further authorisation of shipments scheduled by the VMI-partner (Figure 25).

The one company insisting on authorization has established a very special model: There is just one supplier in the VMI programme and the responsible person at the buyer company is in constant close contact to him. Apparently, this is some sort of combined responsibility for the inventory management.

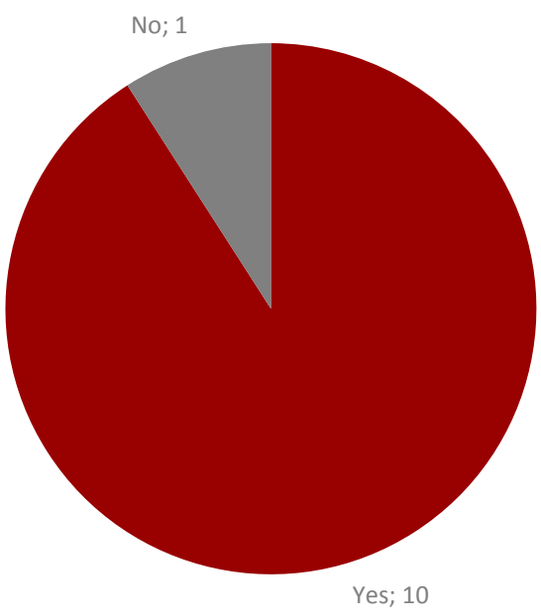

Figure 25: Authorisation of shipments required

Key findings

- All companies provide demand forecasts and the number of items in stock and/or a signal when parts are consumed.
- None of the companies use RFID or webcams to capture stock information.
- One- or two-way web-based platforms to transfer data are most common.
- Data is updated and transferred at least once daily.
- Defined Min/Max levels are the most common trigger for replenishment.

9 Physical Flow of Goods

This section describes the alternatives chosen in the physical flow of goods and at the same time, it summarises the overall set-up of VMI in the participating companies. This is because the physical flow heavily depends on the commercial set-up.

We found that the interviewed companies use three basic models, which mainly differ in terms of the warehousing responsibility and location. Six companies use the standard model (model 1). Two firms apply Model 2, which includes a 3PL. Three firms have implemented VMI with suppliers who are delivering highly critical parts and who are deeply integrated in the buyer's processes, a system which we will call model 3.

The first choice under normal circumstances will be model 1. As was argued in chapter 5, we only recommend to organise VMI via a 3PL when a large number of suppliers are included in the system. Model 3 will only be relevant for critical suppliers and parts.

Our models may serve as simple blueprints for the implementation of VMI, with further detail added from other parts of this report.

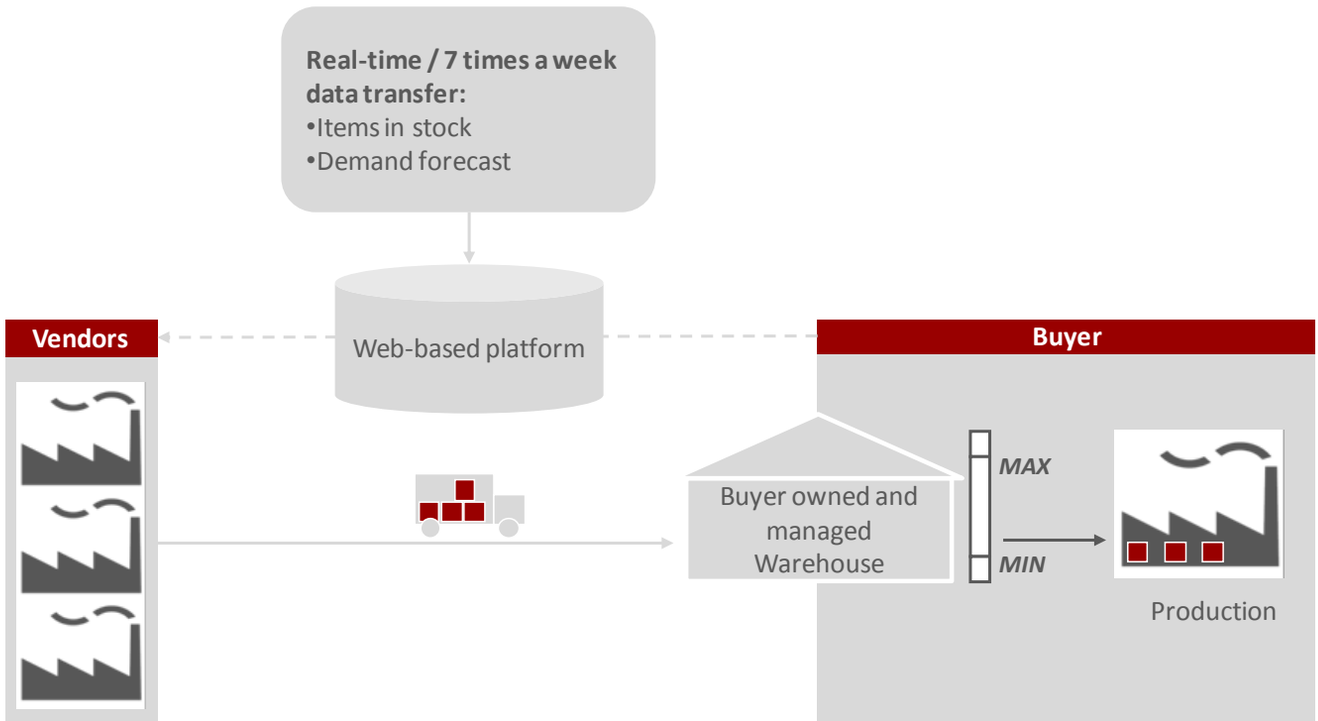

Figure 26: Model 1

Model 1 – Standard VMI-setup

In the standard setup (Figure 26), the vendor is responsible for replenishing the inventory, while the buyer is responsible for supplying the necessary information to do so.

All companies transmit a demand forecast, actual items in stock and in some cases additional information like stock consumption signals or actual customer orders, allowing the vendor to replenish the inventory. The exchange of information is organised through a web-based platform in almost all cases. The most common technique is to set Min/Max-levels as boundaries for the stock of inventory.

We found that consignment stock is a common practice, although not all companies practice it in this model. None of the buyers made commercial concessions but stated that system-based advantages, like “optimisation of lot sizes in production and transportation” were sufficient.

The buyer usually owns or rents a warehouse on his premises or close-by. Goods are transported from suppliers’ premises to this warehouse and from there to the assembly or production line. In one case, goods are delivered directly from the vendor to the buyer’s shop floor buffer with a just-in-time arrangement.

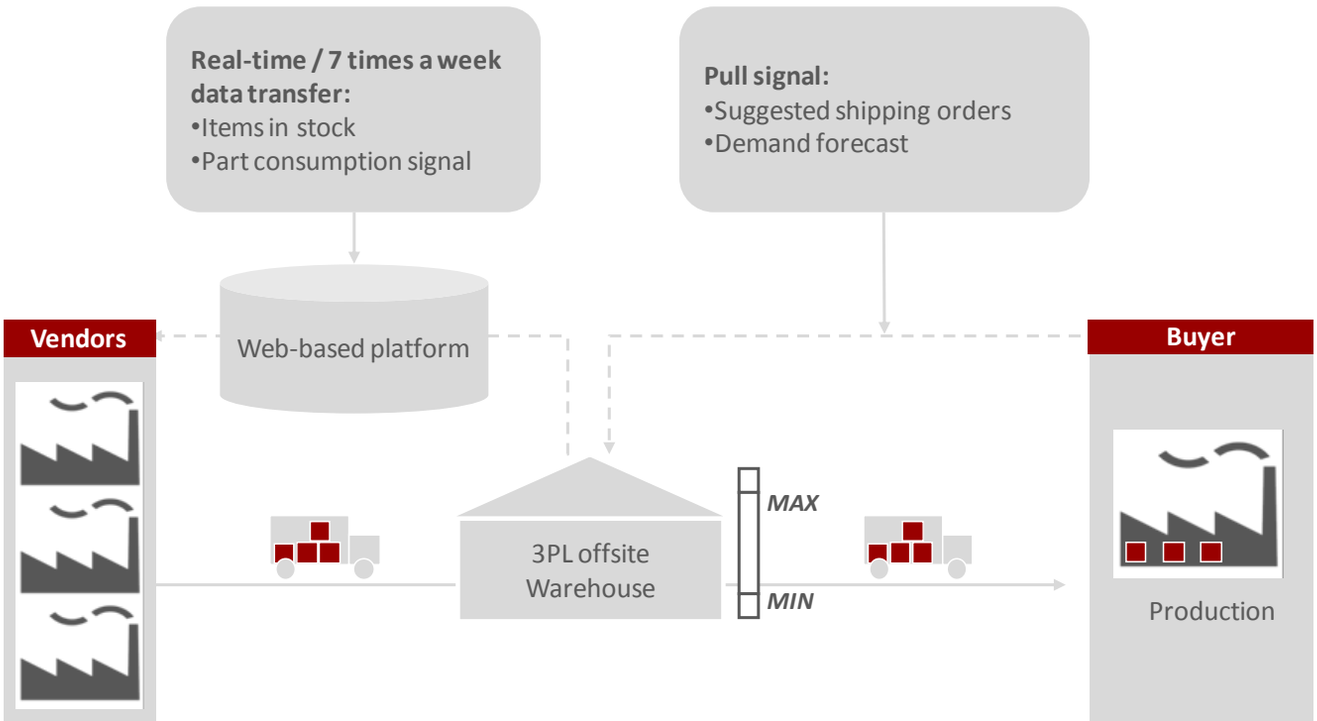

Figure 27: Model 2

Model 2 – 3PL-based VMI

In this model, a 3PL manages the inventory. He receives information on demand-forecast and shipping suggestions from the buyer according to his production schedule. In his warehouse, the 3PL replenishes inventory based on pre-defined minimum and maximum levels (Figure 27). Information transfer takes place over a web-based platform, connecting the 3PL-owned warehouse and the suppliers.

This model reduces the administrative effort of the buyer, but the 3PL will usually charge a service and handling fee.

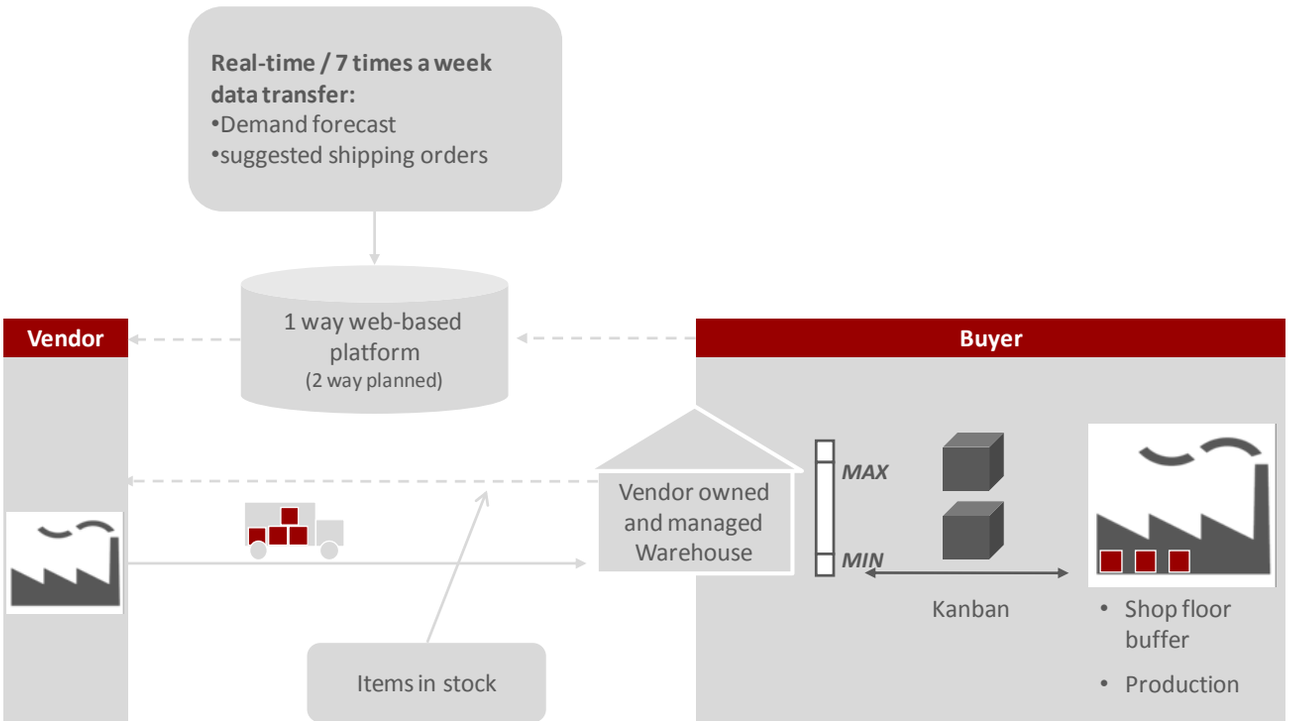

Figure 28: Model 3

Model 3 – Close collaboration VMI

Three companies have installed a setup in which intensive care is taken of critical parts and/or critical vendors. In this model, a single vendor owns a warehouse on or close to the buyer's premises (Figure 28). From this warehouse, the vendor delivers his parts to the buyer's production line. In two cases of the three cases, the parts in the warehouse are consigned.

The supplier's warehouse is situated on or close to the buyer's premises in order to reduce stock-out situations and assure delivery of mostly critical parts. To compensate the additional effort, commercial concessions have been made in all three cases. These concessions include higher item prices, service fees or earlier payment.

10 Recommendations for the Implementation

Vendor-managed inventory has proven to be successful practice in a small volume production environment. It can help the buying firm to concentrate on its customer side processes and at the same time to reduce its inventory. Potential drawbacks need to be taken into account, however. The survey has shown that the most common problem is conflicts with suppliers. To help avoid problems with VMI, we will sum up the key recommendations derived from the survey along the lines of the VMI framework introduced at the beginning of this document. Finally, we will propose a procedure for the implementation.

Revisiting the VMI Framework

In the commercial arrangement (Figure 29), a major issue is the point of transfer of ownership. The survey has shown that many companies combine their VMI-programmes with consignment stock and it turned out that they do not experience significantly more conflicts with their suppliers over inventory ownership or payment.

Commercial Arrangement					
VMI Partner	Vendor	3PL	Combination/ Other		
Parts delivered	Single parts	Kits	Batches		
Point of change of ownership	Pick-up of part	Delivery	Consumption into shop floor	Payment received from final customer	
Point of custodial ownership	Pick-up of part	Delivery	Consumption into shop floor	Delivery of final product	Coincide with handling responsibility
Compensation in case of production delay	None	Compensation fee	Parts paid latest X days after delivery	Other	

Figure 29: Recommended commercial arrangement

Moreover, it makes good sense to implement a consignment stock arrangement in order to create an incentive to the VMI-partner for keeping optimal inventory levels. While it is not so common to implement a form of standardised up front compensation scheme in the case of production delays, we would recommend setting the point of transfer of custodial ownership of parts to coincide with the transfer of handling responsibility in order to avoid conflicts in this area.

Companies will need to decide whether to transfer responsibility for the replenishment decision to a 3PL or let suppliers assume inventory responsibility. Due to the characteristics of high-value VMI, we recommend to put the vendors themselves in charge of the replenishment decision. Including a 3PL may be considered when involving a large number of different suppliers.

The flow of information represents the core of the VMI-system. Inventory responsibility can only be transferred if sufficient information on stock levels and requirements is provided. Therefore, the information processes should be designed carefully and IT-Experts from all stakeholders will need to be involved (Figure 30).

Flow of Information					
Replenishment Technique	Kanban	Fixed Min/Max levels	Reorder Point/ Quantity	Other	
Information shared	Shipping Orders	Demand Forecast	Items in Stock	Stock Consumption Signal	Customer Orders
Signal capturing	Scanner	RFID	Webcam	Physical Kanban signal	Manual
Signal transfer	Manual (mail, phone, fax)	Automatic Email	1-Way web-based platform	2-Way web-based platform	Connected MRP systems
Transfer frequency	Realtime	Daily	X times per week	Weekly	
Shipping authorisation necessary	yes	No			

Figure 30: Recommended information process

Flow of Goods					
Inventory held at	Vendor	External Warehouse	On-site warehouse	Shop-floor buffer	
Partitioning of warehouse	No partitioning	Separate on part level	Separate area for each vendor	Separate area for all VMI	
Location of shop floor preparation	Vendor	External Warehouse	Onsite Warehouse	Assemby Line	

Figure 31: Recommendations regarding the physical process

Some standards seem to have evolved. Companies generally agree replenishment according to Min/Max levels and use scanners to capture stock information. They transfer demand forecasts and conclusive information on inventory levels over web-based platforms daily or even in real-time and let their VMI-partners arrange shipments without further authorisation.

The goods flow (Figure 31) has to be adjusted to the conditions of each individual company. We have presented and discussed three alternative models in chapter 9. However, the survey has revealed that irrespective of other conditions, separating VMI parts from other parts in the warehouse plays an important role in achieving process improvements. It will help to reduce process complexity and to win the support from suppliers who want to have as much transparency of the whereabouts of parts as possible, in particular in a consignment stock operation. Therefore, we strongly recommend arranging a designated area for the VMI-parts within the warehouse and create a separate ERP warehouse (cf. Micheau, 2005).

Project Management

Figure 32 presents a recommended procedure for implementing VMI. It may have to be individually adapted to a company's needs, e.g. firms may want to involve key suppliers already in the system design phase or selects parts before defining the processes. However, it will give good first guidance to the project manager.

Throughout the implementation of VMI, communication between all related partners is crucial. The project manager will have to ensure that communication keeps going beyond implementation to avoid conflicts.

Like any such change in procurement processes, the implementation of VMI will require support from a number of different stakeholders – internal and external. The consistently positive picture drawn by the participants of our survey can help win this internal support. Especially the fact that all companies including the more experienced ones are planning to expand their VMI-programmes shows the success of this concept throughout the small volume industries. It will also help to know that combining VMI and consignment stocks – against all expectations – does not create more problems or conflicts.

Once internal support is gathered, external stakeholders, i.e. VMI-partners, need to be convinced. Their potential for process improvements thanks to better transparency should be the basis of negotiations. If a consignment stock arrangement is considered, the fact that it is common practice in our sample and the measures presented to avoid conflicts, should help to convince VMI-partners of its feasibility and significance. Some companies mentioned that the prospect of becoming a single source helped convincing suppliers. Open and frequent personal communication will be the key to success for any VMI project.

Select Team	☐
Including • Purchasing • Logistics • IT • Assembly staff	
Set Targets	☐
• Inventory reduction • Administrative cost reduction • Improved service levels	
Define Set-up based on own capabilities	
Commercial arrangement	☐
• Consignment Stock • Custodial Ownership • Guaranteed Payment	
Information processes	☐
• Data to be transferred • ERP arrangement (separate warehouse, booking procedure, purchase order arrangement) • Replenishment system • Data transfer platform	
Physical processes	☐
• Separate warehousing space • Direct delivery to assembly or via warehouse • Location of warehouse	
Select Suppliers and Parts	☐
• Suppliers based on closeness of relationship and capabilities • Parts based on value, demand stability and physical characteristics	
Negotiate with suppliers	☐
• Present the desired solution and advantages to the supplier	
Define supplier/part specific set-up	☐
• Stock levels • Commercial arrangement • Information process • Physical process	
Implement the VMI system	☐
• Change contract • Set up information systems • Prepare warehouse/ shop floor accordingly	

Figure 32: Recommended Implementation Process

11 Glossary

Consignment Stock	Consignment Stock is stock at a buyers' premises which is owned by the vendor - usually until it is used or sold by the buyers
High-Value Parts	Used to distinguish the parts in question here from low-value items which are often managed through a C-Part Kanban System
SCM	Supply Chain Management
VMI	Vendor-managed Inventory: The buyer provides additional information to enable the vendor to manage inventory at the buyer's site. Sometimes also referred to as *Supplier Managed Inventory*.
VMI Partner	The party managing the inventory, can be the manufacturer, a wholesaler or a logistics service provider
3PL	Third Party Logistics Provider

12 Bibliography

Blackhurst, J., Craighead, C., & Handfield, R. (2006). Towards supply chain collaboration: an operations audit of VMI initiatives in the electronics industry. *International Journal of Integrated Supply Management* , pp. 91-105.

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* , pp. 199-215.

Eitelwein, O., Goldsby, T. J., Pohlen, T. L., & Wallenburg, C. M. (2008). The Evolution in Supply Chain Replenishment Models: New Opportunities to Create Value. *Supply Chain Management* , pp. 15-23.

Gümüs, M., Jewkes, E. M., & Bookbinder, J. H. (2008). Impact of consignment inventory and vendor-managed inventory for a two-party supply chain. *International Journal of Production Economics* , pp. 502-517.

Kuk, G. (2004). Effectivness of Vendor Managed Inventory in the electronics industry: Determinants and outcomes. *Information and Management* , pp. 645-654.

Lee, H. L., Padmanabhan, V., & Whang, S. (1997a). Information distortion in a supply chain: The Bullwhip Effect. *Management Science , 4*, pp. 543-558.

Lee, H. L., Padmanabhan, V., & Whang, S. (1997b). The Bullwhip Effect in Supply Chains. *Sloan Management Review , 3*, pp. 93-102.

Micheau, V. A. (2005). How Boeing and Alcao implemented a successful Vendor Managed Inventory program. *The Journal of Business Forecasting* , pp. 17-19.

Sarpola, S. (2007). *Evaluation framework for VMI systems.* Helsinki: School of Economics.

Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2008). *Designing and managing the supply chain: concepts, strategies and case studies.* New York: McGraw-Hill/Irwin.

Som, O. (2007). *Strukturen und Treiber des Innovationserfolgs im deutschen Maschinenbau. Innovationstag 2007.* Frauenhofer Institut für System und Innovationsforschung, Magdeburg.

Supply Chain Digest. (2009). *Supply Chain Digest.* Retrieved January 12, 2010, from http://www.scdigest.com/assets/newsviews/09-04-29-1.pdf