VAASAN AMMATTIKORKEAKOULU
VASA YRKESHÖGSKOLA
UNIVERSITY OF APPLIED SCIENCES

Jukka-Pekka Poutanen

VENDOR MANAGED INVENTORY

CASE WÄRTSILÄ INDUSTRIAL OPERATIONS

International Business

2010

FOREWORD

This thesis was concluded during spring 2010. The supervisor from Vaasa University of Applied Sciences was Mr. Jukka Paldanius and from Wärtsilä there were three operational purchasing managers acting as supervisors. I would like to express my gratitude to my three managers Mr. Juha Päivike, Mr. Markus Honkala and Ms. Heli Raunio. The idea for this thesis came from Wärtsilä where I have also worked on and off besides my studies for two years. Doing this thesis was the biggest project in my life so far both academically and professionally. Even though the subject has not been easy I have enjoyed doing thesis and the challenge it brought tremendously.

Vaasa 12.5

Jukka-Pekka Poutanen

VAASAN AMMATTIKORKEAKOULU

UNIVERSITY OF APPLIED SCIENCES

Degree Programme of International Business

ABSTRACT

Author	Jukka-Pekka Poutanen
Topic	Vendor Managed Inventories – Case Study Wärtsilä Industrial Operations
Year	2010
Language	English
Pages	91 + 1 Appendix
Supervisor	Jukka Paldanius

The purpose of this thesis is to research Vendor Managed Inventory (VMI) and to see how it can be implemented in Wärtsilä. The purpose is also to see what benefits VMI brings in our case study. In the theoretical part VMI, general terminology and concepts related to VMI are defined.

The advantages and disadvantages of VMI are researched well and in this research they are more elaborately split into pieces through changes that arise from VMI. The empirical research was done by conducting several qualitative interviews with personnel from Wärtsilä and the information was then applied together with VMI theories to create options on how to implement VMI. Theoretically VMI can be implemented in many ways and several options were created for Wärtsilä.

All the VMI enablers named in theories were found from Wärtsilä's organization and further suggestions were given on how they could have optimal implementation and what would it need. In this case study logistical advantages were found to be emphasized more than in theories due to the large size of the components. Large size and long lead time also pose additional challenges regarding information change.

The originality of this study comes from the long lead time and large size of the components. The different operational and technical aspects of VMI have not been researched extensively and this thesis shows different operational and technical solutions for how to implement VMI and what is the rationale behind each choice. Besides Wärtsilä practical implications exist for all manufacturing companies looking to implement VMI.

Keywords: Supply Chain Management, Procurement, Outsourcing, Inventory Management, VMI

VAASAN AMMATTIKORKEAKOULU

Degree Programme of International Business

Tiivistelmä

Tekijä	Jukka-Pekka Poutanen
Opinnäytetyön nimi	Vendor Managed Inventories – Case Study Wärtsilä Industrial Operations
Vuosi	2010
Kieli	English
Sivumäärä	91 + 1 Liite
Ohjaaja	Jukka Paldanius

Tämän opinnäytetyön tarkoitus on tutkia Vendor Managed Inventorya (VMI) ja kuinka sen mahdollista käyttöönottoa Wärtsilässä. Tutkimuksen tarkoituksena on myös tutkia VMI:n mahdollisia hyötyjä tässä tapaustutkimuksessa. Teoriaosuudessa VMI, yleinen terminologia ja VMI:iin liittyvät käsitteet on määritelty.

VMI:n hyötyjä ja haittoja on tutkittu paljon ja tässä tutkimuksessa ne on myös jaettu osiin VMI:n tuomien muutosten mukaan. Empiirinen tutkimus suoritettiin tekemällä useita kvalitatiivisia haastatteluja Wärtsilän henkilökunnan kanssa ja niistä saatujen tiedon sekä VMI:n teorioiden avulla luotiin malleja, kuinka Wärtsilä voi toteuttaa VMI:n. Teorioiden mukaan VMI voidaan toteuttaa monella tavalla ja useita malleja luotiin Wärtsilälle.

Kaikki VMI:n teorioissa mainitut mahdollistajat löydettiin Wärtsilästä ja sille annettiin lisäehdotuksia mitenkä se voisi toteuttaa VMI:n optimaalisesti ja mitä siihen vaaditaan. Tässä tapaustutkimuksessa logististen etujen havaittiin olevan isommassa asemassa kuin teorioissa yleensä johtuen komponenttien isosta koosta. Iso koko ja pitkä läpimenoaika luovat myös lisähaasteita tiedonvaihtoon liittyen.

Tutkimuksen omaleimaisuus tulee komponenttien pitkistä läpimenoajoista ja isosta koosta. VMI:n eri operatiivisia ja teknisiä osa-alueita ei ole tutkittu laajalti. Tämä opinnäytetyö esittelee erilaisia VMI:n operatiivisia ja teknisiä malleja valintaperusteineen. Wärtsilän lisäksi työstä voivat hyötyä kaikki tuotantoyritykset, jotka suunnittelevat VMI:n käyttöönottoa.

Asiasanat: Toimitusketjun Hallinta, Hankinta, Ulkoistaminen, Varastohallinta, Toimittajan Hallinnoima Varasto, VMI

CONTENTS

BACKGROUND OF THE THESIS

The present trend of outsourcing is that more goods are being outsourced with more advanced services included (Iloranta & Pajunen-Muhonen 2008, 48). Vendor Managed Inventory is an example of such value added process being outsourced (Zammori, Braglia & Frosolini 2009, 165). The history of Vendor Managed Inventory starts in the 1980s when mass retailers started to require their suppliers to take control of the inventory management. Later VMI has expanded to many other industries and different kind of products as well. (Claassen, van Weel & van Raaij 2008, 406).

Wärtsilä produces complete lifecycle power solutions for the marine and energy markets. Wärtsilä Industrial Operations' (WIO) Delivery Centre Vaasa is part of the Industrial Operations organization that produces engines, gen sets, propellers, gears, seals & bearings, and electrical power and automation to be sold internally to Wärtsilä's selling units. In their procurement they have previously used VMI for nonstrategic goods for a few years now. The idea to start implementing VMI for strategic goods has also been considered every now and then and last time was around 2006 or 2007. At that time the economy was booming and suppliers' capacity to deliver was being tested even without process changes and therefore VMI was seen as too risky to start. After the credit crunch of 2008 the volumes have been lower and the idea has been topical again. The motivation for Wärtsilä to start implementing VMI is to have more optimized inventory practice, lower total supply chain costs and more agile suppliers.

I have worked in the WIO purchasing department for two years besides my studies. To further improve my knowledge of procurement I wanted to do my thesis for them also. In December 2009 I was introduced to the idea of VMI and asked if I want to do my thesis about it. VMI was suggested for me as a topic as it is a demanding and complex process for both Wärtsilä and their suppliers so proper research was wanted before initial pilots. Evidently I accepted this topic proposal and worked on this study full time between 11.1.2010-31.3.2010.

1.1 Thesis Objectives

The first research objective is to find out if Wärtsilä can use VMI for more strategic goods. The second objective is to define the process for Wärtsilä as VMI has not been used for these kinds of products. To have VMI implemented with a large supplier base with different abilities no one-for-all solution exists. Therefore the objective is to find out several different ways how VMI can be implemented with different suppliers. After the process is created the last objective is to see what is needed from both parties for a successful implementation.

My personal objective is to gain knowledge of this process and to expand my knowledge of different areas of procurement. This will further improve my professional skills I have managed to obtain during my studies. To manage to create a large process for a multinational company is a good experience that I have not had prior this thesis. In addition, my academic aspiration was to learn how to do and write scientific research to give me a good base to start to pursue my Master's degree.

1.2 Limitations

This study is done for only one company and more specifically only one business unit of the case company. This study has three different limitations. First, the components chosen have industry and company specific volume, size and lead-time characteristics that are most likely not so common in other industries. Second, only one procurement organization was used as a customer to do this study so the IT-infrastructure, managerial capacity and other things from the customer's side were a constant variable. Third, this study is preliminary meaning that is at the time this thesis is published Wärtsilä has not piloted VMI. Therefore no actual results of the implementation are analyzed in this study. To minimize this limitation newest available sources were used extensively and professionals from many areas related to VMI in the case company were interviewed.

1.3 Usability

The usability of this study exists in many ways. Obviously the case company will benefit the most of this study as it is tailor-made considering their capabilities. Other companies thinking of implementing VMI will also benefit from this study as this can be used as a guideline on how to implement VMI. First, technical aspects are considered from SAP ERP point of view and thus all companies that use SAP can benefit from those. Second, the logistical aspects are considered specifically for products that take a lot of space and thus the leeway can not be large. Third, the long lead time of the products and manufacturing to manufacturing relationship are considered when thinking of the information change.

By reading this study the reader should also have a thorough understanding of where the benefits of VMI actually come from. By understanding this expectations of VMI can be set accordingly and it will help both parties involved in VMI to have valid expectations for the new relationship.

1.4 Novelty

What this paper has to offer academically is that is that in my best knowledge this is the first ever research done for components with this long lead times and large size. This study also compares different technical and operational aspects extensively and contains in-depth analysis of manufacturer to manufacturer relationship changes. This is especially important for manufacturing companies that are considering implementing VMI. The actual benefits are also considered more in-depth than the VMI theories often have and they are split up to different changes that possibly arise from VMI depending on how it is implemented.

1.5 Outline

The first part of this thesis is the introduction. In the first part the research background, problems, objectives, limitations and novelty are defined. The second part of this thesis is the theoretical framework. The theoretical framework has four main themes: general terminology, outsourcing, purchasing and finally Vendor

Managed Inventory. After the theoretical framework comes the empirical part of this thesis which is divided into two main themes: the current process that is used in Wärtsilä and the new process where VMI comes into picture. The fourth and last part of this thesis is for results and recommendations.

1.6 Research Problems

The research questions answered in this research are the following:

1. Explain the theory of VMI

2. Describe the process for Wärtsilä

3. What is needed from the vendor in order to start a VMI?

As said in the theory VMI can be implemented in many ways depending on the industry and other set ups. (See for example Claassen, van Weele & van Raaj 2008.) The purpose of this paper is to find out if VMI is suitable for Wärtsilä and how Wärtsilä could implement VMI. Later the study is expanded to find out what the specific operational and technical options would require from Wärtsilä and from a vendor.

2 Theoretical Framework: Outsourcing, Procurement and Vendor Managed Inventory

The purpose of the theoretical framework of this thesis is twofold; firstly to go through the terminology and basic concepts used in this paper and secondly to go deeper into the theories of vendor managed inventory. Although the reader of this thesis is expected to be aware of the basic theories of purchasing and outsourcing I will also explain them shortly.

Some of the chapters in the general terminology were written from only a few sources. That is due to the fact that the author was well aware of many of these terms so the reliability assessment was easy to make. For theories relating procurement and outsourcing a book by Iloranta and Pajunen-Muhonen (2008) was chosen because of several reasons. The reliability of the book is assessed well: it has sources marked in it and secondly as the book is published in the year 2008 the information is still very up to date. Lastly it is written by Finns with a lot of studies about the Finnish industries, which is relevant as the case company is from Finland as well. For theories about VMI the reliability was assessed by using the newest and most relevant academically approved sources. Also multiple sources per topic were used to be sure of the reliability.

2.1 VMI Literature Review

Even though literature found on VMI is quite extensive; the theory found is often more theoretical instead of being technical or practical. Many of the more practical researches found concentrate on performance of VMI instead of its technical aspects. (Zammori, Braglia & Frosolini 2009, 165.) The other problem with VMI theories is that its maturity phases are not usually elaborated and the expected benefits vary between first and second stage of VMI. (Claassen et al. 2008, 407.).

Thirdly a lot of the studies conducted of VMI are made on manufacturer to retailer form of VMI. However, the scope of this study's empirical part is manufacturer to manufacturer VMI and of strategic components rather than commodity goods. No

studies were found that would have mentioned VMI being used for goods that are as large as in our case with as long lead time so much effort has been made to find what options would be the most suitable for Wärtsilä. This has a big effect on the operational and logistical side of VMI.

Lastly as there is not much technical or operational literature found on VMI there is even less literature on the aspects from the vendor's perspective. What I noticed was that most of the theories found are under supply- and inventory management and thus often made from the buyer's point of view. Therefore the first phase was to define how Wärtsilä could use VMI and then it was studied how it may affect Wärtsilä's suppliers. Also no theory mentioned having more than one supplier for a product that has only one material number.

The strength of the theoretical part of VMI, or this paper, is that the theories are uniform and do not contradict each other much. That is partly due to the fact that VMI as a concept is not defined strictly. Although the benefits and reasoning for VMI are very congruent, when researching the theories of VMI in a more operational and technical way it can be noted that there are many ways to implement it and the basic interactions such as purchase orders and invoices are done in varying ways. Another thing to note is that the terminologies are not always used correctly or congruently. Some theories mix up Consignment stock, Automatic Replenishment Program and VMI.

In this thesis all the benefits mentioned in theories were identified where they come from. It was also notable that that VMI itself targets mostly decision change and minimum and maximum inventory levels. All other benefits come from other process changes that often come along with VMI implementation. In our case study not all the operational ways how to implement VMI that are mentioned in theories are possible due to relatively small leeway between minimum and maximum levels and long lead times.

2.2 General Terminology

In this part of the thesis I will go through the basic terms and concepts used so the reader is better able to understand the main theoretical part of this thesis while reading it. If the theories have specifically mentioned how they relate to VMI I have tried to include that fact also. This part of the theoretical framework will act as a general introduction to the core theoretical part of this thesis which will cover the concept of VMI thoroughly.

2.2.1 Auto-ID Technologies

Auto-ID technologies collect data about the objects and then communicate it into a database without human intervention. Primarily Auto-ID technologies are used in identification and tracking boxes, people, animals or other moving objects. Common forms of Auto-ID technologies include Radio Frequency Identification (RFID), Magnetic Ink Character Recognition (MIRK), magnetic strip, voice recognition, biometrics, and barcodes. (Brown, Patadia, Sanjiv & Meyers 2007, 24).

2.2.1.1 Barcode

Barcodes are a form of Auto-ID technology that consist of black and white stripes of varying widths. There are several hundred different types of barcodes with the Uniform Product Code (UPC) being the most commonly used in the retail industry. Barcodes need a line of sight and they must be orientated compatible with the scanners. Barcodes need to be properly aligned to the readers so they don’t work hands- and eyes-free. (Brown et al. 2007, 24.).

2.2.1.2 Radio Frequency Identification (RFID)

RFID is a form of Auto-ID technology that is based on radio-frequency which allows distance reading possibilities. As a sub-group of Auto-ID technologies Barcodes are the closest to RFID with the biggest difference being that whereas Barcodes need be aligned with the scanner and require line-of-sight, RFID tags can be read from a distance without line-of-sight. RFID readers can read the tags even if they’re optically hidden as long as they’re within the range. In supply

chain RFID can be used in shipping and receiving, warehousing, retail outlet and inventory management. Manufacturing applications on the other hand exist in tracking work in progress, finished goods, inventory levels and locations. (Brown et al. 2007, 24, 31-32).

2.2.2 Automatic Replenishment Program (ARP)

Automatic replenishment program is a concept used in inventory management where the inventory restocking decisions are made more on actual sales than long term forecasts or safety stocks and the decisions are made by the supplier. There are varieties of names that address to these programs such as Vendor Managed Inventory, Continuous Replenishment Program and Quick Response for example. (Sabath, Autry & Daugherty 2001, 91.).

2.2.3 Bullwhip Effect

“The bullwhip effect is a phenomenon observed in forecast-driven distribution channels, caused by uncertainty of demand or interrupted information flows between supply chain partners.” (Claassen et al. 2008, 407.) The demand distortion comes because the orders to the supplier tend to have a larger variance than sales to the buyer. (Lee, Pahmanabhan, & Whang 2004, 1875.) “Inaccuracies in forecasts and the tendency to build safety stocks result in variations between production and demand and these variations are amplified as one moves upstream in the supply chain, i.e. away from the final customer.” (Claassen et al. 2008, 407.) Lee et al. 2004 list the disadvantages of such behaviour to the manufacturer as follows: “The manufacturer incurs excess raw materials cost due to unplanned purchases of supplies, additional manufacturing expenses created by excess capacity, inefficient utilization and overtime, excess warehousing expenses and additional transportation costs due to inefficient scheduling and premium shipping rates.” Studies have estimated that these costs would account in excess costs in between 12.5% to 25%. (Lee et al. 2004. 1875).

2.2.4 Consignment Stock

Consignment stock is a stock owned by the vendor at a supplier's premises. With consignment stock the customer removes the products from the stock when needed and the goods are then invoiced based on actual consumption. (Persona, Grassi, & Catena, 2005, 4970-4972). The advantage of consignment for the customer is that it has increased service and lower costs, while the supplier on the other hand achieves service-based competitive differentiation. (Bendoly & Jacobs 2005, 112).

2.2.5 Enterprise Application Integration (EAI)

Enterprise Application Integration (EAI) -program is a name for programs that integrate modules of ERP programs to each other. EAI works as a link between ERPs or their modules and converts the information to a proper form so the other system is able to read it. (Linthicum 2000. XVII-XX.).

2.2.6 Electronic Data Interchange (EDI)

Electronic Data Interchange (EDI) is an effective tool for supply management that provides a way to transfer and use information among supply chain members. (Zhang, Hill, Xia & Liang 2010, 96) The data in EDI is sent from a computer in one organization to a computer in another organization in a structured, pre-determined way. (BCC 1997, 246.) EDI was originally developed more than 35 years ago but its use has not vanished due to popularization of Internet, rather it has expanded due to the expansion of communication capabilities and platforms for it. In recent studies EDI has been reported as the most popular way of communicating between the supplier and the buyer. (Zhang et al. 2010, 96.). Bendoly & Jacobs (2005) mention EDI being commonly used in a VMI setting.

2.2.7 Enterprise Resource Planning (ERP)

Koh & Simpson (2007) describe ERP as following: "The term ERP can be defined as an accounting-oriented information system for identifying and planning the enterprise-wide resources needed to take, make, ship and account for customer

orders.“ ERP programs are used as production planning and control tools. The supply chain competitiveness relies on how efficiently the information is shared between the members of the supply chain and this information can be shared by utilizing ERPs. Common providers for big ERPs are SAP, BaaN, ORACLE, JDEDWARDS, and PeopleSoft. For medium-size and less complex ERPs the main providers are Alliance Manufacturing, MFG/PRO, WinMan and all-in-one. (Koh & Simpson 2007, 59-60.).

2.2.8 Incoterms

Incoterms are internationally applicable standard rules for delivery that define the responsibilities for each party. More specifically Incoterms define the exact place of delivery from seller to buyer, the responsibility for costs of delivery, what are the needed actions, and at what point the risk passes from the seller to the buyer and thus helps to avoid misunderstandings in these matters by being an internationally accepted norm. Incoterms can be used nationally also but in that case it has to be remembered that not all the Incoterms are suitable for trade within borders. (BCC 1997, 36-38; Iloranta & Pajunen-Muhonen 2008, 491.). Incoterms do not consider transfer of title of goods, only the responsibilities of the seller and buyer considering the delivery of the goods. (Gardner 2004, 102)

Incoterms 2000	
Group E	**Departure**
EXW	Ex Works (named place)
Group F	**Main Carriage Unpaid**
FCA	Free Carrier(named place)
FAS	Free Alongside Ship(named shipment port)
FOB	Free On Board (named shipment port)
Group C	**Main Carriage Paid**
CFR	Cost and Freight (named destination port)
CIF	Cost Insurance and Freight (named destination port)
CPT	Carriage Paid To (named destination place)
CIP	Carriage and Insurance Paid (named destination place)
Group D	**Arrival**
DAF	Delivered At Frontier (named place)
DES	Delivered Ex Ship (named destination port)
DEQ	Delivered Ex Quay (duty paid at named destination port)
DDU	Delivered Duty Unpaid (named destination place)
DDP	Delivered Duty Paid (named destination place)

Table I: Classes of Incoterms (Iloranta & Pajunen-Muhonen 2008; BCC 1997)

Incoterms are divided in four groups E, F, C and D where in the E class the buyer has the least responsibilities, risks and costs and in D it has the most. (BCC 1997, 36-38)

2.2.9 Just in Time (JIT)

Just in Time is a lean-manufacturing policy that aims for optimal production flow. In JIT manufacturing it is only produced what is needed and when it is needed. (White, Pearson and Wilson 1999, 1-2.) JIT purchasing is in line with the manufacturing and thus it is only ordered what is needed and delivered when they're needed in small batches. The traditional model of JIT purchasing used by Toyota is that there has been only one supplier located close to the factory. The buyer-supplier relationship in that kind of setting is based on close co-operation

and fast information change. (Adehorunmu, Bolourin and Bryson 1995, 375.) JIT most definitely addresses the issue of inventory control, but the risk is too big with suppliers, varying production and whimsical clients in multiple countries. (Gardner 2004, 97) For example Aisin, Toyota's valve supplier, stopped Toyota's production for a week after suffering a fire at their plant and not being able to supply valves as planned. (Bensaou & Andersen 1999, 461.)

To compare the two different philosophies, VMI and JIT, Gardner 2004 explains the differences of philosophies as follows: "Most notably, JIT pushes the model towards zero inventory, while VMI has inventory built into it. It is also of interest to note, however, that each school promotes continuous improvement, the elimination of waste and intense supplier management. Paradoxically, the JIT model works because there is no inventory being held, whereas the VMI model works because there is inventory held."(Gardner 2004, 103.).

2.2.10 Kanban

Kanban, which means signboard, is a technique invented by Taiichi Onho in the 1940s to control production between processes and to implement JIT. The signboard gives visual visibility that is used to improve demand scheduling. Originally Kanban was used by Toyota to reduce costs and to manage machine utilization and nowadays its use has expanded to identify obstacles to flow and opportunities for continuous improvements. (Gross & McInnis 2003, 13-14.).

2.2.11 Order Penetration Point (OPP)

The order penetration point (OPP) is the point in the supply chain where the demand (order) is allocated to the product. If the order penetration point of the product is in storage keeping the product will be delivered to the customer straight from the storage when the customer makes the order. On the other hand if the OPP is located in production, the supplier will produce the goods based on the order. The OPP affects the cost-structure of the purchasing process. If the goods are stored in the storage the supplier is able to ship immediately but capital is tied. The vendor has to make the decision if it wants to have little capital tied but with

the risk of having longer delivery times or to minimize capital and accept the risk of longer delivery times. If the OPP is in the production the supplier is able to customize products but the delivery time is longer. To move the OPP from warehouse to the starting point of manufacturing may slower the delivery but also improve the flexibility of the manufacturing of the supplier. (Iloranta & Pajunen-Muhonen, 2008, 357-358.).

2.2.12 Product Activity Record (PAR)

Product activity record is a set of information about a certain product and its usage. What a product activity record consists of depends largely on the setting it is used in. In VMI the most essential information is the current stock level. Other data that may be included in a manufacturer – wholesaler –setting are point of sales data and/or incoming orders. On the contrary in the manufacturer – manufacturer –setting the master production schedule and the stock withdrawals should be sent. (Zammori et al. 2009, 167.).

2.2.13 Retailer Managed Inventory (RMI)

Retailer-managed inventory is the traditional form of trade where the customer manages the inventory replenishment. In this inventory management system the customer independently makes replenishment decisions and initiates the purchase order and the supplier's role is limited to communicating availability, pricing and delivery. (Bendoly & Jacobs 2005, 108.).

2.2.14 SAP

SAP is an ERP provider originally from Germany and later expanded worldwide with more than 95,000 customers in 120 countries. SAP offers a portfolio of business software, technology and related services for companies of all sizes and industries. (SAP Website 2010)

2.2.15 Value Offering Point

Value offering point is the point in the customer's demand where the supplier perceives the demand. In a traditional supply chain this point is located in

purchasing. The supplier delivers based on orders or home calls made by the procurement personnel but the value offering point can also be moved to the customer's storage i.e. VMI. (Iloranta & Pajunen-Muhonen, 2008, 357-360.).

2.2.16 Vendor Managed Replenishment (VMR)

Vendor managed replenishment is the first stage of VMI where the supplier takes control of ordering, inventory management, and replenishment. At this point significant customer service levels can be expected but total costs do not commonly improve. In contrary they may even increase. (Claassen et al. 2008, 411-412).

2.3 Outsourcing

Outsourcing has many definitions, but a generally accepted definition for outsourcing is the following: the operations of a company that have been previously done by the company are shifted to be done by an external party. The general idea of outsourcing is that by focusing on one or more fields of know-how the company can improve its know-how and efficiency. (Iloranta & Pajunen-Muhonen, 2008, 205, 207.).

The trend of outsourcing has been that more goods are outsourced with more advanced services being included. Individual processes or larger entities previously done within the company are being moved to the supplier's responsibility. (Iloranta & Pajunen-Muhonen, 2008, 48.) VMI is an excellent exemplar of a value added logistic process being outsourced. (Zammori et al. 2009, 165.) Other common outsourced processes are IT-departments, cleaning, cafeteria, drivers, accounting etc. (Iloranta & Pajunen-Muhonen, 2008, 48.)

2.3.1 Outsourcing Goals

Iloranta & Pajunen-Muhonen (2008) divided the benefits that companies deciding to outsource are seeking into six separate areas:

1) Cost savings;

Cost savings are the core advantage in outsourcing and they are at least a part goal for almost all outsourcing projects. According to international studies outsourcing can bring on average 20% cost savings without a notable decrease in quality of the product. The cost savings arise from supplier's economies of scale, more efficient processes or other factors. The supplier is able to use economies of scale in their own purchases or they can improve their processes further due to large volume.

2) releasing capital;

When the company outsources products or services it has previously done itself it releases capital. When for example IT or production is outsourced often the machinery will be owned by the supplier also. A fairly common mode of outsourcing is also when the company sells its property and agrees a long lease for it. These changes affect the company's cost structure as the share of fixed costs goes down. Outsourcing may also be decided to use when the company doesn't have the will or the resources to make investments to the required properties, systems or know-how.

3) achieving technology advantages;

Technological benefits are sought from the supplier markets when the company itself doesn't have the possibilities to attain technologies necessary for competitiveness. Reasons for that may be for example the size of the investments needed, fast changes or advancements in the technology or patent protection the supplier has. This is often related to economies of scale which allows the supplier to make investments in the latest technologies or in more efficient production facilities. For instance in the information technology field the large companies are well aware of new technologies out in the markets and they have already established processes for such new technologies that they're able to implement in many customer companies.

4) benefits of concentration;

Concentration benefits develop when the customer outsources production- or process-steps where it does not have the comparative advantage and is therefore

able to concentrate its resources on its core business better. This way the management and key personnel are able to devote more time to think and take care of more essential matters. The learning of the employees is directed more towards the company's core knowledge and as they do not have to learn subjects from such a broad area they will be better focused on the important matters.

5) exploiting market competition; and

Especially in large companies there is a lot of internal sharing, or trading, of goods and services. Since all the units have strict profit expectations it is a matter of how to have proper prices so that the total price does not increase too much and competitiveness can be remained. It is easier to charge loose prices internally than to an external customer. To outsource some of the functions it will force them to have competitive prices and thus the end products will be more competitive. Another way to cope with this is to support internal entrepreneurship which works in small and large scale.

6) flexibility; or

Sometimes the company wants to improve its flexibility by decreasing the size of the organization. The seasonal variation is often large in businesses which may follow either annual or economical rhythms. The own organization, personnel and machinery mean fixed costs that do not adjust to periodical changes. By outsourcing functions the company shares the risks of seasonal changes with another party.

7) other reasons.

Sometimes the true reasons for outsourcing may be other factors than the six ones described above. Outsourcing has also been accepted as a means of successful business management. Oftentimes when companies announce outsourcing plans the company's share price goes up and they receive praises from press and analysts. The expected positive reaction from press and from analytics may spur the management to outsource especially when making decisions where the true

pros and cons in the long run are not known. (Iloranta & Pajunen-Muhonen, 2008, 210-216.).

2.3.2 Levels of Outsourcing

There are different possible levels of outsourcing determined by the level of relationship. The simplest form of outsourcing is a standard sell-buy –relationship where no other value adding processes are involved. In practice the relationship rarely stops evolving at this level. More common and advanced forms are different kinds of network relationships that often have some forms of synergy, reciprocity, interdependence, and power-relationship. With these factors involved the value of the relationship can no longer be measured simply by numerical analysis as more subtle matters are involved. The four levels of outsourcing are defined by Iloranta & Pajunen-Muhonen (2008) as follows:

1) Price competition based relationship

In this level of outsourcing the company buys goods or services it does not want to produce. The most important benefit gained is usually costs savings. The products are simple to produce and the contract is usually made for a short period of time. The relationship can be defined as very “one-upmanship” where both parties try to maximize their own benefit. The vendor concentrates on cost savings and no long term developments are made as the relationship is not seen stable.

2) Quality competition based relationship

At this level the customer buys products from the vendor it is not capable to produce. At this level the customer chooses the vendor that is able to produce the right kinds of products or services for the cheapest price. The relationship remains distant and inactive. The supplier is not expected to act proactively or to present development ideas and the communication is often limited to operational matters. At this phase there starts to evolve a stabile relationship as the customer is concentrating its purchases to fewer suppliers.

3) Close co-operation based partnership

At this level the customers aims to improve its competitiveness by forming a close partnership with capable and efficient suppliers. The supplier is expected to act proactively and to have special know-how. The supplier is often integrated in the process of designing the product, service and production. The co-operation is present in many parts of the organizations, mutual trust exists and the communication is more informal. This kind of communication is not possible with several suppliers so therefore the number of suppliers is reduced.

4) Strategic partnership based relationship

The customer tries to focus on its core functions strongly and tries to build up a network of suppliers that are capable of supporting its strategy. In a strategic partnership the customer's role is emphasized as a coordinator and as one who shows the way. In a strategic partnership the communication is intense and informal and trust exists between the parties. The supplier's are aware of the customer's long term plans so they are able to plan their investments accordingly. In a typical strategic partnership the communication and logistics are integrated to maximize efficiency. (Iloranta & Pajunen-Muhonen 2008, 221-223.).

2.4 Procurement

Procurement is defined by Iloranta and Pajunen-Muhonen (2008) as follows: Procurement is management of organization's external resources. The organization's function, maintenance, management and development need different kinds of products, services and also different kind of know-how and knowledge outside of the organization. Procurement's goals are to take advantage of the supplier network so that the end customer's needs are satisfied in a way that maximizes the total benefit of the company.

When the company focuses more on its core business and consequently more functions are outsourced, the effect of purchasing grows stronger. According to recent studies of Finnish companies from different industrial sectors the procurement costs average around 80% of total costs. (Iloranta & Pajunen-Muhonen 2008, 40-42.).

The traditional purchasing model has been to have the suppliers compete between with each other on prices. This would work in an ideal world where there would be several suppliers for the same product and real competition. As this is often not the case, and to consider the fact that internal costs are regularly only a small part of all the costs for a company, it is easy to understand why companies should engage in reducing total supply chain costs. (Iloranta & Pajunen-Muhonen 2008, 40-42.).

The new development trends in procurement compiled from several studies by Iloranta & Pajunen-Muhonen (2008) are:

- Integrating procurement to company strategy;
- organizing procurement and increasing cross-organizational co-operation;
- finding new purchasing sources and new ways to seek added value;
- taking advantage of low-cost procurement sources and advantages of geographical differences;
- building up a competitive supply chain by systematically improving supplier performance;
- integrating research and development in supply chain;
- increasing and strengthening inter-company co-operation; and
- strengthening procurement organization's capabilities.

2.4.1 Procurement Key Performance Indicators

In general the measuring of Key Performance Indicators (KPI) in procurement organizations is insignificant or lacking totally. The indicators are often coarse and they are used more to measure negative occurrences such as claims, deviations, late deliveries and material shortages. It has often been attempted to quantify the cost-savings from procurement, but so far this has been done with

little success. This has been speculated to be one of the reasons for why procurement is underrated. (Iloranta & Pajunen-Muhonen 2008, 431.).

Following and measuring are important factors in increasing effectiveness. Data collection, handling and interpreting have to be target-oriented, planned and preferably done by specialized professionals. The measured and analyzed information is only useful when it is properly communicated to those who are able to change performance related factors. (Iloranta & Pajunen-Muhonen 2008, 433-434.).

Good key performance indicators are in line with company's goals and strategy. They're simple and easy to understand, but on the other hand broad. The KPIs have to be followed in all echelons of the organization. (Iloranta & Pajunen-Muhonen 2008, 434-435.)

2.4.2 Procurement Cost Calculations

Total costs of purchase are termed "total cost of ownership" and can be divided in three parts: pre-purchase, during purchase and post-purchase. The principle is that all the costs that come from preparing the purchase or request for quotation, choosing the supplier, or collaboration with the supplier should be taken into account when thinking of the total costs. (Iloranta & Pajunen-Muhonen, 2008, 187-188.).

TOTAL COST OWNERSHIP		
PRE-PURCHASE	PURCHASE	POST-PURCHASE
• need identification • need analysis • sourcing • supplier evaluation and quality assurance • supplier choice • supplier development	• price • ordering • information change • delivery arrangements, controlling and delivery • quality controlling • controlling and monitoring • payment transactions	• deviated goods and returns • repair and re-machining • maintenance and service parts • product support and training • co-operation with the supplier, supplier knowledge utilizing and shared research and development • increased sales revenue • costs of lost sales • depreciations and reputation • recycling and ending the life cycle

Table II: Total Cost of Ownership (Iloranta & Pajunen-Muhonen 2008, 188.)

Total costs of ownership -thinking gives value in making many decisions considering procurement and supply chain processes. Examples of such are supplier evaluation and selection, decisions of procurement content and alternative choices, supplier performance follow up and evaluation, outsourcing decisions, improvements of modes of operation and service processes, and developing the end product and service. Many procurement professionals think that the benefit of calculating total cost of ownership is in the more in depth understanding of supplier performance and the understanding of product or service total life cycle influence to the organization and to the customer that the knowledge brings. (Iloranta & Pajunen-Muhonen, 2008, 187-188.).

2.4.3 Inventory Management

Inventory management has been recognized as one of the most important aspects of an organization. Inventory management addresses the question of how to find a balance between high and low inventory to maximize benefit with minimized risk. With high inventory the company will suffer high holding and obsolescence costs of excessive stock and on the other hand with low inventory there will be poor service levels and high shortage costs. Managing the inventory has a direct impact on the profit of the company. (Nenes, Panagiotioudou & Tagaras 2009, 313.).

2.5 Vendor Managed Inventory (VMI)

VMI is a supply chain coordination system where the vendor assumes responsibility for managing the stock. (Çetinkaya & Lee 2000, 217.) The vendor manages the inventories based on the demand information provided by the customer. The biggest difference in VMI compared to standard manufacturer / retailer managed inventory is that the supplier has responsibility of stock levels. (Zammori et al. 2009, 165-166.) In some variations of VMI the title to goods doesn't move to the supplier until the goods are consumed from the vendor managed inventory and in some it does. (Bendoly & Jacobs 2005, 112.)

In a true VMI setting, the supplier has the freedom to plan its own production and decide the replenishment schedules as long as the agreed customer service levels are met. VMI is often implemented with minimum and maximum levels for inventory and the vendor is responsible in maintaining those. (For example Claassen et al. 2008, 406; Zammori et al. 2009, 167.) VMI shifts responsibility in decision making of the replenishment schedule and inventory management from the customer to the supplier. (Zammori et al. 2009, 166.). In other words, VMI is a form of outsourcing as organizational functions previously done by the customer are done by the vendor. (Iloranta & Pajunen-Muhonen 2008, 49.).

In JIT system the Vendor is often sending smaller batches and more frequently which creates expenses. In VMI however, as the Vendor is empowered to control the timing and quantity of downstream resupply decisions, it has more freedom to

consolidate resupply shipments over time and geographically. With consolidation of shipments economies of scale are more easily achieved to lower transportation expenses. (Çetinkaya & Lee 2000, 407.). JIT and VMI concepts are not the same, but they can be implemented together. (Bendoly & Jacobs, 2005, 112.).

VMI was first used by large retailers like Wal-Mart and recent studies show that its use has expanded to many industries such as chemical, construction and electronics. (E.g. Claassen et al. 2008, 408; Cetinkaya & Lee, 2000, 217.)

2.5.1 VMI Characteristics

2.5.1.1 Partnership

Oftentimes the customer represents a large part of vendor's sales. They have a mutual trust in each other's activities and they're willing to share information. Customers also often employ a centralized inventory planning. (Bendoly & Jacobs 2005, 126.)

2.5.1.2 Technological

Established electronic capabilities are a common feature of VMI. Usually VMI suppliers and customers use an ERP system with an integrated database. EDI linkages are also one of the enabling features in VMI. (Bendoly & Jacobs 2005, 126.)

2.5.1.3 Product

A typical VMI product is fast moving and represents a large part of the supplier's sales. The products also represent a large part of customer's purchasing and are considered valuable items. They are also accountable; distinct, unitized, and countable. (Bendoly & Jacobs 2005, 126.)

2.5.2 VMI Information Sharing

The information sharing is a core process in VMI and is usually based on two transactions. The first one is the advance ship notice (ASN) and the second is the product activity record (PAR). ASN is sent by the supplier to the customer when the shipment is made and it contains information about the content and the

destination of the freight. (Zammori et al. 2009, 167.). The information sharing in VMI exceeds well over usual data required for plain purchase placement. (Gardner 2004, 100.) Angulo et al. (2004) on the other hand mention that the following information can be shared: inventory levels and position, sales data and forecasts, order status, production and delivery schedules and capacity, and performance metrics. From sharing this much information arise issues of trust and confidentiality that need to be overcome. The receiving company i.e. vendor also needs to use that information efficiently. (Angulo, Nachtmann and Waller 2004, 101.)

“The ability to manage and track the flow of relevant information across supply chain members has been greatly enhanced by recent technological advances. Beyond the technology itself, though, companies are recognizing that forging partnerships based on knowledge transfer and information integration across the chain can serve as a strategic competence worth cultivating.” (Kulp, Lee & Ofek 2004, 431.). VMI Information sharing process can be anything from fully manual to 100% automatic where manual work is only needed to move the goods physically. “VMI programs do not require an ERP system, but since ERP systems are robust and scalable transaction-processing systems with an integrated database, they have become the typical enabling system platform for VMI.” (Bendoly & Jacobs 2005, 110.).

Extranets can provide the information needed but same ERP systems enable more profound inter-firm integration of planning and execution of systems. By having a thorough integration full visibility through multiple echelons of the supply chain can be provided. (Bendoly & Jacobs 2005, 126.). Linked information systems were also mentioned by Claassen et al. (2008) as something that leads to more collaborative planning. They also found out in their research that good IT infrastructure will make it more likely that good results are achieved from VMI. VMI can be made working either through the customer’s or the supplier’s IT system, but to implement it with many different suppliers the solution should be owned by the customer. (Tanskanen & Holmström, 2009, 39.)

2.5.3 VMI Vendor-Buyer Relationship

Maybe the biggest change in VMI when comparing to traditional inventory management practices is its more collaborative nature. It is important to be in constant contact with the client in order to reduce deviations between forecasts and actual consumption. Compared to the traditional way in VMI both the supplier and the customer are forced to work more proactively. (Gardner 2004, 99.) In a traditional relationship both the buyer and the supplier are trying to get advantage over another; in VMI however, the relationship is more based on mutual benefit. (Gardner 2004, 103.) The role of customer changes from inventory management to one that provides all the relevant information it thinks may help the supplier to make optimal decisions. (Claassen et al. 2008, 407.).

When VMI is implemented for strategic products the buyer is expected to be highly involved in the process; however, for commodity products the supplier is expected to take full control of the supply chain without much participation from the buyer. (Claassen et al. 2008, 408.)

2.5.4 VMI Maturity Stages

Results by Claassen et al. (2008) suggest that VMI maturity stages are a grey area in the theories as many of the VMIs are in fact only vendor managed replenishments (VMR). However, a noteworthy factor is that they did not measure this in their studies.

VMI maturity stages are defined by Claassen et al. (2008) as follows:

1) In the first stage the supplier takes responsibility of ordering, inventory management, and replenishment. In this phase the increases are seen in service quality but usually the total cost benefit is not yet achieved. In contrary, the total cost may even increase at this point.

2) In the second stage the supplier takes control of the full pipeline. Only in this stage noteworthy cost reductions can be achieved without compromising service levels.

2.5.5 VMI Benefits

"As in all complex business processes, the benefits of VMI programs and partnerships are multidimensional." State Bendoly and Jacobs (2005) and continue: "Some benefits accrue to both the supplier and the consumer, while others are supplier or customer specific." VMI benefits also come together with other improvements made with VMI programs so it is not always easy to differentiate benefits that come purely from VMI. (Bendoly & Jacobs 2005, 122) VMI may presently be an order winner, but in the future it may be order qualifier. (Bendoly & Jacobs 2005, 129).

2.5.5.1 Shared

Expected outcomes in VMI are reduced costs, improved service and greater transparency in the supply chain. Improved information change should decrease the bullwhip –effect. (Claassen et al. 2008, 407.).

Making the supplier responsible for the inventory fills should reduce the inventory and logistics costs throughout the supply chain. (Claassen et al. 2008, 407). Total stock levels are reduced in the supply chain (Zammori et al. 2009, 167.) and the whole supply chain is better able to avoid inefficient use of capacity. Companies involved in VMI make better decisions considering the whole supply chain instead of each party trying to optimize their own profit. (Claassen et al. 2008, 407). Companies' lean manufacturing abilities are improved with VMI as less waste is created. (Emmett. 2006, 132.).

In the first stage of VMI where the supplier takes control of ordering, inventory management, and replenishment significant customer service levels can be expected but total costs do not commonly improve at this point. On the contrary they may even increase. The first stage is termed vendor managed replenishment (VMR). (Claassen et al. 2008, 411-412).

By moving inventory management from the customer to the supplier and giving the supplier all the information as early as possible removes one echelon of the supply chain. “Removing an echelon in a supply chain can result in considerable benefits because it eliminates delays in the information and material flows and removes a source of uncertainty and distortion in supply chain decision-making.” (Claassen et al. 2008, 407.).The speed of process is improved due to VMI and there is a reduction of data entry errors. (Zammori et al. 2009, 167).

In non-commodity goods VMI can create innovational benefits also that arise from the strengthened relationship. Both partners benefit from less costly and effortless transitions to drawing updates for established parts. (Bendoly & Jacobs 2005, 122).

Companies utilizing a successfully implemented VMI give the image to their customers that they are able to be involved in a complex process that involves their technological infrastructure and management; a collaborative competence that includes technological and managerial skills and trust. (Bendoly 2005, 124).

2.5.5.2 Supplier

The greatest benefit for the supplier is that they are better able to adjust their production schedules to customer demand. For supplier to take advantage of the possibility they should have VMI implemented with a large number of customers. Because information is available at an early stage the supplier is better able to even the fluctuations and can also act more proactively instead of reactively. (Claassen et al. 2008, 407-408.). This allows the supplier to better utilize labor end equipment resources. (Kulp, Lee & Ofek 2004, 434.). In addition, when VMI is implemented broadly, the flexibility of the shipping will allow the supplier to send full truck loads which will decrease the transportation costs. Furthermore as the uncertainty of order is reduced greatly the supplier is able to drop safety stocks and thus lower inventory costs. (Claassen et al. 2008, 407.).

As the supplier has more up-to-date information constantly it becomes less reliant to the forecasts. Also as the supplier works based on forecasts and not actual orders there is a reduction of order modifications. (Zammori et al. 2009, 167.).

Early availability of demand-information allows the supplier to work more proactively and thus reduce lead times. (Claassen et al. 2008, 407.).

VMI customers usually represent a large percentage of the sales for the supplier. The suppliers are able to use VMI as a strategic tool to stand out among competing suppliers by giving extra value to their customers. This type of diversification may not last long but there may be a first-mover advantage. (Bendoly & Jacobs 2005, 123, 126.) VMI also creates an advantage for the supplier with deepened customer relationship and thus more reliable and secure sales for them. (Claassen et al. 2008, 407.). Besides deepened customer relationship the supplier also benefits from increased switching costs that also lead to more secure sales. (Bendoly & Jacobs 2005, 123.)

2.5.5.3 Customer

The customer also benefits from better service levels which are followed from the higher level of collaboration and better communication of each other's needs. (Claassen et al. 2008, 407.). The administrative costs can be decreased as broad material planning is not needed anymore. (Claassen et al. 2008, 406.). Claassen et al. 2008 also found out that buyers with VMI noticed decrease in emergency orders and in the number of incorrect orders. The purchasing process is simplified and the customer should have a decrease in stock-outs and the inventory costs are decreased. (Zammori et al. 2009, 167; Claassen et al. 2008, 406.)

The supplier creates improved customer service and customer level satisfaction by having better product availability, higher fill rates and on-time delivery, shorter delivery lead times, greater order accuracy, and order process error decrease. (Bendoly & Jacobs 2005, 120). VMI customer may get preferential shipments over RMI customers as the supplier wants to avoid the agreed penalties of not keeping the service levels. (Boone 2001, 346).

2.5.6 VMI Key Success Factors

Even though VMI system promises a lot, the real life implementations are not always so successful. "Out of 10 VMI implementations, three or four achieve

great benefits. Three or four have some benefits, but not as much as anticipated, and two or three do not get any benefits". (Claassen et al.2008, 406).

Claassen et al (2004) concluded that there are four different categories for enablers of VMI process: Relationship quality, information quality, information sharing and the quality of information and communication system.

"While all of the operational details inherent to a successful VMI operation can be articulated, the most important component of the program is more subtle. From the outset, the fortunes of VMI rely on the philosophy and attitude that both vendor and manufacturer apply to their relationship." (Gardner 2004, 103.). VMI needs sufficient management and personnel resources to get started and to perform well. Potential employee resistance must be managed especially among purchasing personnel of the buyer and the sales personnel of the vendor. The ability to execute VMI effectively can be seen as an organizational capability, which on other hand is a competitive advantage. (Bendoly & Jacobs 2005, 123).

The VMI philosophy makes both parties recognize that a disruption in supply chain affects both parties and not just the one holding the inventory. Both vendor and the manufacturer must realize that for operational and financial purposes they must work together in order to reduce lead time, inventory, and production variables. All involved variances in the areas of product quality, lead times and inventory management will create unnecessary supply chain cost. (Gardner 2004, 103.).

The key for making VMI work is the availability of accurate data. (Zammori et al. 2009, 167.). For the supplier to be able to manage the inventory it should have information about inventory levels, expected demand, promotional activities, and product related costs. This information allows the supplier to make better decisions and decrease the costs in the whole supply chain. Information qualities can be broken down into separate parts: information sharing, availability, completeness, and reliability. (Claassen et al. 2008, 407.) When VMI is used in a manufacturer to manufacturer both the MPS (master production schedule) and the stock outputs should be sent to the vendor. Due to the manufacturing lead-time the

supplier is forced to use the MPS as a main scheduling tool and thus its accuracy becomes paramount. The MPS should be split to two parts containing a frozen horizon (fixed orders) and a planned horizon containing forecasted orders which are predictive of the future orders. Integrating MPS to the supplier's MRP is a prerequisite for a win-win relationship. (Zammori et al. 2009, 167, 172.).

As the shipments are executed based on the information the vendor has about the inventory levels the accuracy of the counts must be 100%. If the data shows less than the actual inventory there will be excess materials and if it shows more than the actual inventory the lines may go down and deliveries to the customer are in danger. Neither of these means good for the supplier/buyer relationship. It should be clear that either excess or less than needed inventory can take a manufacturing facility out of work. (Gardner 2004, 100.).

The information should be available early so that the supplier is able to act pro-actively and thus reduce lead times. Implementing VMI effectively thus requires a cross-functional and inter-organizational approach. (Claassen et al 2008, 407.).

Frozen horizon should be longer than the manufacturer's lead time, or if that is not possible, at least the planned horizon should be longer. This allows supplier to plan their production schedule in accordance to the provisional orders. If the frozen horizon is shorter than the lead time of the supplier the system is sub-optimal. In this case the supplier is forced to have safety stocks and also most of the benefits of VMI are lost. In case also the MPS is longer than the supplier lead-time the supplier is forced to have additional safety stock. (Zammori et al 2009, 172-173.).

2.5.7 VMI Agreement

VMI agreement is a contract that is usually divided into separate parts of financial terms, inventory constraints, and performance targets such as service measures. VMI agreements are private contracts and they are not regulated by any legal code nor is there any codified structure to conform to. (Zammori et al. 2009, 166-168.)

If the technical details of a VMI agreement are not correctly covered and defined in a legally sound agreement, the whole performance is compromised even logistically especially on supplier's side. VMI is a long lasting relationship and thus the document must also be made flexible to fulfill the requirements of the possible changes. (Zammori et al. 2009, 166, 168.).

By having a twofold agreement, where the first part has the legal and the generic sides of any VMI agreement and the second has the technical details and specific issues, the possible changes can be made more easily when the body of the contract can stay unaltered. Technical details featured in the example contract by Zammori et al. 2009 contain product characteristics, plants and premises, equipment, information systems, data type and operating procedures.

In a VMI setting as the vendor owns the product until taken from the inventory the Incoterms should be modified so that it has the responsibility also until that point. The use of Incoterms like DDU or DDP should not be disregarded from a landed cost perspective. If the vendor fails to account these additional costs into the price it will lose money even before the first shipment is made. It would be wise for the vendor to employ a third party logistics company to handle the freight. (Gardner 2004, 102.).

2.5.8 Inventory Ownership

Even though the issue of who controls the inventory is congruent in the theories, the ownership is a whole another story. Many of the articles about VMI state that the vendor has the ownership until the goods are withdrawn from the inventory. (See for example Gardner 2004). However, Bendoly and Jacobs (2005) say the following: "VMI should not be confused with consignment inventory. In consignment situations, the supplier's inventory resides on the customer's premises. The customer owns the inventory and owes payment on it only when the customer draws on that inventory." In addition to that Bendoly and Jacobs (2005) continue that VMI and consignment inventory are not excluding; "VMI addresses decision making and timing of inventory replenishment, while consignment addresses timing of ownership."

By using a consignment strategy in VMI the vendor owns the inventory. With international suppliers bonded warehouses come in need when the title to goods does not transfer until usage from inventory. (Bendoly & Jacobs 2005, 112.).

2.5.9 Inventory Minimum and Maximum Values

The minimum and maximum levels are to be in line with the demand or there will be shortage of inventory or there is excess inventory that takes shelf space. (Gardner 2004, 100) For an unreliable supplier the customer may set tight minimum and maximum levels. The tighter the levels are the less flexibility the supplier has on deciding the optimal replenishment schedules. (Claassen et al. 2008, 407). In a qualitative study done by Claassen et al. they found that in practice these minimum and maximum values were strict compared to the theory that exists of flexibility enablers. (Claassen et al. 2008, 408.).

After agreeing the value minimum (s) and maximum (S) values the penalties are determined per pieces that go under s or over S. The value of S-s must be large enough to provide the supplier enough flexibility. (Boone, 2001, 332). In the case study by Zammori et al. 2009 they used a minimum value that covers consumption for a time more than twice the freight time. Their maximum value was defined considering the variables of freight interval (once a week) and so that the supplier is able to ship full truck loads (difference between S and s equaled full truck load and 25% extra to provide leeway).

They had a delivery time of one day with local supplier and their minimum value was more than twice the quantity consumed during the freight time. They defined the margin by using the full truck load quantity as a base and then adding 5 pieces which in their case study corresponded to a one fourth of a truckload and approximately 1 day’s usage. (Zammori et al. 2009, 175)

2.5.10 Messages and Information system in VMI

Claassen et al (2008) cites Simchi-Levi et al (2003) that the objectives of IT system in supply chain management and thus in VMI are:

- To provide information availability and visibility;
- to enable a single point of contact for data;
- to allow decisions based on total supply chain information; and
- to enable collaboration with supply chain partners.

Information transmission is often done by using EDI to distribute information but there are other choices also for example document attachments in e-mails, web-based forms with or without XML, File Transfer Protocol, and other electronic and telecommunication mechanics. (Bendoly & Jackson 2005, 111-112.). The compatibility and quality of Information systems has been emphasized as one of the enablers of VMI. (Claassen et al. 2008, 408).

In the VMI process described by Zammori et al. (2009) the information change was sent via EDI system and it consisted of six different transactions:

1) Daily updates of products activity record (PAR)
2) After receiving the PAR the supplier updates its replenishment plan and in case the reorder point is reached a purchase order is created
3) The supplier sends a purchase order acknowledgement and waits for the customer approval.
4) When the supplier has received the confirmation it sends the order and the advance shipment note (ASN).
5) After receiving the shipment the customer checks the actual composition of the order and matches it to the purchase order.
6) The customer updates the MPS weekly to the vendor.

The purchase order acknowledgement was decided to use for a start up period of a three months and then decided whether or not it was still needed.

In the example process Zammori et al. (2009) opted to include the following information to the barcodes:

- Identification code of the supplier;
- identification code of the production lot;
- identification number of the product;
- date of completion;
- product specifications; and
- executed quality checks.

Due to the large amount of information coded they decided to use code 128-B as it allows all the ASCII characters and has unlimited length. (Zammori, et al. 2009, 177).

2.5.11 Invoicing and Creating the Purchase Order in VMI

VMI programs often employ a demand-pull –logic, including kanban-orders, but they can also be implemented differently. Kanban purchase orders guide the timing and quantity of replenishments. (Bendoly & Jacobs, 2005, 112.). In the process defined by Zammori et al. (2009) they used a reorder point to automatically create orders. After that the supplier sent a purchase order acknowledgement and waited for a confirmation by the purchaser. The purchase order acknowledgement was decided to be used only for a three month period and after that it was to be left out if problems did not arise. (Zammori et al. 2009, 177.). On the other hand Claassen et al. (2008) mention leaving out the individual purchase orders and using blanket orders instead. Lastly Gardner (2004) presented a model where no purchase orders are made and the manufacturer self bills according the actual consumption. Alike invoicing procedure was also used in the case study by Tanskanen & Holmström (2009) where the customer was able to do self check-out from a consignment stock. The stock replenishments were

controlled automatically with the use of a replenishment level that triggered an email to a person appointed by the supplier.

2.5.12 Implementation Process of VMI

A typical team to establish VMI described in Bendoly and Jacobs' (2005) case study includes inventory analyst, and EDI/information systems specialist, and the appropriate sales or account representative from the supplier. From the customer's side the team usually consisted of the purchasing manager, EDI person from IT group, and a logistics person from a site where the case company was having a replenishment plan.

Besides the information technology infrastructure changes VMI also needs effective VMI management that can obtain the key management processes involved with VMI. Bendoly et Jacobs (2005) state the following: "A second, related strategic implication is that the ability to support, plan, and execute both an overall VMI program and individual VMI partnerships is a fundamental, valuable organizational capability that is, in turn, a competitive competence. The ability to rapidly implement a partnership and smoothly execute, with low coordination costs, both the VMI partnerships and the program as a whole is valuable." (Bendoly & Jacobs 2005, 123).

When starting a VMI Bendoly & Jacobs (2005) presented a model which describes the different phases of VMI implementation:

1) Partner identification;

At this point the potential partner is identified via business model.

2) Marketing presentation to potential customer;

After the marketing presentation the partner's interest is evaluated and the decision to continue is made based on that. In a case study made by Tanskanen and Holmström (2009) was found that it was easy to find suppliers for a pilot VMI project in construction business as they thought it was a good way to secure business.

3) Data collection, analysis, and detailed proposal

If the partner has shown interest a next contact with it includes the data collection and making a detailed VMI proposal.

4) Partner approves proposal?;

If the partner accepts the proposal then it is time for the pilot project.

5) Both parties satisfied and approve formal agreement;

If both parties agree that the pilot has been successful it is time to approve a formal agreement.

6) Full-scale VMI program implementation;

When the agreements are negotiated and ready it is time to start implementing the full-scale VMI program.

7) GO-LIVE;

8) Periodic performance review and inventory policy revision

This also goes in line with Zammori et al. (2009) as they suggested a two part contract that is possible to be modified from VMI's part more easily.

2.5.13 VMI Financial Effects

Even though most companies starting to implement VMI expect major cost reductions it often is not the largest benefit achieved. Cost reductions in VMI come from administration and inventory costs. (Claassen et al. 2008, 406). The customer not only avoids purchase orders but also self-bills the goods. To take away purchaser orders and invoices offers huge benefit in productivity. (Gardner 2004, p 101.) A normal relationship where the buyer decides the replenishment based on their inventory levels and handling costs is sub-optimal. In a VMI where all the relevant information is provided to the supplier it is able to make decisions based on total supply chain costs and sub-optimization is avoided. Costs from

maintaining flexible capacity and transportation costs are better taken into account. (Claassen et al. 2008, 407.) VMI creates steeper information sharing which leads to reducing the bullwhip effect. According to studies these costs account for 12.5-25% of the excess costs for suppliers. (Claassen et al. 2008, 407; Lee et al. 2004. 1875.)

As the title of the goods does not move to the customer until drawn from inventory this has a clear balance sheet ramification. (Gardner 2004, 100.). Since the supplier is better able to make decisions thinking of the entire supply chain it should result in a higher overall margin. (Claassen et al. 2008.).

2.5.14 Performance Measurement

"There is a pressuring need for better VMI performance measurement capabilities. Industry needs comprehensive, practical models of the strategic and tactical costs and benefits of VMI opportunities, implementation, and execution." (Bendoly & Jacobs 2005, 127).

Metrics for cost, stock and service levels currently exist but there is a need to have measures of the strategic partnership and market growth opportunity benefits. Also there are no measures that span to more than three echelons of supply chain. The current focus of VMI effectiveness is usually in only one party of the trade. (Bendoly & Jacobs 2005, 127).

2.5.15 What Is Needed From the Vendor

The relationship attitude and philosophy must change also from the vendor's part. (Claassen et al. 2008, 407.) Besides attitude changes VMI needs human capital as well. To implement VMI effectively the vendor needs managerial capacity to obtain key management processes involved in VMI and if frozen horizon is weeks longer than the lead times of its suppliers' the supplier furthermore needs managerial capacity to take advantage of this. Especially production planning is involved in this process and logistics personnel as well to plan the shipments. (Bendoly & Jacobs 2005, 123.). Managerial capacity is also needed widely to

control information delay and to take use of all the information. (Angulo, Nachtmann and Waller 2004, 101.).

Technological capabilities needed to adopt VMI differ from how it is implemented. Oftentimes the supplier needs EDI but VMI can be implemented without it. Vendor's ERP system's availability is also a factor in technological integration of VMI. (Bendoly & Jacobs 2005, 123.).

2.6 Summary

What I found out from this research is that VMI can be applied in many ways. There is not much operational literature available and there were no studies found where there would have been thorough analysis of the different options would have been conducted. The different options can, however, be analyzed by splitting the changes that arise from VMI into separate parts and looking at their consequences. VMI needs changes mentally, technologically, operationally and contractually so it is not a simple project to implement without proper preparation. This applies especially in situations where neither of the parties involved have previous knowledge of setting up a VMI. More research should be done on how VMI works in manufacturer to manufacturer relationships and how the technical aspects are handled in such relationships. In the end of this thesis I am going to present some future research topics for VMI.

3 Empirical Study

3.1 Prologue

The information for the empirical part of this study is gathered from several interviews with personnel of Wärtsilä Industrial Operations' Delivery Centre Vaasa's purchasing, logistics and process development departments. It should be also noted that I have worked in the purchasing department besides my studies on and off for two years so prior to starting my research for this thesis I had already gathered knowledge of the processes in Wärtsilä. Therefore I did not have to find out everything from scratch when doing this study and that is also the reason why in some parts of this thesis no source is mentioned. The purpose of the empiric part is to define options on how Wärtsilä can implement VMI and also to try to see how it affects the supplier and what are needed from both parties.

VMI in Wärtsilä will be a manufacturer to manufacturer VMI which is the most complex form of VMI. (Zammori et al. 2009, 168.). What makes this even more complex is that there are multiple suppliers with different abilities involved so it is impossible to create one generic model that would work with all the suppliers because of the technical complexity of the process. The empiric part goes through different technical and operational aspects involved in VMI and will provide the basis for decision making on how to implement VMI in Wärtsilä.

As this is a case study not all the aspects of VMI need to be considered as for example only one ERP-system is used by Wärtsilä so in other words the customer's technological and organizational capabilities are a constant variable in this study. In the Current Process part Wärtsilä's present ordering process is explained shortly to give a proper image to the reader of how things are done at the moment. More concentration is made later to give outlines for how VMI process could be implemented in Wärtsilä and what changes does it need.

3.2 Research

Sharp and Howard (1996) define research as: "Seeking through processes to add one's own body of knowledge and, hopefully, to that of others, by the discovery

of nontrivial facts and insights." At the higher levels the research must add to existing knowledge. (Sharp & Howard, 1996, 7).

3.2.1 Research Approach

There are four major research types: the laboratory experiment, the field experiment, the case study and a survey. Case study is a common research in social sciences. In a case study the student spends a period of time at an organization and the study will be done based on that. (Sharp & Howard, 1996, 12).

Obviously as the name of this thesis suggests this is a case study. Wärtsilä is the case organization and the information gathered cannot be generalized to other organizations or cases. Besides my prior working in the company I spent 3 months working on this thesis solely and during that time I gathered most of the information.

3.2.2 Data Type

Data types can be divided in two categories: primary data and secondary data. Primary data consists mainly of information the researcher has gathered him/herself and secondary data consists of information collected by others. Primary data can be collected by laboratory measurements, field observations, archives/collections, questionnaires and interviews. Sources for secondary data are books and journals, technical publications, official publications, trade association data, private data services and computer databases. (Sharp & Howard, 1996, 142-143).

In this research primary data was used mostly as there was no secondary data available to be used about the company's organization capabilities. By using primary data it was also assured that it was up to date as an organization's capabilities can change rapidly considering VMI related factors. w

3.2.3 Interviews

The interview is a unique data collection method as the interviewer can be in direct interaction with the interviewee. This has its advantages and disadvantages. The biggest advantage is the flexible nature of the process. In a qualitative research interviews are the main method. The interview can be made case-by-case and there are more ways how to interpret the results. (Hirsimäki, Remes, Sajavaara, 2005, 193-194).

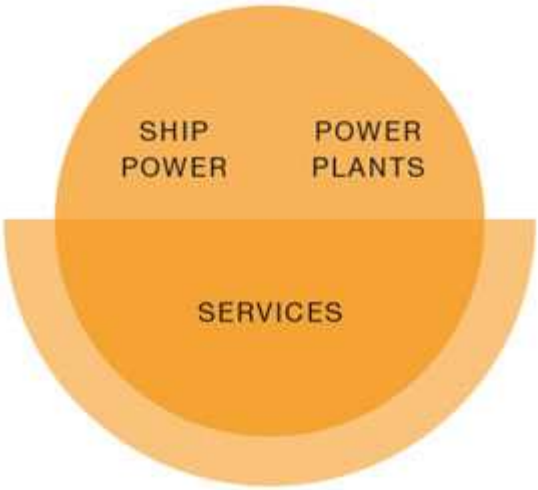
There are many reasons why qualitative interviews were chosen in this study. First, all of the interviewed persons are professionals in their own field who are able to devote a certain amount of time for this research. Second, the wanted information is from a new field for the author and for the organization. Therefore it would've been impossible to plan a quantitative questioning to get the same information. Third, the participants are seen as subjects and they were wanted to express themselves as much as possible. Fourth, when answers were received for a specific question often clarification was needed or new questions arose from the answers. All of the abovementioned reasons are mentioned as advantages of qualitative interviews (Hirsimäki, Remes, Sajavaara, 2005, 193-194). The number of interviewees is also 19 which is a low number and therefore supports the use of qualitative research.

3.2.4 Validity and Reliability

The validity of the new process was assessed by interviewing a professional from each field that is operationally or technically connected to VMI. All of the professionals were willing to help and devote their time to this research. For example none of the interviews had to be hurried due to insufficient amount of time for the interview. Also as many of the areas are interconnected one's professional skills were not questioned as the interviewees were congruent in their opinions. Therefore a single person's lack of vocational proficiency could not have created a research bias. Some of the interviewees were also interviewed many times to get more knowledge if necessary. In order to avoid writer's errors the operational purchasing managers evaluated this empirical part.

3.3 Wärtsilä

Wärtsilä is the case company that is planning to implement VMI in their procurement for goods used in production. Wärtsilä is a globally working lifecycle power solutions provider. It has three selling units Ship Power, Power Plants and Services which each account to approximately one third of its business.



Areas of Business (Wärtsilä Intranet 2010)

At the year end 2009 Wärtsilä employed circa 18 000 persons spread throughout six continents, 70 different countries and 160 locations. Wärtsilä's headquarter and head administration is located in Helsinki.

Wärtsilä's *mission* is to provide lifecycle power solutions to enhance the business of their customers, whilst creating better technologies that benefit both the customer and the environment and their *vision* is to be the most valued business partner of all their customers. (Wärtsilä Intranet 2010.).

Wärtsilä's industry specific characteristics are that it is a manufacturing company and the products have long lead times. The volume of the products is notably smaller than in other industries where VMI has been implemented such as car industry and retail and they're also significantly larger in size.

3.4 Wärtsilä Industrial Operations

Wärtsilä Industrial Operations (WIO) is a part of Wärtsilä's organization that produces engines, gen sets, propellers, gears, seals & bearings, and electrical power and automation to be sold internally to Wärtsilä's selling units Ship Power, Power Plants and Services. At the present WIO employs over 5000 employees and owns sites in Finland, Norway, UK, Netherlands, Italy, Switzerland, Spain, India, China and Japan. In addition WIO has licensee's sites in Brazil, Croatia, Poland, Russia, Vietnam, China, South-Korea and Japan and joint ventures in China and South-Korea. (Wärtsilä Intranet 2010.).

WIO's purchasing organizations are localized and every production facility has its own local team to handle purchases. Purchased products are divided in separate categories based on attributes and are taken care of by category teams which consist of category manager, strategic purchaser(s) and operational purchaser(s).

Wärtsilä Industrial Operations' ethos in manufacturing is to maintain effective and flexible production capacity and to work in close collaboration with suppliers so VMI suits very well for both of these goals. Making supplier responsible for the stock levels, or the early availability of information that comes with it, will decrease the supplier's lead time and deepen Wärtsilä's relationship with them and thus work accordingly especially with its strategy of close collaboration. (Claassen et al. 2008, 407.).

3.5 Suppliers

The researched suppliers in our case are either Finnish or Central-European. Thus different freight times and costs are to be taken into account when deciding on how to implement VMI. For main suppliers in these categories the relationships are well established with years of history for supplier - buyer relationships. The managerial capacity and the relationship quality of the suppliers can be evaluated based on previous interactions especially well with national suppliers. In the characteristics of VMI it is said that the customer represents a large part of the supplier's sales. However, as it is not specified what is considered as a large part it

is hard to see if that characteristic is filled but it can be said that Wärtsilä's share of the orders are very varying as its suppliers are anywhere from large publicly listed conglomerates to small family owned businesses. (Bendoly & Jacobs 2005, 123,126.).

3.6 Components

Components included in this research are connecting rod drop forgings, connecting rod lower parts, cylinder head castings and main bearing cap castings. Categorically speaking connecting rods belong to forgings and the other parts belong to castings. The machining program is a distinctive characteristic in these categories and it creates extra effort as to find out if VMI can be implemented based solely on Wärtsilä's MPS or not. (MPS in VMI see for example Zammori et al 2009.).

Also what defines these components is that they are all, not generally, but in Wärtsilä's scale high volume components and take a lot of storage space. They ca not be stored near the machining facilities in high quantities as there is not enough space and this is why they are more demanding and have a larger need to be logistically more optimized than smaller and cheaper components. Even though the volume of the components per material number may be high in Wärtsilä's scale, the suppliers are still delivering only a few batches per week which accounts around 100-300 pieces which is a really low number compared to VMI in other industries. At the moment the components are stored at an external storage and then home called to the machining facilities by the machinists through Wärtsilä's logistics department. Wärtsilä's goals are to optimize its storage practices and to improve efficiency in general. (Interview.).

These components are definitely categorized as strategic components instead of commodity components. Thus according to theory the supplier-buyer relationship can be expected to be intense in a VMI setting. (Claassen et al. 2008, 408).

Furthermore to define forgings and castings as categories is that there are no constant revision changes in these categories so the engine specifications stay

relatively well the same compared to for example electrical components where there may be changes monthly. The aim of this study is not to create a specific model for only these components. Rather they were chosen as case components because of their different risk level attributes than in most other components that are not machined in Wärtsilä's premises. The risk management is special due to tendency to build up a safety stock because of possible machining break downs which affects the need and usage of the components. Later the use of VMI in Wärtsilä can of course be expanded to more components that have the partnership, product and technology characteristics of VMI. (Bendoly & Jacobs 2005, 126.).

3.7 Current Process

In this part of the empirical study I am going to present Wärtsilä's current process briefly in order to describe what technologies or processes related to the VMI process are used by Wärtsilä. These factors are to be taken into account when designing Wärtsilä's new process in order to see what changes come and what is needed from the customer.

3.7.1 Forecasting and Ordering

Long term forecasts covering approximately 6-12 months time depending on the component are sent to the supplier by the operational purchaser. What makes the chosen components problematic is that their machining schedule is not always strictly aligned with Wärtsilä's master production schedule for engines making short-term accurate forecasting harder for the operational purchaser. This is controlled by production and more specifically machining and the information is not distributed to operational purchasers. Presently this information does not even exist in any form for more than only a few weeks' time span. With the plans of improved efficiency the general idea is to have them to be more aligned with the master production schedule and thus make it possible for the supplier to plan the replenishments based on MPS. (Interview.).

Wärtsilä does not have a strict frozen period as was suggested by Gardner (2004) in their manufacturer to manufacturer VMI as Wärtsilä's strategy is in flexible

manufacturing. The time period for how fast Wärtsilä can take a new order depends on order bookings, material availability and other factors. The possible unforeseen material needs are a result of either new engine orders or service parts provided to Wärtsilä's Services department. Of those two the latter is a problem as it can more often cause larger changes in short-term orders causing the supplier to have tight schedules. In general the changes within three months time span should be small and tolerable for the supplier. (Gardner 2004, 97)

For components in these categories the product costs per purchase order ratio is low i.e. there are only a few order positions per week. (Interview)

3.7.2 Lead-time

The manufacturing lead-time for all the components researched is between 4-8 weeks. Wärtsilä's time span for at what point their production schedule becomes less likely to have changes is three months in the present situation, so the supplier should be able to adjust its production program accordingly at ease. According to Zammori et al (2009) it is one of the conditions for a successful VMI that the Supplier's lead-time is shorter than the frozen horizon and in Wärtsilä's case this condition is met even though Wärtsilä does not have a so-called frozen horizon in a strict sense. If the lead-time would be longer then the results would be sub-optimal. (Zammori, et al. 2009, 172-173.).

To establish a safety stock at the supplier's premises, for example for three weeks' consumption, will of course shorten the planning period and thus make the supplier less able to adjust their production planning according to Wärtsilä's changes that may arise.

3.7.3 Machining

All of the chosen components are machined within the premises of Delivery Centre Vaasa. Main bearing cap castings are machined in the Module machining workshop, cylinder head castings in the Cylinder head workshop and connecting rod drop forgings and connecting rod lower parts in the Conrod workshop.

At the present situation the weekly machining amounts for these components vary from 100-300 depending on component and week. As there may be over 100% change in machining volume between weeks it is essential for the supplier to have an exact forecast of Wärtsilä's machining volume to be able to deliver the goods with VMI. (Interview)

3.7.4 Logistics

All of the components are delivered with FCA term so Wärtsilä has full control and responsibility to agree on the freight. (BCC 1997, 36-38.) In general some components that come from foreign suppliers go through Wärtsilä's consolidation truck that gathers shipments from multiple European suppliers. This way Wärtsilä can have efficiency in shipments as full truck loads can be achieved more easily without ordering too large batches. Because of this the batch size is not always directly controlled by logistical efficiency i.e. truck load size. (Interview)

When the goods arrive at Vaasa they're delivered to Wärtsilä's external storage and from there they're 'home called' by Wärtsilä's machining foremen. This process creates administrative work and extra manual labor also to move the goods from a few kilometers distance to Wärtsilä's production site. To get rid of this external storage practice would definitely increase Wärtsilä's operating efficiency by having storage in only one place and removing internal shipping. (interview.).

The logistics department always does the goods receipt in SAP based on a delivery note, which has Wärtsilä's order number in it. Thus no goods are in Wärtsilä's premises that are not owned by Wärtsilä from ERP point of view.

3.7.5 Obsolete Stock and Defective Goods

New revisions in castings and forging are rare and also mostly affect only the machining programming. Therefore as they're not a constant thing it makes the demand planning easier. When a new revision is released for castings/forgings the old revision is usually consumed before the new revision is taken into use. As the

revision changes are often only for the machining programming it doesn't affect the supplier directly. (Interviews operational purchasers / strategic purchaser 8.2)

In these categories if there are deviations found and a claim is made for the received goods there are three options used on how to handle the deviated parts: they can either be sent back to the supplier, repaired in Wärtilä's premises or be scrapped. The choice of action is based on Wärtsilä's capabilities to repair the parts, on how obvious the claim is and on what is the price of the goods. The capabilities and price of the goods affect what is the most economical option. In general easy fixes that require for example burring or bushing are done at Wärtsilä and parts that need larger repairs or if the deviation is more questionable are sent back to the supplier. These actions are decided case-by-case oftentimes in co-operation with the supplier. (Interview.).

3.7.6 Information Sharing

The information sharing with the suppliers is frequent but can still be categorized as regular interaction for purchasing more strategic goods compared to an extensive information sharing mentioned in VMI theories. (See e.g. Claassen et al. 2008; Zammori et al. 2009.). What is shared with the supplier is categorized as normal purchase order placement information such as purchase orders, forecasts, revision changes, and new delivery times etc.

3.7.7 Information technology

Wärtsilä uses SAP for material resource planning and EDI links have been in use with many suppliers for a long time. Both of these were defined as VMI enablers in a qualitative study done by Claassen et al. (2008). However, the suppliers chosen for VMI don't fill the traditional characteristics of EDI suppliers and thus some of them do not have it in use yet. The savings in administrative cost have to be looked from this angle also. If the supplier does not use EDI presently it has to be analyzed if it is needed for VMI transaction or if there is some other way to do it. The benefit of EDI comes as it enables deeper integration, but if the integration

is not planned for the specific relationship EDI will also lose lots of its advantages with these suppliers. (Interviews)

Of other relevant purchasing process automation technologies the Kanban signaled purchase orders have also been in use in Wärtsilä for years. However, self-billing of the goods that is mentioned in the theories has not been in used by Wärtsilä and therefore in case it is chosen to be used it has to be piloted well before usage. Consignment stocks are also not used and thus purchase orders or invoices based on actual consumption have not been tried. Self-invoicing the goods is a standard application in SAP mm-module and therefore possible to have technically without large investments. (Interviews; Gardner 2004, 101.).

In the current process the supplier loses track of the shipment as soon as it is picked up by the freight forwarder. This, of course, is natural as FCA Incoterms is used and the supplier has no logistical or legal responsibilities for the goods after the pickup. Of technologies on how to more automatically monitor shipments barcode readers are in use but RFID has only been introduced and planned but not piloted in Wärtsilä. In the future there are still plans to start involving Wärtsilä's larger suppliers to use RFID so it is included in this research also to see how Wärtsilä could benefit of RFID in VMI. (Interviews) Suppliers for the planned VMI components are large, publicly listed companies who do not deliver frequently to Wärtsilä so it would be necessary to do the cost calculations whether to involve barcodes or RFID in their shipments also. The relative costs of the administrative work are also small in the administrative work of the logistics department. In the VMI process RFID tags would have benefits especially in stocks held at supplier's premises and in possible bonded/internal warehouse in Wärtsilä's premises. That is because RFID's superiority over barcodes is in its distant reading possibilities but oftentimes this needs a clear port through which the goods must move. (Brown et al. 2007.). Oftentimes the suppliers have a separate storage place for ready goods and to have RFID from the beginning to monitor that would prove in handy for at least three reasons. Firstly Wärtsilä could monitor the possibly agreed safety stock at the supplier's inventory without extra work for neither party and secondly this information could be used to

evaluate the performance of the whole supply chain also as the supplier's stock levels could be monitored in ready goods. Thirdly RFID or barcode tags could have information that would guide the logistics personnel how to do proper goods receipt or other relevant actions. This would have benefits especially if there are process changes that would require things to be done differently than they are done at the moment.

In Wärtsilä's manufacturing facilities RFID may not be convenient to use because there are no clear ports through which the goods go when withdrawn from the stock. Therefore barcodes are often more convenient when taking the goods from the stock. This does not remove the advantage Wärtsilä would also get when making the goods receipt more automatically. (Interview.) It must be noted that these two systems are not mutually exclusive as the same printer can make both tags. Both technologies do allow Wärtsilä and the supplier to have real-time surveillance of the deliveries and stock levels when integrated to ERPs through for example EDI technology. (Interview.)

Supplier portal is designed, but not implemented at the moment and in its first phase it is not planned to have SAP integration or automatic data sending. Some suppliers have EDI linked to their system so they are so called system-to-system – suppliers. The information shared with these suppliers is more basic; for example purchase orders and purchase order confirmations. Wärtsilä's stock levels are not shared with any of their suppliers at the moment and what comes to their production programs they are shared but not integrated to suppliers' MRPs. Wärtsilä does not have any enterprise application integration –program in use. Therefore there are no means to link for example Wärtsilä's SAP to the supplier's SAP not to mention different ERPs such as Oracle. (Interview.).

3.7.8 Invoicing

The standard procedure is that Wärtsilä makes the purchase order months in advance and the supplier then sends the invoice approximately at the same time as they ship the goods. The invoice is not accepted until goods receipt has been made with quantity that matches the purchase order and the price has been checked to

be in accordance with the order. Thus it is not possible to create an invoice only as there has to be a purchase order for it to be checked. Oftentimes Wärtilä's MPS changes within the ordering period and they have to move the delivery date which creates extra work. In some cases the supplier has already started production for the goods and then they are reluctant to postpone the shipment because of tied up capital etc.

3.8 New Process

In the second part of the empirical study I am going to go through the new process and create alternatives on how VMI can be implemented. These processes are different from any of the theories and also no cookie-cutter method can be applied due to different abilities of Wärtsilä's broad supplier base. As there is a lack of fully applicable theory it has to be noted that these processes are based on projection from many parts. The reliability of the author's speculation is assessed well with several discussions of Wärtsilä's personnel from all areas of business that are affected by the possible changes.

3.8.1 Perceptions of VMI in the Case Company

After two months of researching VMI I gave an open questionnaire to the purchasing managers of Delivery Centre Vaasa to get an overall view of what is the perception of VMI before it is implemented in the company. This includes General Managers for both strategic and operational purchasing and two Team Managers for operational purchasing. All of the participants have years of experience from purchasing activities and three out of four respondents in managerial position as well. The respondents were introduced with the findings of this research by the author before the interview so there is a purposeful research bias in that. Respectively, two of the respondents were also the ones who originally introduced VMI to the author before initiation of this thesis. Another research bias comes from the fact that the purchasing managers had been in VMI-related meetings with each other and had other discussion also. Due to this fact it is likely that their answers are more congruent than if they hadn't been in contact with each other about the topic. Open end questions were chosen to get a broader

view of the perceptions as all of the respondents chosen for this questionnaire are high level professionals and only four interviewees were interviewed. A take of four was chosen because there are four purchasing managers in Delivery Centre Vaasa purchasing department. In this part I will gather the results from the interviews and the first chapter is always about the answers and in the second I have analyzed how it is in line with the theories:

The history of VMI in Wärtsilä is quite little. It has been used in nonstrategic components since the 90s with a supplier that has VMI as its business concept. It has not been used with a solution owned by Wärtsilä. The idea to start using VMI for strategic components has been around since 2006 or 2007 but the markets were different then with the booming economy and it was seen too risky to start. For reasons why VMI is to be implemented now four reasons came up. With the present market situation the volumes are lower but also more volatile. Internal factors that drive for VMI in Wärtsilä are the need for more agile suppliers, aim to have a smaller inventory physically and demand for more cost-effective supplier network.

And now for the author's own analysis of this answer. Claassen et al. (2008) mentioned trust as one of the enablers for VMI. Earlier with the booming economy the suppliers had more problems in delivering on time and thus trust was also at lower level. Now that the total market volumes have gone down there is also more trust that the suppliers are able to do on time deliveries. Of internal drivers mentioned all of them (more agile suppliers, less inventory and more cost-effective supplier network) have been mentioned as results of VMI. (Claassen et al. 2008, 407; Zammori et al. 2009, 167.).

For the **expected benefits** one reason rose above others. All four interviewees mentioned something that is categorized under more optimized inventory practice as one of the reasons. This includes more JIT-deliveries, less warehouse space needed, less tied up capital in the inventories and smaller internal logistics costs. One manager also mentioned better cost structure as the most attractive benefit of VMI and another one mentioned improved information flow and consequently

better reaction time for changes as one of the most attractive reasons to implement VMI.

The expected benefits are also all found in the theories. (Claassen et al. 2008, 407; Zammori et al. 2009, 167.). All of the managers gave some inventory practice related answer and what makes optimal inventory practice the 'clear choice' in our case study is that the parts are physically large compared to for other typical VMI products in retail, construction, electronics or other businesses. For this reason the pressure for it is a lot higher than in for example nuts and bolts.

When asked about the **growth potential** the opinion was congruent that growth potential exists for VMI and Wärtsilä. Components that have stable consumption, high volume and single source were mentioned as VMI qualifiers for now. To achieve full growth potential a working solution for dual sourced products was also mentioned as a must.

In the answers for the third question high volume and stable consumption were mentioned as characteristics of VMI components but the issue of single-sourced or dual-sourced has not been explored at all in VMI theories. (Bendoly & Jacobs 2005, 126.). Why it has not come up in VMI theories is most likely due to the fact that it is a problem only in manufacturer to manufacturer VMI where product numbers and usage may be the same for products from different suppliers. Definitely more research needs to be done there for manufacturing companies to start utilizing VMI more.

The fourth question asked was on the **expected challenges with suppliers** to get them convinced to start a VMI practice. Also for this question the answers were quite congruent. The expected problem is that the supplier will only see that this is a move of inventory to their premises at their cost. To overcome this problem the supplier needs to be convinced that VMI will bring cost savings and other benefits for them also. It was mentioned that they need to have information about the VMI process and that how much for example the bull-whip effect makes their work harder presently.

To target this question is one of the benefits of this research for the case company. As the benefits or VMI are well researched and the process is better known, it will be easier to market VMI for suppliers. For example according to studies bull-whip effect can account for 12.5 to 25 percentages of the excess costs for the supplier and in our case company it will be easy to show the supplier how reducing it will help them. (Lee et al. 2004. 1875)

The fifth question asked about possible **internal marketing and implementation challenges**. This question divided the opinions the most as two of the managers answered that VMI will be easy to market and implement internally and two answered that there will be internal challenges. The implentation challenges come from having SAP-information consistent with Wärtsilä's real machining schedules. It will pose internal marketing challenges that the strategic purchasers or category managers may also see this as a cost increasing activity like the suppliers are speculated to do. To overcome the internal marketing challenges the strategic purchasers and category managers need to be well aware why this is not something that will increase the price even though the service is better.

I can analyze what favors the easy marketing point of view of VMI at first through my own experiences. While doing this study I introduced the idea of VMI in several meetings for total of 14 persons from different areas of business. All of these persons seemed to understand the concept of VMI and what are the benefits of VMI and why Wärtsilä should implement it. What is yet to be tested is how easily the strategic purchasers and category managers will be convinced that they want to start to strive for this change but definitely results from this study will make that convincing easier internally as well. Implementation is a whole another thing, as there are a lot of changes needed especially in information technology and some of the optimal solutions would need investments. This will not be easy or fast to do and likely the easier solutions will be used in the pilot projects. How well SAP is consistent with Wärtsilä's MPS has not been measured yet and it is obvious that it is a must in case the supplier delivers based on Wärtsilä's SAP information.

The sixth and last question asked about the perceptions of what **Wärtsilä's strengths** in starting to implement VMI are. Interestingly the managers mentioned different things as Wärtsilä's strength. Two respondents mentioned good analyzing beforehand and that Wärtsilä will only use VMI for proper components and suppliers. Another one said that Wärtsilä's strengths are its long, well established relationships with the suppliers and lastly it was mentioned that Wärtsilä has a long order book and it knows its consumption well beforehand.

Definitely because of this study it is a fact that Wärtsilä has studied VMI well before implementation. Long, established relationships create trust and supplier knowledge. Trust has been mentioned as an enabler for VMI and long term relationships help to evaluate managerial capacity that is needed from the supplier's part so definitely being able to assess these is strength for Wärtsilä. **(**Bendoly & Jacobs 2005, 126). The long order book and the fact that consumption is known well beforehand is a strength indeed, but to also consider the long lead times of the suppliers it nullifies this effect from most part.

What Wärtsilä expects from VMI can also be analyzed through reasons to outsource defined by Iloranta & Pajunen-Muhonen (2008). From those 6 reasons VMI is expected to account in cost savings, releasing capital, benefits of concentration and flexibility. Technological advantages are not expected as the relationship is already in a high level and no new products are being outsourced. The same reasoning applies for the benefit of exploiting market competition which was also mentioned in theories as one of the reasons for companies to outsource.

3.8.2 Relationship and attitude

Changing relationships from having cost competition between suppliers to longer relationships and mutual goals to take down total supply chain costs have been identified as one of the Japanese success models later implemented in the Western countries. (Iloranta & Pajunen-Muhonen 2008, 51.). Wärtsilä and its VMI process definitely support this idea of deeper relationships and total supply chain cost reduction. Relationship quality was defined as one of the enablers of VMI by

Claassen et al (2008) so it has to be taken care of that the quality of the relationship is in a necessary level.

The supplier relationship must change from “one-upmanship” where everyone tries to benefit from each other maximally to trying to have maximum benefit for both parties. (Gardner 2004, 103) Wärtsilä and the supplier must work together towards operational and financial efficiency to reduce lead time, inventory and production variables. It has to be understood by both parties that disruption in supply chain affects both parties and not just the one owning the inventory. (Gardner 2004, 103).

3.8.3 Logistics

Depending on their previous situation and if a safety stock is used at the supplier’s premises they may need extra storage to store the components before shipment. The stored amounts should not be large so that the supplier is able to optimize its productions schedule and cost-structure. Questions to think about in this case are whether the supplier needs extra storage facilities and how are the costs distributed. According to Claassen et al. (2008) the weaker counterpart of the trade always pays for the inventory costs which can be used as a default, not in negotiations, but in expected cost-benefits per supplier.

According to theories to run a consignment VMI in international settings would need a permit to have a bonded warehouse. (Bendoly & Jacobs 2005, 112.). However, within the EU area this is not needed even though the supplier would own the goods in Wärtsilä’s premises. All of the components researched come inside EU area so there are no needs for bonded warehouses. In case Wärtsilä would want to expand its use of VMI to outside EU suppliers it would have to expand its use of bonded warehouses to the new components as well. There is a plan for Wärtsilä to apply for a permission to have a bonded warehouse within its premises, so in that way it is at least theoretically possible to arrange. (Interview)

Contrary to the old process where Wärtsilä had to use an external storage in the new process no external storage is needed as all the components are held within

Wärtsilä's premises. Compared to the old process where both parties have been forced to hold safety stocks in the new process only the supplier is going to hold extra storage. In other words only one safety stock is held which creates logistical efficiency.

3.8.4 Choosing the minimum and maximum values

It is the consensus between Wärtsilä's machining foremen that Wärtsilä should have approximately two to three weeks of storage held in their facilities. However, the purchasing team's goal is to have maximum two weeks of storage within Wärtsilä's premises. Theoretically setting up tight limits for VMI takes away the decrease in full supply chain costs as the supplier does not have much freedom on deciding the replenishment schedule. (Claassen et al. 2008, 412.).

In order for VMI to be effective also logistically the supplier should be able to send full truck loads. (Claassen et al. 2008, 407.). In general Wärtsilä's suppliers have a relatively small client base and not that many stock keeping units per customer compared to suppliers in retail business so they are not able to consolidate shipments to multiple customers in a specific region at the same time and this makes the full truck load possibility especially important. For above mentioned reasons the margin should be at least the amount of one truckload and more in order for the supplier to be able to ship full truckloads. (Zammori et al. 2009, 165; Claassen et al. 2008, 407.).

The fact that the total percentage of the defective goods is a bit higher in these components compared to Wärtsilä's average needs to be considered when setting the minimum and maximum values. In some cases there is also a possibility that Wärtsilä machines a whole batch wrong which has 8 pieces and these values have to be considered when deciding the minimum value. The affect of these depends on how Wärtsilä is going to negotiate the contracts regarding a safety stock at the supplier's premises. If Wärtsilä and the supplier agree upon to have safety stocks at the supplier's premises then the effect of the defective goods is smaller especially with national suppliers because of their ability to re-replenish the stock fast. If it is not agreed the supplier should still have a minor safety stock for these

instances to avoid fines. To decide the minimum value the logistics time and goods receipt processing time should be taken into account as it affects the suppliers ability replenish the stock in case they send defected goods or there is a major inventory inaccuracy. (Interviews.).

The margin between maximum and minimum value should be in line with the desired shipment rate. For example if the supplier is expected to deliver once a week the margin should be more than one week's consumption with additional leeway. The maximum value is also defined by how much space there is for each component in their specific storage but it has been decided that the maximum value should rather be defined by production factors than logistical reasons and the space then arranged accordingly. (interview; Zammori et al. 2009.). The space available does set limits that need to be considered even if consignment inventory is used. In that case the limits are logistical due to the large size of the goods even though they are not in Wärtsilä's balance sheet. Gardner (2004) mentions that in some forms of VMI the supplier also decides upon the minimum and maximum levels. In our case study this is clearly impossible. As the goods are considered to be strategic in nature Wärtsilä wants to define the minimum level and due to their large size also the maximum. Also it would be counter-productive for the whole supply chain if the supplier would have a lot of capital tied up.

3.8.5 Obsolete Stock and Defective Goods

If consignment stock is not used there is no need to change the process much except that the supplier should be always aware if Wärtsilä has possible deviated parts in the stock levels that is shared with them. In the new process possible deviations have to be informed to the selling units of the supplier also in case the information has been previously sent to the quality units of the supplier only. The question that is not mentioned in any theories is whether to accept these for the stock levels when looking if the supplier is able to keep the stock in agreed levels. This, of course, is a contractual factor to be decided case-by-case.

On the other hand if Wärtsilä uses consignment stock it may become more prone to ship the goods back without repairing as it has never owned the goods at any

point. This decision has two things to consider: If the goods are sent back more easily, will the supplier then become more efficient and send less deviated parts or is it only an extra cost to the total supply chain costs since Wärtsilä's present process to repair the goods here may be cheaper considering the total supply chain costs. (Interviews)

3.8.6 Shipment

Theoretically as the supplier is able to decide when to ship it should be able to consolidate shipments better. However this most likely applies to VMI used with retailers as Wärtsilä's suppliers in general have only a small customer base especially within a specific region. (Claassen et al. 2004) To allow large shipments the VMI leeway has to be broad enough so that the supplier is able plan better and have the opportunity to send larger shipments i.e. full truck loads. In case DDU/DDP would be used the only limitation wanted would come for the supplier to send shipments in full pallets for practical reasons. At the moment the goods are delivered with FCA so Wärtsilä is liable to pay the freight. Because the suppliers have not always been able to make their shipments as ordered they have delivered smaller batches so extra costs have been created for Wärtsilä. The shipment frequency will be dominated by the leeway of maximum and minimum values so it has to be decided also on how often the supplier is wanted to ship the goods. (Zammori et al. 2009.).

3.8.7 Information Flow

Previously the operational purchaser has not received exact machining programs from the machining and thus they have not been able to make fully accurate orders based on true consumption on a weekly level. This has been one factor to create excess inventories as it has been impossible to order based on the elaborate consumption. The goals are that the machining schedules would be aligned more exactly with Wärtsilä's master production schedule and thus make it possible for the supplier to estimate consumption based on master production schedule or SAP reservations. Even though the operational purchaser is not going to create the purchase order anymore he is still responsible for sending the long term forecasts

to the supplier and depending on the system chosen maybe responsible for distributing other stock consumption related information as well.

In the new process, Wärtsilä's master production program is sent, or shared, through a chosen IT link, to the supplier. Removing one echelon from the supply chain also happens in our case study as mentioned in the theory by Claassen et al. (2008) and they also mentioned sharing the detailed production program to the supplier. (Claassen, et al. 2008, 407-408.).

Because Wärtsilä is in the manufacturing business rather than retail its inventory history is not a good indicator of future usage. This information is shared in some variations of VMI but in Wärtsilä Industrial Operations' case there is no need for that for the abovementioned reason. If VMI is later implemented for Wärtsilä's Services business unit it might be useful to send the inventory history also but that it is out of the scope of this study. (See for example Bendoly & Jacobs 2005). Information that is shared is not going to change significantly in a strategic manufacturing to manufacturing relationship of Wärtsilä and its suppliers. Rather what is going to change is how this information is shared. The new information shared is the stock level and future consumption. That is something the supplier has not been aware of previously as their value offering point has been in purchasing (Iloranta & Pajunen-Muhonen 2008, 360). The study done by Claassen et al (2008) states that information quality is not as important as theories suggest. In Wärtsilä's case the long lead times and not so large leeway will also make it essential that the information quality is at high level. It must be up-to-date and correct in order to avoid stock outs or excess stock.

3.8.8 Information Technology

To integrate Wärtsilä's MPS to supplier's MRP is a prerequisite for a win-win relationship defined by Zammori et al. (2009). At the present this has been done with orders and order requisitions via EDI but no extensive module-to-module integration has been done. However if Wärtsilä opts not to create any orders for the supplier the supplier will need to integrate the MPS to their system to achieve the most administrative benefits. The easiest way to share the MPS is via email in

an Excel sheet but they are often not the easiest to integrate to MRPs. At present it is not possible to share MPS or stock levels via EDI. The required changes are theoretically possible with system to system suppliers that have EDI capability. It would only need a few system modifications. The system that allows module-to-module information sharing would have to be owned by Wärtsilä. However, it has to be noted that suppliers now thought for VMI have not traditionally been EDI suppliers due to their relatively low number of purchase orders and positions and this is why EDI has not been in use with these suppliers. Even though they do ship consistently they don't need so many positions per purchase order and thus the administrative work is relatively low compared to suppliers in many other categories.

By researching theories it is said that same ERP programs can be enable more profound inter-firm integration. (Bendoly & Jacobs 2006). Tanskanen & Holmström (2009) state that VMI can be made working either through the customer's IT system or the supplier's, but to have VMI implemented with many suppliers the system should be owned by the customer. By considering these two factors I can say that there are at least two good options for sharing the information which are not excluding:

1. The first and preferred option would be to use an Enterprise Application Integration –program that could share all the wanted information in the wanted form to the supplier's ERP program. The program chosen should be flexible to have the possibility to integrate to most commercial ERP-systems. This would provide the benefit of profound inter-firm integration mentioned by Bendoly & Jacobs (2006) and as mentioned by Tanskanen & Holmström (2009) the IT system would be owned by Wärtsilä to allow broad implementations. This would be a large investment and if it is considered purely from VMI's point of view there are not enough benefits for the company that would justify the costs, but to look at this from a larger perspective it is something Wärtsilä should consider implementing on a large scale. EAI solution would also be beneficial from the

user's point of view as the purchaser and the seller could continue using their old programs and the learning curve would be steeper. This information could be linked through EDI and it would have the possibility to be real-time which creates a significant advantage compared to present systems. ERP integration would also have the largest decrease in the administrative costs as it would have full automation of information change. The true benefits of less short term forecasting and less order and invoice transaction costs would be achieved. The negative side of this system is its high ramp up costs and that the supplier needs the most convincing and managerial capacity compared to other ways to distribute information. The system also needs to be tested well before it can be fully trusted which takes time and effort.

2. Extra nets or supplier portal in Wärtsilä's terminology would be the second preferred option. It would enable information sharing but the integration of the information to the customers ERP would not most likely be possible as it is not planned at the moment. (Interview) These extranets are also often provided by RFID solutions suppliers. The definite advantage in this system also is that it *does not* need any ERP or demanding system from the supplier's part as they should be able to access the data via Internet-browser or a special client software supplied by Wärtsilä to the supplier and this option would also fill the requirements of ownership of the solution stated by Tanskanen & Holmström (2009). (Bendoly & Jacobs 2005, 126; Interviews.).

3. The third and not preferred option would be to allow the supplier to have access to Wärtsilä's information in SAP. Basically obtaining the present system and only allowing them restricted access to Wärtsilä's inventory modules. This would still need work from Wärtsilä's side as the system would need to be built and there would be no system integration benefits and thus no significant

administrative cost decrease. This is the simplest system to start and would need less investment than the previous two and would be also faster to take into use. Another way would be to have an automated information sending system that would send all the stock related information to the supplier for example via email as was mentioned by Bendoly & Jacobs (2005).

4. Web-cameras are also used in some industries and they could be possible for some other components. These components are physically large which would pose problems and even if they could be visually monitored the replenishment can't be made based on visual information due to their long lead times and fluctuating demand. (Interview)

3.8.9 The Use of Auto-ID Technologies

To fully automate the process of information management it seems the best way to start implementing RFID tags and barcodes to increase the amount of automated data inputs. Automating the information inputs will make the data more up to date and take away input errors made by manual inputs. It would be the technologically optimal model that the supplier has RFID or barcode system available in their production. This includes RFID or Barcode-printer and possible RFID-ports or barcode readers in varying amounts. Also changes in the suppliers' information system may be needed so they can take use of the automated information flow via EDI to their own ERP system through EAI. This system would be optimal for both parties as no lag would be in the information flow. A lagless system without information distortion would eliminate the bullwhip effect. (Lee et al. 2004. 1875.)

Furthermore if it is agreed with the supplier that safety stock on their premises is used automated inventory updates would allow Wärtsilä to measure supplier efficiency. If the supplier has larger than negotiated safety stocks it is a sign of inefficiency that goes against the goal of achieving full supply chain optimization. This model would be efficient, but considering the investments, also demands a

lot of work from both parties. The volume in these components is relatively low and thus they wouldn't be the top priority in such implementations that demand investments. The investments needed for RFID are large compared to the savings and benefits from VMI. This investment should be thought from whole Wärtsilä's perspective and VMI as a supportive factor for it.

3.8.10 Contracts

Wärtsilä has already established relationships with all the suppliers included in this research so consequently also frame agreements are in use already and hence only VMI specific contractual factors need to be thought of. Some of the VMI specific contractual factors are included in Wärtsilä's frame agreements such as Incoterms. Therefore to make a VMI contract it may be necessary to change the contracts from the existing parts also. This, of course, requires annulment and reformulation of the contract. (Zammori et al. 2009, 173.).

In the model described by Zammori et al (2009) they used the frozen horizon approach with agreed maximum tolerable variables. Even though Wärtsilä does not have such frozen period it may be possible that Wärtsilä's suppliers will bring that issue up in the negotiations to minimize their risk in case there comes a sudden stop for usage or large new demands. In their case study if there came changes inside the frozen horizon the supplier was not obliged to fulfill the extra orders and they were granted premium price for fulfilling the needs. Other such factors are if there are revision changes and in the worst case the parts become obsolete from the moment the new revision is published. (Zammori et al. 2009, 167-177).

Ownership of the inventory is a varying factor in VMI theories and definitely one of the key issues to be negotiated. (Bendoly and Jacobs 2005) This may possibly have the most clear financial effect as it will tie up capital and thus will most likely be the hardest one to negotiate.

All the components included in this research are currently delivered with FCA Incoterms. However, in a true VMI setting, when the ownership is not moved

until the goods are withdrawn from the vendor managed inventory, DDP or DDU are often used. (Gardner 2004, 100.) VMI can be implemented both ways and thus Wärtsilä has to make a decision first whether it wants to continue using FCA or to change to DDU / DDP. It is Wärtsilä's current policy to have all the goods delivered with FCA and as Incoterms do not state the ownership of the goods FCA can be used even though the supplier would own the inventory until withdrawal. As Wärtsilä's suppliers are not able to consolidate shipments to Wärtsilä's area but Wärtsilä is able to consolidate shipments from their area it is likely that FCA is more cost-efficient. (SAP; Bendoly & Jacobs 2005; Interview; BCC 1997.).

3.8.11 Ordering and Invoicing

The invoicing and ordering practices go hand in hand thus should be looked at together. The invoicing and purchasing practice is dependent on how VMI is implemented regarding ownership. If consignment stock is used Wärtsilä could self-invoice the goods based on actual consumption from the stock or a purchase order could be created based on actual consumption. These kinds of systems have not been used previously as the goods have to be technically owned by Wärtsilä when they are taken into use by machining. There are SAP modifications that allow this by default but they have not been tried.

There are many ordering and invoicing practices for VMI found in the theories. Here are options for Wärtsilä from the most preferred to least preferred.

1. Timely invoicing or ordering by actual consumption. This kind of practice is used by Wärtsilä in smaller and cheaper components. As the components researched for VMI are more expensive the time period should be short but not too short so that the administrative costs would go too high. Due to several daily withdraws from stock in our case it wouldn't be convenient to have an invoice from all of the withdraws as was used by a construction company in a case study by Tanskanen and Holmström (2009) and also by Gardner (2004). Daily invoicing would be too often and monthly invoices would create administrative costs also as the

operational purchasers could not approve the invoices anymore and they would have to be sent to a higher level to be approved. Weekly invoicing would be the most logical option considering the frequency. It would also go at least somewhat in line with the shipments and would be a proper amount to optimize the administrative work. This would work well with a consignment strategy as Wärtsilä could create purchase orders or invoices directly based on actual consumption. To create only an invoice would leave out one echelon of the present process but would need to have a great trust in the system. Self-invoicing the goods based on actual usage is supported by SAP by default but there have been signs that purchase orders based on actual consumption would be possible. The problem is that if the goods are invoiced based on actual consumption there is no purchase order made at any point of the trade. Also such system would have to be created and piloted which requires effort from Wärtsilä's side and trust from the supplier's side. This would remove Wärtsilä's purchase order making and invoice control costs would also go down as the invoices would always match the data in their system.

2. To continue Wärtsilä's present invoicing practice but to allow the supplier to either create the purchase order or to give information for the operational purchaser to create the purchase order. This can be done either automatically with a sales order via EDI system or by sending an advanced shipment note and let Wärtsilä create a purchase order based on that. The creation of a purchase order by the operational purchased based on the advanced shipping note can be done for example a week before. This way the supplier has full power to optimize their shipment quantities and schedules which will lead to higher total supply chain benefits. Also no invoices will be sent without a matching purchase order as the quantity of the sales order can be determined at a very late phase.

3. Continuing Wärtsilä's normal invoicing practice where they create a purchaser order and the supplier invoices us based on that. The purchase order can be created with Kanban as mentioned by Bendoly & Jacobs

(2005) and when the supplier invoices accordingly administrative cost in Wärtsilä would go down as they would never have to handle invoices for orders that are 1) not received or 2) with different quantity. Also as the length of time between purchase order and the invoice is short it would be up to the strategic purchaser to keep the contractual price updated. If the strategic purchaser succeeds also the third condition to accept invoices would be met better. To have a Kanban triggered purchase order at a certain inventory level would definitely decrease the amount of scheduling and production planning possible for the supplier. The purchase order would have a certain quantity defined and as the difference between maximum and minimum value is not going to be especially large the supplier would only have a few days time span to time the replenishment. This would decrease the administrative cost benefits and other whole supply chain benefits and thus Kanban is the least preferred option. In our case study Kanban would not even fit the characteristics of VMI as the supplier would not have the possibility to make decisions concerning replenishment.

3.8.12 Financial Effect of VMI

As VMI is a complex business process its benefits are multidimensional. (Bendoly and Jacobs, 2005.) Also as VMI can be done in many ways, its financial effects may vary substantially case by case. In this part I am going to evaluate each decision made when implementing VMI and its expected financial effect for Wärtsilä. Financial effects can also be divided in short- and long-term effects. Effects from changes in for example Incoterms, non-consignment to consignment stock and in general lower inventory levels come into account almost immediately, but some benefits will take more time to develop as the process matures.

3.8.12.1 Information Sharing

The information change improvements reduce the bullwhip effect. According to Lee et al. (2004) the supplier gets damage from the bullwhip effect from excess

raw material costs due to unplanned purchases of supplies, additional manufacturing expenses created by excess capacity, inefficient utilization and overtime, excess warehousing expenses and additional transportation costs due to inefficient scheduling and premium shipping rates. Properly implemented VMI addresses the bullwhip effect so the supplier should be able to work more cost-efficiently.

3.8.12.2 Incoterms

As many of the suppliers have sent incomplete shipments with FCA term these costs should theoretically be more optimized by making supplier responsible for paying for the freight and making smaller shipments infrequent. In VMI theories it is mentioned that the supplier is able to optimize the transportation costs. However in Wärtsilä's case as FCA will be used it is Wärtsilä that will get the cost benefit. The supplier will not send small batches anymore that have been an issue previously. This has been due to the supplier's inability to send full shipments as ordered and then they have sent the rest of the orders as incomplete batches. (see for example Claassen et al. 2008.).

If DDU or DDP would be used and the supplier would want to include these into the material costs, the new prices should be negotiated by using the freight costs of only shipping full truckloads. Consequently in this case Wärtsilä would also get rid of the costs that have arisen from the supplier's disability to send full batches as ordered. In case the other factors would not favor using FCA it should also be studied if changing FCA to DDU or DDP would have a negative financial effect as Wärtsilä may be a stronger negotiator with the freight forwarding company than its possible supplier. This is especially likely as Wärtsilä is able to consolidate shipments with FCA terms in contrary to their suppliers who do not have many customers at Wärtsilä's geographical area. (SAP; Interviews)

If VMI would be implemented with DDU or DDP instead of FCA it would also affect Wärtsilä's cost controlling. At the moment the product costs and the logistics costs are counted separately but if Wärtsilä moved to DDU or DDP the costs would be together and therefore the procurement costs will rise statistically.

Considering the likely negative cost effects and other factors it is unlikely that Wärtsilä would want to change its policy of having FCA with all suppliers.

3.8.12.3 Inventory

With VMI the aim is that the inventory levels are lower than with the present system and also located within the production factory's premises no external storage fees are to be paid anymore. Inventory handling costs are also dropped as internal shipping is not needed anymore. This goes in line with findings of Claassen et al. (2008).

3.8.12.4 Consignment

Previously Wärtsilä has owned the goods from the FCA date but if VMI is implemented with a consignment stock the goods are not owned by Wärtsilä until they are withdrawn from the stock and is has a clear balance sheet ramification as the freight time and storaging are taken out of Wärtsilä's balance sheet. In other words this will release capital from Wärtsilä's side. The effect of capital release has to be thought also from total supply chain perspective since the cost of capital may be different for Wärtsilä and for the supplier. This is affected by the structure of the capital the supplier possesses. If they have external financing involved in their capital its price may be more expensive for them than what is Wärtsilä's price for the tied up capital. The effect of consignment in general, though, can be nullified by adjusting the payment terms accordingly which will always be a contractual factor to be decided between the supplier and Wärtsilä. Even if Wärtsilä does own the inventory it should have less inventory costs and also smaller inventories than with the present system. The advantage from Consignment strategy would also come from not owning any deviated parts as they could be sent back to the supplier before owning them and thus the supplier would not get a so called free loan. This way Wärtsilä would rarely own any deviated parts and thus would not pay for those and wait to receive the money as the claim is processed.

The importance of accurate inventory comes once again important as if there any unresolved issues concerning the inventory, or more specifically the ability to

count for usage, the supplier's receivables will end up being late. To avoid any mistakes the system should have a minimal amount of human and machine errors. (Gardner 2004, 103)

3.8.12.5 Administrative Work

In general the administrative costs are reduced from both purchasing and accounting functions. However when looking at this from a total cost of ownership point of view these costs in the case company can be a lot less significant than in other industries since most of the tasks are not going to change. Changes come in supplier development, ordering, information change, delivery arrangements, controlling and delivery, quality controlling, controlling and monitoring, and payment transactions. These costs are less significant because administrative work reductions come from only a small area and in the beginning they can even be expected to rise. (Claassen et al. 2008; Iloranta & Pajunen-Muhonen 2008.).

3.8.12.6 Automated Purchase Process

Leaving out or automating the purchase order will have administrative benefits as less work is needed in that area. The side effect of this has to be researched well case-by-case as the operational purchaser may have to use more effort to create more reliable short-term forecasts. To put more time to forecasting may discredit the administrative benefits of leaving out delivery scheduling. This goes partly against Claassen et al. (2008) as they mentioned that VMI will decrease administrative costs in this area. This is dependant on the factor of how well the information integration is done. If an EAI-program is implemented properly the administrative costs will go down significantly.

3.8.12.7 Delivery Controlling

Normally the operational purchaser is responsible for monitoring that the goods are coming at a right time. This means that before the purchase they have to manage that the scheduling is according Wärtsilä's consumption in SAP. In case it is not the delivery will have to be advanced or postponed which always creates administrative work. In a VMI setting these changes are left out from Wärtsilä's

part and the supplier is responsible for timing the shipment there is a reduction of order modifications and thus less delivery controlling. (Zammori et al. 2009, 167.). The modifications come because the order horizon is too long. With VMI orders are not needed for a long period of time as the supplier has different kind of security for orders.

3.8.12.8 Invoicing Practice

With the present systems invoices take more than necessary administrative work as it is fairly common that the price, quantity or goods receipt demands are not met when the invoice is received. In those cases there is always extra effort needed rather than just checking and accepting the invoice. If Wärtsilä will self-invoice the goods or if the purchase order is made based on sales order then the invoice accuracy should be notably better which will lead to less time being spent on these invoices.

3.8.13 Logistics Administrative work

When internal shipping is left out it will leave out administrative work from logistics. Even if consignment stock is used the practice will remain almost the same in goods reception. This requires only a few markings done differently in SAP. RFID or Barcode tags would be beneficial as the information could be integrated in the tags and this would leave out the possibility for human mistakes. The goods are signed out of the stock normally. In the consignment stock process there will be start up costs as new process has to be learnt but it includes mostly SAP training and can be done internally.

3.8.14 Dual Sourcing

If a component has more than one supplier it will definitely pose many problems in VMI. It would be a whole another research to see where this affects everything so for this reason it is not deeply included in this research. The competitive relationships can be divided into two categories: open competition and closed competition. In an open competition relationship the suppliers are aware of the market shares they have and information can be shared openly for all parties. In a

closed competition on the other hand information can not be shared openly as the parties are not aware of their market shares, competitors and other factors. Dual sourcing creates changes in the process especially in information sharing and management and in inventory management. There is also an influence in multi-sourced VMI if the products can be used in the same end-product or if there is a reason not to use them together. The biggest challenges for Wärtsilä in this situation will be how to communicate the actual usage of their share and how to control that the logistics and productions planning departments consume the goods as agreed.

3.8.15 Performance Measurement

As said by Bendoly & Jacobs 2005 metrics for cost, stock and service levels currently exists but with the present information system Wärtsilä is not able to retrieve information of past inventory levels i.e. it wouldn't be possible to see if the values have been within minimum and maximum values in the past. This information does exist in Wärtsilä's SAP but it is not in easily retrievable form at the moment. As the information already exist it should be fairly easy to do a specific SAP transaction for this. (interview)

3.9 Summary

What I found out when doing this study is that the idea of VMI can be easy to understand, but to implement it broadly or even with one supplier is another thing. It involves almost all aspects of procurement and needs technological and mental changes. To implement it managerial capacity and support from many echelons of the company are also needed. For a large-scale implementation Wärtsilä should own the IT solution, and the solution should be flexible to suit the needs of different suppliers. The choice on how to implement VMI affects the results greatly and therefore it is important to find the optimal way possible before starting VMI.

What I found out from the case company is that perceptions of VMI are largely congruent with the theories. Due to the large size of the components inventory

management is emphasized in the case company. The relatively small leeway and long lead time of the products make information change even more crucial than it is in other forms of VMI.

To get the most out of VMI the information change must planned so that it allows inter-firm integration. Without it VMI can still work but the information must be made available properly. Several options were created for Wärtsilä and recommendations were given on what is the best way to implement VMI. The recommendations are listed in the next chapter.

4 Recommendations

In this part of part of the empirical study I am going to present what is needed from Wärtsilä and from the supplier to perform optimally. The supplier's part will be more preliminary as there are several alternatives of what kind of organizational capabilities they posses currently. Many recommendations for Wärtsilä were also given during meetings and here I have listed only some of the larger ones.

4.1 What is needed from Wärtsilä

As stated by Claassen et al. (2008) VMI needs commitment, and not only commitment from management, but from other tiers of the organisation as well. Managerial and employee commitment was also defined as enablers of any procurement development projects by Iloranta & Pajunen-Muhonen (2008). At Wärtsilä the purchasing managers, especially in operational purchasing, have already shown commitment for VMI but it is not entirely in their hands how VMI will be implemented. Strategic moves and contract negotiations are most often led by category managers within their respective purchasing categories. Therefore it is going to need internal marketing skills to get VMI accepted as an idea and to get the most out of it in all the suitable components. Potential employee resistance has to be managed well especially in purchasing and in the sales departments of the suppliers'. (Bendoly & Jacobs 205, 126.). In this case study it has not been measured if category managers are reluctant to accept new practices for their components as they will be informed only after all the relevant material is ready.

Several technological deficiencies were also found from Wärtsilä's side. These technological deficiencies can be classified more as optimizers of VMI rather than enablers so they are not necessarily needed at the same time VMI is taken into use. However, in the long run these improvements will give advantage to Wärtsilä in the form of process improvements and information management. Many of these are related to ICT which goes very well in line with findings of Claassen et al. (2008). They identified four enablers of successful VMI of which three are under

information management: quality of ICT systems, quality of information and intensity of information sharing.

1. **EAI-program** to integrate Wärtsilä's modules to suppliers' ERP-programs. This would allow full scale information integration to eliminate the bull-whip effect. This is not only for VMI, also all the suppliers with a high number of order positions would benefit greatly from reducing administrative work and the bull-whip effect. (Bendoly & Jacobs 2005, 126.). Investments for additional customized ICT-tools were also mentioned by Claassen et al. (2008).

2. **Supplier portal or extra net** should be available so that the supplier could view Wärtsilä's stock quantities, future consumptions and other inventory management related things. The supplier portal comes especially handy when the supplier's ERP is not possible to be linked to Wärtsilä's SAP. This way the supplier would have all the necessary information real time and automatically and save administrative costs especially for Wärtsilä. It is clear that Wärtsilä is the one who should own this solution to have broad implementation with many suppliers as suggested by Tanskanen & Holmström (2009).

3. **SAP transaction to monitor stock performance** i.e. stock history should be available for controlling and performance measurement purposes. The efficiency of VMI should be measured and stock level history is one of the most relevant measures for VMI. For this reason Wärtsilä should have the information easily available in a proper form to show for suppliers also. With EAI-programs this information could be shared to the supplier as well as their respective ERPs.

4. **Auto PO possibility by actual consumption** would be an efficient way to handle making of purchase order in a consignment VMI setting in a case where automatic invoicing would not be possible. This would need a transaction that would automatically make the purchase order weekly based on consumption during that week in SAP. Even if Wärtsilä could

make an automatic invoice the supplier might not accept that procedure. This is why the possibility to make a PO automatically should also be possible.

5. **Purchase order creation based on sales order** is a possibility mentioned in theories. The supplier creates a sales order and the customer automatically replies to that via EDI. This would allow the supplier to plan the shipments freely and no administrative work would be done by Wärtsilä to create a sales order.

6. **RFID** technology would improve efficiency in tracking products both in the supplier's end in Wärtsilä's premises. The information would be more real-time and be less prompt for human errors.

7. **Logistics practice change when making the goods receipt for goods that are not owned by Wärtsilä** is needed since at the present the goods receipt is always done upon arrival which always tells the storage location also. When consignment strategy is implemented no purchase order is established for the goods when they arrive so the supplier has to be able to mark the storage location and instructions in their shipment papers. These could also be easily arranged with RFID technology as the tag could hold this information and would thus remove the possibility for human errors.

4.2 What Is Needed From the Supplier

What I have found in these studies that the changes in the supplier's side are almost the same but reverse when looking at the big picture. Therefore the process won't be fully mirrored as it would be another topic for a full thesis. After the start of this thesis this topic was decided to leave for less attention compared to the other two research questions. Attitude change and managerial capacity is needed as well as technological capabilities. The vendor must understand the ideology that they are responsible for managing the inventory. Change in relationship is going to happen as it was mentioned to be the distinctive characteristic in VMI by Gardner (2004). Reluctance to accept new practices must be managed well

especially from the sales department. (Bendoly & Jacobs 205, 126.). As all the solutions should be owned by Wärtsilä the technological investments from the suppliers' side are significantly smaller. As it has been decided by Wärtsilä that Incoterms will remain the same, no changes will come from that part. The price of the product will remain the same in the sense that no DDU/DDP price will need to be included. Changes in the price may of course occur later when the pros of VMI have been well noticed and communicated. From the Supplier's side it will need a lot of acceptance of the new ideology as was mentioned in the interviews.

5 Future Research

The importance of information quality was questioned by Claassen et al. (2008) in their results but its importance in a manufacturer to manufacturer relationship should be researched. There are indications that it would still be important in Wärtsilä's case. For further research topics more technical and operational case studies should be done especially for manufacturer to manufacturer VMI. Also what I found out is that there are no sources available that mention dual-sourcing for the goods which would definitely be useful for manufacturing companies. Further research questions for manufacturing to manufacturing VMI are for example:

From where do the financial benefits come from and how remarkable are they? This is also relevant because of findings by Claassen et al. (2008) as they found out that the link between VMI and cost improvement is low.

If the administrative costs are decreased from purchase order scheduling how much are they increased in forecasting? This question is especially relevant in industries where the lead times are long.

How can ERP to ERP information integration be done the best when implementing VMI with a large supplier base.

VMI implementation in manufacturer to manufacturer VMI from the point of view of the supplier.

6 LITERATURE

6.1 Printed Publications

Bendoly, Elliot and Jacobs, Robert F. 2005. Strategic ERP Extension and Use. Palo Alto. Stanford University Press.

Brown, Mark, Patadia, Sam and Dua, Sanjiv 2007. Mike Meyers' Comptia RFID+ Certification Passport. Emeryville. McGraw-Hill Osborne.

Emmett, Stuart 2006. Relationship-Driven Supply Chain: Creating a Culture of Collaboration Throughout the Chain. Abingdon. Ashgate Publishing.

Gardner, Daniel L. 2004. Methods for Linking the Execution of Global Business Models with Financial Performance. Boca Raton. J. Ross Publishing Inc.

Gross, John M. and McInnis, Kenneth R. 2003. Kanban Made Simple: Demystifying and Applying Toyota's Legendary Manufacturing Process. New York. AMACOM.

Iloranta, Kari and Pajunen-Muhonen, Hanna 2008. Hankintojen Johtaminen: ostamisesta toimittajamarkkinoiden hallintaan. Jyväskylä. Gummerus Kirjapaino Oy.

Linthicum, David S. 2000. Enterprise Application Integration. USA. Addison-Wesley.

Sharp, John A. and Howard, Keith 1996. The Management of a Student Research Project. Cambridge, University Press

Sheldon, Donald H. 2005. Class A ERP Implementation: Integrating Lean and Six Sigma. Boca Raton. J. Ross Publishing Inc.

The British Chamber of Commerce. International Trade Manual: Export Import Forwarding. Maine. Butterworth-Heinemann. 1997.

6.2 Articles

Aderohunmu, Rotimi, Mobolurin, Ayodele and Bryson, Noel 1995, Join Vendor-buyer Policy in JIT Manufacturing. Journal of Operational Research Society. Vol. 46, no. 3. pp. 375-385

Angulo, A., Nachtmann, H., Waller, M.A. 2004. Supply Chain Information Sharing in a Vendor Managed Inventory Partnership. Journal of Business Logistics. Vol. 25. no. 1. pp. 101-120

Bensaou M. and Andersen, Erin 1999. Buyer-Supplier Relations in Industrial Markets: When Do Buyers Risk Making Idiosyncratic Investments?. Organization Science. Vol. 10, no. 4. pp. 460-481.

Claassen, Marloes J.T., van Weele, Arjan J. and van Raaij, Erik M. 2008. Performance outcomes and success factors of vendor managed inventory (VMI). Supply Chain Management: An International Journal. Vol. 13, issue 6. pp. 406-414

Cetinkaya, Sila and Yee Lee, Chung 2000. Stock Replenishment and Shipment Scheduling for Vendor-Managed Inventory Systems. Management Sciences. Vol. 46, no. 2. pp. 217-232.

Koh, Siau Ching Lenny and Saad, Sameh M. 2007. Could Enterprise Resource Planning Create a Competitive Advantage for Small Businesses?. Benchmarking an International Journal. Vol. 14, no. 1. pp. 59-76.

Kulp, Susan, Lee, Hau L. and Ofek, Elie 2004. Manufacturer Benefits of Information Integration with Retail Customers. Managament Science. Vol. 50, no. 4. pp. 431-444.

Lee, Hau L., Padmanabhan, V., Whang, Seungjin 2004. Information Distortion in a Supply Chain: The Bullwhip Effect. Management Science. Vol. 50, no. 12. pp. 1875-1886.

Nenes, George, Panagiotidou, Sofia and Tagaras, George 2008. Inventory Management of Multiple Items with Irregular Demand. A Case Study. European Journal of Operational Research. Vol. 205, no. 2. pp. 313-324.

Persona A., Grassi A. and Catena M. 2005. Consignment Stock of Inventories in the Presence of Obsolescence. International Journal of Production Research, Vol. 43, no. 23. pp. 4969-4988.

Tanskanen, Kari and Holmström, Jan 2009. Vendor-Managed-Inventory (VMI) in Construction. Industrial Journal of Productivity and Performance Management. Vol. 58. no. 1. pp. 29-40.

White, Richard E., Pearson, John N., and Wilson Jeffrey R. 1999. JIT Manufacturing: A survey of Implementations in Small and Large U.S. Manufacturers. Management Science. Vol. 48, no. 1. pp. 1-15

Zammori, Franceso, Braglia, Marcello and Frosolini, Marco 2009. A Standard Agreement for Vendor Managed Inventory. Strategic Outsourcing: An International Journal. Vol. 2, no. 2. pp. 165-186.

Zhang, G. Peter, Hill, Graig A. and Xia, Faming 2010. IEEE Transaction on Automation Science and Engineering. Vol. 7, no. 1. pp 96-110

6.3 Electronic Sources

Wärtsilä SAP Database

Wärtsilä Internal Website 2010 <URL:http://compass.wartsila.com/Our_Wartsila/Fast_Facts/Pages/Default.aspx>

SAP Homepage 2010 <URL:http://www.sap.com/index.epx>

6.4 Interviews

General Manager Operational Purchasing (several)

General Manager Strategic Purchasing 4.3.2010

Team Manager #1 Operational Purchasing (several)

Team Manager #2 Operational Purchasing (several)

Development Engineer Purchasing (several)

Strategic Purchaser #1 (several)

Strategic Purchaser #2 (several)

Operational Purchaser #1 (several)

Operational Purchaser #2 (several)

Development Manager Logistics 21.1.2010

Material & System Data Coordinator Logistics 21.1.2010, 28.1.2010

Development Manager Process Improvement 22.1.2010

Development Manager Applications & Data 19.3.2010

Development Expert Applications & Data 19.3.2010

Machining Foreman #1 12.1.2010

Machining Foreman #2 12.1.2010

Machining Foreman #3 22.1.2010

Production Planning Engineer 27.1.2010

SQA Engineer 22.2.2010

Appendix

Interview Emailed to Purchasing Managers 4.3.2010

1. What is the history of VMI in Wärtsilä? From where did the idea come to start examining the opportunity to implement it for your business?

2. So as you're now enlightened by the theory of VMI, what are the expected benefits and which one of the benefits is the most attractive one in Wärtsilä's case?

3. If the piloted VMI practices will prove to be successful, how much growth potential do you see that Wärtsilä has with VMI?

4. What kind of challenges do you see when trying to get suppliers convinced that they want to start VMI practice?

5. VMI needs a lot of internal support as well. Do you think that it will be easy to market the idea internally? Do you see other possible internal challenges?

6. According to theories only four out of ten VMI implementations achieve great benefits so what do you consider as Wärtsilä's strength so it can achieve great results?