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LEAN IMPLEMENTATION IN CO- OPERATION WITH THE SUPPLIER

Case Wärtsilä (DCV, Power Tech)

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Vuonna 2012, Wärtsilä on vienyt läpi kehitysprojektin kahden valitun toimittajan kanssa parantaakseen Wärtsilän ja toimittajien välisiä prosesseja Leanin avulla. Opinnäytetyö kirjoitettiin, jotta saataisiin tietoa saavutetuista hyödyistä, ja palautetta kaikilta osallistujilta. Tavoitteena oli parantaa tulevaisuudessa seuraavien toimittajien kanssa toteutettujen Lean yhteistyöprojektien tehokkuutta.

Tutkimus koottiin ensin tutustumalla Lean -teoriaan ja projektin muistioihin, ja viimeiseksi lähettämällä kysely kaikille osallistujille.

Projektin tuloksena pieniä ja keskisuuria hyötyjä on saavutettu jo lyhyellä aikavälillä. Koska osa kehityskohteista on vielä työn alla, vasta myöhemmin nähdään millaisia pitkän aikavälin etuja saavutetaan. Eniten vähennystä saavutettiin tarpeettomassa liikkeessä ja kuljetuksessa, ja tarpeettoman työn määrässä. Lean tietouden kasvu saattaa lisätä yksilöiden kykyä tunnistaa potentiaalisia kehityskohteita paremmin, ja eri organisaatioiden välisen kommunikaation paraneminen nähtiin yhtenä merkittävistä kehityksistä. Lisäksi suurin osa arvioi, että saavutettuja parannuksia ei luultavasti olisi saavutettu ilman Lean -projektia.

ABSTRACT

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In the year 2012 Wärtsilä has followed through a development project together with two chosen suppliers to make the processes between Wärtsilä and the suppliers more efficient with the help of Lean. This thesis was written to get information on the achieved results, and to get feedback from all the participants in order to improve the efficiency in the future Lean co-operation projects with other suppliers.

The research was done first by becoming familiar on Lean theory, by collecting data from the project Minutes of Meetings and finally by sending a questionnaire to all participants.

As a result, small to moderate benefits were achieved in short-term. As some of the cases are still under work, only later it will be seen what kind of long-term benefits will be achieved. Most decrease was found in unnecessary movement, transportation and in the amount of unnecessary work. The growth of Lean awareness might increase the individuals' ability to recognise potential development targets better, and increased communication between different organizations was seen as one of the significant improvements. Also, a majority estimated that without the Lean Project the improvements would probably not have been achieved.

Terminology

WIO	Wärtsilä Industrial Operations (today known as Power Tech) – Wärtsilä’s internal “supplier” for the selling units; Ship Power, Power Plants and Services
WGP	WIO Game Plan – A plan for Quality Management in WIO
DCV	Delivery Centre Vaasa – Wärtsilä’s organisation developing, producing and delivering W20 and W32/34 engines and gensets sold by Ship Power and Power Plants
WSM	Wärtsilä Supply Management – Wärtsilä’s global organisation managing supplier relationships and ensuring the required amount of goods with the right delivery time, right quality, and with the set cost targets
SCM	Supply Chain Management – The Management of all activities, information, knowledge and financial resources associated with the flow and transformation of goods and services in order to meet the end users expectations. (Weele 2010, 18)
SC	Supply Chain – Consists of all parties involved in fulfilling the customer’s request
OP	Operative Purchasing / Operative Purchaser- Department and/or a person responsible for the operative actions in procurement
PT	Power Tech – Renewed Wärtsilä’s organisation, formerly known as Wärtsilä Industrial Operations
VSM	Value Stream Management – An 8-step process in order to implement Lean concepts and tools originating from the Toyota Production System.

LEAN	A term for a manufacturing paradigm based on the fundamental goal of the Toyota Production System, aiming to minimizing waste and maximizing flow.
WIP	Work-in-process
TAKT TIME	“Available production time/required daily production quantity=time/volume”
PITCH	The amount of time (based on takt) required for upstream operation to release a predetermined pack-out quantity”
EDI	Electronic Data Interchange – an electronic system to send purchase orders’ information to the supplier and delivery information to the buyer, which is essential to cut down the data transfer time and entry mistakes.

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1 INTRODUCTION

1.1 Background

The idea for the thesis was found during spring 2012, while I was already working for the Operative Purchasing Department, Delivery Centre Vaasa (WIO, Wärtsilä Finland Oy).

During the year 2009, Wärtsilä started to implement a so called Lean Thinking in all areas and departments one by one in Vaasa factory. The aim was (and still is) to provide all the employees in every level with the sufficient information about Lean; what is it, what are the methods of Lean, what can be done in the own area of each individual to find out the small and also bigger issues in people's daily work, and how to easily do things in a more efficient way.

In the year 2012 the concept of Lean is still topical at Wärtsilä, and especially in the Purchasing Department in Vaasa Factory. For the first time, during the winter 2012, Lean has also been done in co-operation with a few pioneer suppliers. This is done to have a view from both parties about the current supply chain and order-delivery process, of the existing problems, and to give everyone a chance to learn the methods and idea of Lean and to utilise the learned ways in order to improve the current way of working.

A so called Lean Workshop was organised with the chosen two suppliers, and this thesis was done to get information on the achieved results, and also some feedback from all the participants regarding this Lean workshop.

1.2 Need

As Lean collaboration has just now been followed through with only a few suppliers, it is important to find out the result of this co-operation based on the findings of the research. With the help of the thesis, the company can get information on the achieved results and also of the possible issues which should be done differently when extending the Lean co-operation to all other suppliers in the future.

1.3 Purpose, The Research Problem And The Research Questions

The purpose of the work and the main research problem is first to clarify what Lean is and more importantly - how can it be used as a tool when developing the company's supply chain, and all processes within the supply chain? Also, the methods used during the process are being studied to improve the process itself. After getting knowledge about Lean itself, the next thing to do is to find out what kind of benefits the case company Wärtsilä has had of the Lean co-operation.

This is done by first finding out what the situation was like before the Lean utilisation and co-operation with the suppliers, what has been done during the process; how Lean was used during the process, what methods were used, what has been changed and what has been achieved, how were the set goals reached and which were the decisive methods in getting result.

The last but also a very important question to which this research tries to find an answer, is: What still needs to be done, and how could the process be improved to gain results more efficiently all in all?

1.4 Scope

The scope of this work is limited to the benefit and results received in the co-operation with the suppliers in the Vaasa Factory, even though several other Lean projects have also been followed through all over the Vaasa factory, in and between different departments.

Also, the research is done to find out what has been received with this method inside Wärtsilä and in Wärtsilä's processes. The processes of the supplier have been excluded.

2 THE COMPANY PRESENTATION

2.1 Wärtsilä Corporation

Wärtsilä Corporation is a globally operating provider of complete lifecycle power solutions in the marine and energy market. The focus of the company is in creating better and environmentally compatible technologies and services related to power. (Wärtsilä Annual Report 2011)

In the year 2011, the net sales of Wärtsilä Corporation were 4,209 million € and the company was operating in nearly 170 locations in 70 countries all over the world. In total, the company was employing approximately 17 900 people. In Finland the company employs about 3400 people, and the different units in Finland are located in Vaasa, Turku, Espoo and Helsinki. The company is listed on the Nordic Exchange in Helsinki, Finland. (Wärtsilä Annual Report 2011)

The mission of the company is to provide lifecycle power solutions to enhance the business of the customers, and to create better technologies to give benefit to both the customer and the environment. The vision again is stated to be the most valued business partner of all its customers. Wärtsilä's strategy aims to be the leader in complete lifecycle power solutions for the global marine markets and selected energy markets worldwide. (Wärtsilä Annual Report 2011)

The functions of the company have been divided under several business units; Ship Power, Power Plants, Services and Power Tech (formerly known as Industrial Operations). In addition, Wärtsilä has some other units to support the main functions, for example Wärtsilä Shared Service Center for financial matters. (Wärtsilä Annual Report 2011)

Ship Power is the leading supplier of marine engines and propulsion- and control systems. The company provides engines and generating sets, propulsion and control systems and sealing solutions for all kinds of vessels and offshore applications. (Wärtsilä Annual Report 2011)

Power Plants focuses on different kind of segments; for instance power solutions for example in oil and gas industry. (Wärtsilä Annual Report 2011)

Services again provides different kind of maintenance for both marine and energy market. The aim is to deliver different sort of solutions, which improve the efficiency and profitability of the operations by offering support through logistics, technical support and other services 24/7. (Wärtsilä Annual Report 2011)

When Ship Power, Power Plants and Services are the selling units and work with direct contact to the end customer, Power Tech again provides the products, services and solutions for the selling units. (Wärtsilä Annual Report 2011)

Today Wärtsilä has approximately 41 900 shareholders, and about 47% of the share capital is held by foreign shareholders. The three biggest shareholders in the end of 2011 were Avlis Ab with approximately 15% of shares, Varma Mutual Pension Insurance Company with 5,20% and Ilmarinen Mutual Pension Insurance Company with the amount of 3,70%. (Wärtsilä Annual Report 2011)

2.2 Wärtsilä Supply Management

As can be seen in Figure 1., Wärtsilä Supply Management is the organisation of which task is to select the right suppliers for all Wärtsilä's business, by benchmarking and sourcing globally, and to build relationships and commitment with the key suppliers. The aim of WSM is to support Wärtsilä by ensuring the supply of materials with the right quality and on-time delivery, with the lowest possible total cost. The organisation is working globally, and the responsibilities are di-

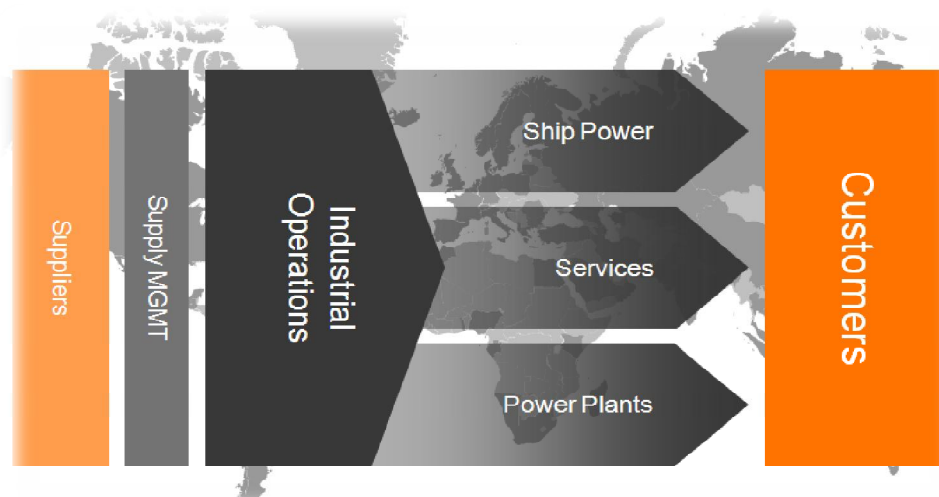


Figure 1. Wärtsilä's Organization Chart (Wärtsilä Intranet)

vided into different component categories. For every category there is a team consisting of the Category Manager, a Strategic Purchaser(s), a Supplier Developments Engineer, and from the Operative Purchasing side, an Operational Purchaser(s). (Wärtsilä Intranet)

2.3 Wärtsilä Power Tech

Wärtsilä Power Tech, formerly called as Wärtsilä Industrial Operations is working internally as a supplier for the selling units; Ship Power, Power Plants and Services, and was employing 23% of the total amount of Wärtsilä employees in the end of 2011. (Wärtsilä Intranet)

To provide the selling units with the needed products, PT has several production facilities all over the world; Finland, Italy, Norway etc. PT's main strategy is to provide the market with market leading products, by offering a competitive product portfolio, flexibility and by focusing on quality, delivery and costs. One of the key drivers for PT organisation is a so called pull production and continuous flow, which are introduced in the next chapters. (Wärtsilä Intranet)

2.4 Operative Purchasing

Operative purchasing, again, is working locally (contrary to WSM), so that every production facility has its own personnel for the everyday operative purchasing actions. The main responsibilities of OP are to provide the suppliers with a forecast on a monthly basis of the possible needed materials, to create the purchase orders and to respond to the schedule and volume changes of the production facility in a best way possible, so that the product assembly has enough of components, but at the same time the stocks are not too full from a logistic point of view, neither the stock values grow too high. (Wärtsilä Intranet)

3 SUPPLY CHAIN MANAGEMENT

Today the supply chain management, the way of organising the logistical issues and the whole order-delivery process, is playing a more and more significant role in creating, maintaining and increasing the competitiveness of the companies. In the end the customer will make the purchase decision on the basis of comparing the costs and the received benefits. By managing a supply chain successfully, a company is able to provide the customer with a variety of good quality products and services, with a competitive price and delivery time, and is a respectable competitor in today's demanding competition environment. (Ballou, 2004)

To be able to understand the possibilities to improve the supply chain and order-delivery process, it is important to go through what the concept "Supply Chain" actually means, what is the target of supply chain management, and what needs to be considered when designing, planning and operating a supply chain. Also, it is relevant to know what problems there might be, and what significance there is for a company's success to manage its supply chain well. (Ballou, 2004)

3.1 Definition

To start with *supply chain management* and only with the concept of *supply chain* itself, for both there are several definitions of which a couple of examples are described below;

"The supply chain (SC) encompasses all activities associated with the flow and transformation of goods from the raw material stage (extraction), through to the end user, as well as the associated information flows. Materials and information flow both up and down the supply chain. Supply chain management (SCM) is the integration of these activities, through improved supply chain relationships, to achieve a sustainable competitive advantage." (Ballou, 2004, 5)

The idea behind all the definitions is quite the same. However, there are differences in the way one sees the relation of logistics and supply chain management; Some claim that SCM is another way of saying "integrated business logistics

management”, when others think that logistics is a subset of SCM. In addition, also Business Logistics Management is today being referred to as supply chain management. The difference in different definitions is in how widely the concept is seen; some include for example pricing and manufacturing, some do not. (Ballou, 2004, 6)

As mentioned in the definition of Sunil Chopra and Peter Meindl (Supply Chain Management – Strategy, Planning and Operation), a supply chain consists of all stages involved (directly or indirectly) in fulfilling the customer’s request. The supply chain doesn’t only consist of the manufacturer and suppliers, but also of transporting companies, warehouses, retailers and customers themselves. “It includes all the functions involved in filling the customer request.” It is about the way of organising the flow of information, products and funds between all the different stages and participants. The supply chain activities start from the customer order and end when the customer’s need request has been fulfilled and the satisfied customer has paid the purchase. (Chopra & Meindl 2001, 3-5)

3.2 Objective

The objective of the supply chain is to maximize the overall value created during the process – the difference between what the final product is worth to the customer, and the cost of the effort and resources which are needed to fulfil the customer’s request. This can be named as *Supply Chain Profitability*. The only actual source of revenue in the supply chain is the customer, and when all flows of information, material and funds create costs within the supply chain; a functioning management of these flows is a key to a successful supply chain. The higher the supply chain profitability is, the more successful is the supply chain management. (Chopra etc. 2001, 5-6)

3.3 Decision Phases In A Supply Chain

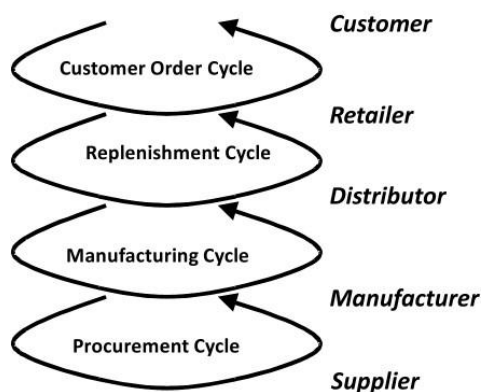
A successful supply chain requires several different decisions, which can be sorted into three categories on the basis of the frequency and time frame over each decision;

The first phase is the creation of *Supply Chain Strategy*, which needs to be in line with the strategic objectives of the company. The strategy defines the structure of the supply chain, including issues such as location and capacities of production and warehouse facilities, products to be manufactured and stored at different locations, mode of transportation, and type of the used information system. The strategic decisions are in general made for the long term. (Chopra etc. 2001, 6-7)

The second phase is *Supply Chain Planning*, of which the result is a set of operating policies that cover short-term operations. The planning is in general started with a forecast of demand in different markets for the following year. Decisions about which market will be supplied from which locations, the planned build-up of inventories, the subcontracting of manufacturing, the replenishment and inventory policies etc. will take place. (Chopra etc. 2001, 6-7)

The third phase is the *Supply Chain Operation*. The target of this phase is to implement the earlier defined operating policies the best way possible. In this phase more short-term decisions are being made about individual orders for inventory or production, scheduling the orders, generating pick lists at warehouses, organising the transportation, placing replenishment orders etc. (Chopra etc. 2001, 6-7)

Process View of A Supply Chain



The supply chain all in all is a sequence of processes and flows during and between the mentioned three supply chain phases. Below are introduced two different ways to view the processes in the supply chain – a Cycle View and a Push/Pull View. (Chopra etc. 2001)

Figure 2. Process View of A Supply Chain – Cycle view (Chopra etc. 2001)

a. Cycle View

Cycle View (see Figure 2.) – “The processes in a supply chain are divided into a series of cycles, each performed at the interface between two successive stages of a supply chain.” (Chopra etc. 2001)

As stated by Sunil Chopra and Peter Meindl in the book “Supply Chain Management – Strategy, Planning and Operation”, all supply chains can be divided into four process cycles (Customer Order, Replenishment, Manufacturing and Procurement Cycle), resulting as five supply chain stages. Not every supply chain has all the four cycles, for example when the manufacturer is selling directly to the customer, bypassing the distributor and retailer. The Cycle View clearly defines the roles and responsibilities of each party of the supply chain; therefore it can easily be used when considering for example operational decisions. (Chopra etc. 2001)

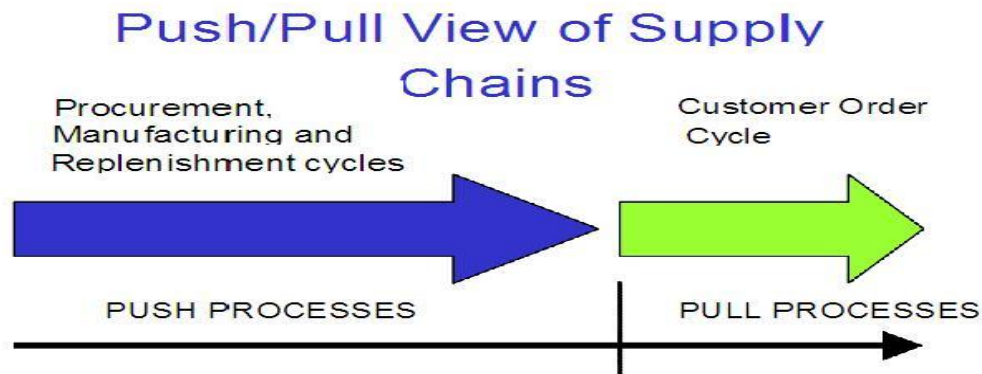


Figure 3. Push And Pull View of Supply Chains (Chopra etc. 2001)

b. Push/Pull View

Push/Pull View (presented in Figure 3.) – “The processes in a supply chain are divided into two categories depending on whether they are executed in response to a customer order or in anticipation of customer orders. Pull processes are initiated by a customer order, and push processes are initiated and performed in anticipation of customer orders.” (Chopra etc. 2001) When implementing a pull process, the exact demand is known with certainty and reaction comes due to customer demand. In the push process instead, the demand is not known and needs to be forecasted, therefore, it is also described as speculative process, because the actions are based on the forecast rather than actual demand. (Chopra etc. 2001, 7-15)

3.4 Lean Supply Chain Management

When going further into the second process view of a supply chain (Push/Pull View, introduced in the chapter 2.8.2.), in Supply Chain Management, the usual outcome is that the supply chain is carried out as a combination of the push and pull type. Today's information technology enables companies to change their SCM model from the "Push Type" to "Pull Type" and, therefore, today a so called Lean Supply Chain Management, representing the Pull Type, is becoming a more and more implemented way of organising the company's functions. (Lean-Manufacturing-Japan; Martin Murray, Logistics/Supply Chain)

Lean SCM enables companies to streamline their processes by eliminating waste and non-value adding activities. Every company has several areas in their supply chain where waste can be identified as time, costs or inventory. To change the supply chain for a "leaner" way of working, every area of the supply chain (procurement, manufacturing, warehousing transportation etc.) must be examined. (Lean-Manufacturing-Japan; Martin Murray, Logistics/Supply Chain)

4 ABOUT LEAN

When talking about Lean, often terms such as “Lean Manufacturing”, “Lean Management” or just “Lean” are used. Originally Lean is a philosophy of how to run a manufacturing organization continuously while minimizing waste to maximizing flow, but Lean can be implemented in different areas such as design, manufacturing and supply management. In the end the main idea is the same in all areas; to minimize unnecessary activities in processes in order to satisfy the customer needs the best possible way and to improve the company’s profitability and competitiveness.

4.1 History

There are traces of the creation of Lean Manufacturing already long in the history, passing from the mass production process of Henry Ford, and continuing to Kiichiro Toyoda’s Toyota Production system in the 1930s. (A Brief History of Lean)

Henry Ford was the person who implemented so called flow production with a moving assembly line, to make it possible to fabricate and assemble the components going into the vehicle within a few minutes, with a much shorter throughput time than the other car producers. The problem with this model was not the flow, but the variety. It was possible to produce only one type of a car with this short throughput time. (A Brief History of Lean)

When people started to search for variety, Kiichiro Toyoda and others at Toyota saw a possibility to provide the customer with both flow and variety of different kind of cars – Toyota Production System (Just in Time) was invented. The system focused on the flow of the product throughout the whole process including information management;

“Toyota concluded that by right-sizing machines for the actual volume needed, introducing self-monitoring machines to ensure quality, lining the machines up in process sequence, pioneering quick setups so each machine could make small volumes of many part numbers, and having each process step notify the previous

step of its current needs for materials, it would be possible to obtain low cost, high variety, high quality, and very rapid throughput times to respond to changing customer desires.” (A Brief History of Lean)

The whole perception, methods and process of Lean was completely introduced with a completely new phrase “Lean Manufacturing” by James P. Womack, Daniel Roos, and Daniel T. Jones in a book called “The Machine that Changed the World”. (A Brief History of Lean)

4.2 Idea

The main idea of Lean thinking is simple and can all in all be seen as common sense. An organisation should focus on the most effective ways of producing value for their customers, understanding the cost of waste and value of each work phase and training staff that does the work as improvement teams. The company should start to view its actions from the customer’s point of view; what is it in our processes that really creates more value for the customer? The aim is to create more customer value by using fewer resources and by minimizing the created waste. It is not only a matter of the management level, but the whole organisation from top to the bottom should understand the customer value, and constantly work for improving the working processes. “The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste.” (Introduction to “Lean Thinking”, CIPFA, McCarron, Brendan, December 2006; Lean Enterprise Institute, What is Lean)

When implementing Lean thinking, the focus of the management should change from optimizing different parts of the delivery process separately into optimizing the flow of products and services through entire value streams inside the organization; across different technologies, assets and ways of working, through different departments all the way to the customer.(Introduction to “Lean Thinking”, CIPFA, McCarron, Brendan, December 2006; Lean Enterprise Institute, What is Lean)

The point is to eliminate waste along entire value streams, not only from certain isolated points. By eliminating the waste, the processes require less human resources, less space, less capital and less time and also fewer defects will occur. As a result the company is able to provide the customer with a high variety of products and services, with high quality and very short through put times, with lower costs. (Introduction to “Lean Thinking”, CIPFA, McCarron, Brendan, December 2006; Lean Enterprise Institute, What is Lean)

However, Lean should not be seen as a short-term cost reduction program, but as a way the company operates, a way of thinking and acting through the whole organization. (Introduction to “Lean Thinking”, CIPFA, McCarron, Brendan, December 2006; Lean Enterprise Institute, What is Lean)

4.3 Methods

Five steps (presented in Figure 4.) have been defined by James P. Womack and Daniel T. Jones to implement Lean techniques inside and throughout an organisation;

1. Identify Value
2. Map the Value Stream
3. Create Flow
4. Establish Pull
5. Seek Perfection

The process starts with defining the value from the end customer’s point of view (1.) by every product family – what the customer really wants. To know what the customer’s value consists of we need to have a precise understanding of the specific needs of the customer. Only a small fraction of the total time and effort inside the organisation can add the value for the customer. The customer can value different areas with different weighting; for example price can be a less important issue if the company has a wide range of services. (Cardiff University, The Five Principles of Lean Thinking, Wärtsilä Internal Sources)

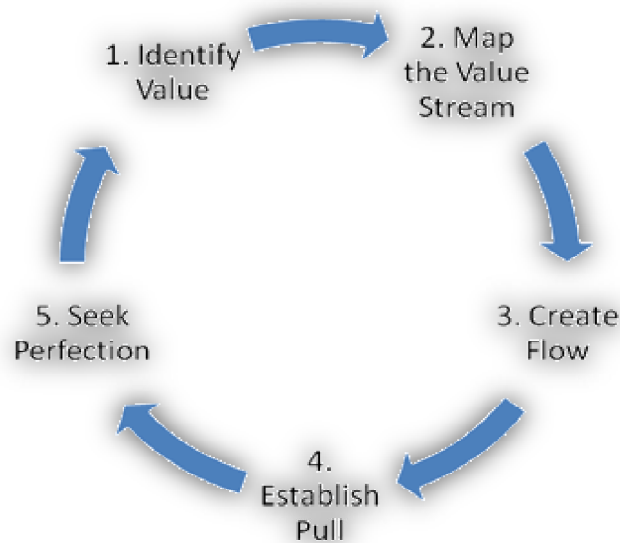


Figure 4. Five Steps To Implement Lean (Lean Enterprise Institute)

The second (2.) phase is to identify all the steps in the value stream for each product family. Defined activities can be separated into three groups (a-c); they can either be (a) unnecessary and wasteful (and should therefore be eliminated), (b) supporting the value-adding activities (which should be reduced whereby possible), or (c) customer value-adding (which should be constantly improved). By defining the value of a specific product from the customer's point of view, it is possible to identify the non-value activities or waste in the process and aim to remove it. (Cardiff University, The Five Principles of Lean Thinking, Wärtsilä Internal Sources)

The third (3.) task is to set the value-creating actions in tight sequence to make the product flow smoothly towards the customer, which can be, for instance, removing the bottle necks in the process which would otherwise slow the flow. This way the product or service should be able to flow to the customer without any interruption, detour or waiting. (Cardiff University, The Five Principles of Lean Thinking, Wärtsilä Internal Sources)

After the flow is introduced, the fourth (4.) step is to respond to the Customer Pull. In the traditional organisations, the work is done at the convenience of the operators, and as a result outputs which actually are not required, occur. When

following lean principles, the aim is to produce only what the customer wants and when the customer wants it. (Cardiff University, The Five Principles of Lean Thinking, Wärtsilä Internal Sources)

In the end, when the customer value is specified, value streams are identified, wastes are removed and the flow and pull are introduced, as a result a good understanding about the whole process is achieved and this way more ideas for improvement should come up. (Cardiff University, The Five Principles of Lean Thinking, Wärtsilä Internal Sources)

The final and fifth (5.) step is to begin the process all over again and to continue it until the perfect process with zero waste is reached. In a perfect process every phase is value-adding, flexible, linked into a continuous flow and all in all produces the desired output. The product is delivered to the customer just at the right time, with a right quality and number of goods, with right amount of value. (Lean Enterprise Institute, Principles of Lean: Cardiff University, The Five Principles of Lean Thinking: Introduction to “Lean Thinking”, CIPFA, McCarron, Brendan, December 2006)

In the next chapters few of the most utilised existing Lean tools; 5S, Kaizen, PDCA and Kanban are introduced. 5S is also implemented in Wärtsilä both in the office and factory side, and Kaizen is now put in action for example on one of the assembly lines (turbo cell). Kanban is also used in the production assembly. (Wärtsilä Intranet)

4.3.1 5S

5S (see Figure 5.) is usually the first Lean method which the organisation implements, as it is easy to do and usually has a positive impact on quality and productivity in the working place whether it is implemented in the office or, for instance, in the factory. It is a system which can be used to reduce waste and variation, to meet the schedules, to expose problems, to improve machine availability and performance and many other things by creating and maintaining orderly working conditions. Besides the actual reorganisation, 5S is also a mindset, among other things it also aims at changing people's attitudes to being well organised.

The 5 S pillars are mentioned to be Sort, Set in Order, Shine, Standardize and Sustain, but can also be named a bit differently depending on the context;

Sort – Eliminate the unnecessary items from the workplace that are not needed in current operations; one should think carefully of each item in the working place, whether it is needed or only used rarely. The sort-stage should be repeated every once in a while.

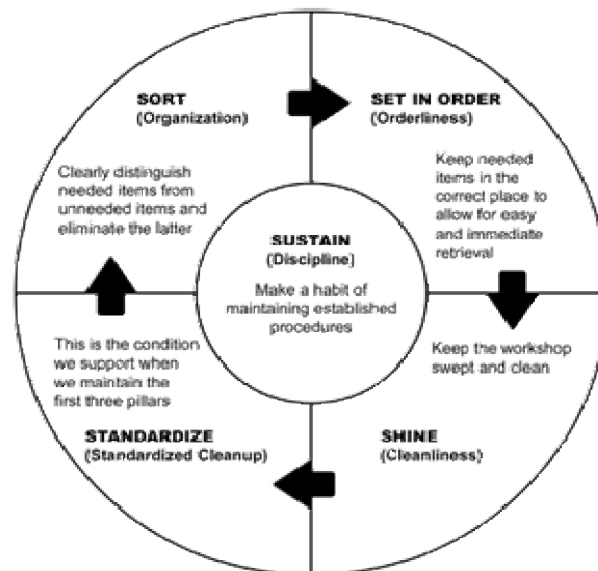


Figure 5. 5S (EPA – United States Environmental Protection agency)

Set in order – Arrange the needed items the best possible way, so that they are easy to find and use; ergonomic principles should play an important role in locating the chosen items.

Shine – Clean the working environment on an ongoing basis, for example by having a standard procedure for a 5-minute cleanup routine.

Standardize – Standardize the best practices in the working area, and prevent accumulation of unneeded parts. Standardising may consist of measuring, recording, training and work balancing.

Sustain – Make it a habit to maintain the correct actions and procedures, for which everyone should participate regularly, for example by doing audits on the “house-keeping”.

(Bicheno & Holweg 2009, 78-80 & US Environmental Protection Agency, Lean Thinking and Methods,5S)

4.3.2 Improvement Cycle – PDCA

PDCA or the ‘Plan-Do-Check-Act’ cycle is probably the most used improvement cycle, and is, when well done, a powerful tool for improvement. Quite often organizations tend to just “do” and neglect the P-D-C, but the method requires balance between each of the stages. ‘*Plan*’ is often supposed to be the first step, but it might also be that planning is not possible before knowing the facts and the situation – however, *PDCA* is an ongoing cycle.

“Plan is not just about planning what to do, but about communication, ‘scoping’, discussion, consensus gaining and deployment. The plan stage should also establish the time plan.”



Figure 6. PDCA (The Asset Reliability Road Map)

The ‘*Do*’ stage ought to be an easy stage to carry through, if the planning stage has been done well. Often it is about carrying out the improvement in a test phase. ‘*Check*’ stage is a vital learning stage to answer questions such as: Is it working as predicted, is it working out as planned or if not, what can be learned for next time?

‘*Act*’ stage is often about standardising the improvements which work, and adjusting the issues which didn’t work. (Bicheno & Holweg 2009, 182-183)

4.3.3 Kaizen

The word *Kaizen* actually means “good change” in Japanese. Kaizen is considered as both a philosophy and a set of tools, and as one of the corner stones of all lean production methods. It is a team event for quick implementation of a Lean Manufacturing Method in a particular area during a short time period. The focus is on eliminating waste, improving productivity and achieving the continual improvement in the targeted activities and processes in the organization. Normally the targeted changes are small and could be achieved by a team of seven, working full-time for a week or less. (Bicheno & Holweg 2009, 192-193; Mann D., 2010, 264; US Environmental Protection Agency, Lean Thinking and Methods, Kaizen, Tapping etc., 2002)

The aim is to gain significant improvements in long term by making small changes and maintaining them as routine applied. This is made by collecting

workers from several different functions and levels in organization to work as a group to find the problems and solutions to improve the process (called as Kaizen Events). Kaizen also brings together several tools and techniques of Lean; the team can use techniques such as value stream mapping or “the 5 Whys”, use different analysis methods and, for example, start the use of Kanban. Usually a periodic follow-up of the improvements is needed. Also, as customers’ needs are continuously changing and standards rising, continuous improvement is needed. (Bicheno & Holweg 2009, 192-193; Mann D., 2010, 264; US Environmental Protection Agency, Lean Thinking and Methods, Kaizen, Tapping etc., 2002)

4.3.4 Kanban

Kanban (meaning signboard), is a Lean (or Just-In-Time) tool to enable the better inventory of certain materials. It was invented by Taiichi Ohno, the former vice president of Toyota. It was developed to coordinate the flow of parts within the supply system on a day-to-day basis, and achieving the pull. The idea is to create instruction cards for transferring materials from parts buffer to the production line, or informing the supplier to produce more parts. (Womack, Jones, Roos 1990, 61, 294)

Kanban is a unique way to view warehousing and inventory positioning – and aims to increase the speed of delivery and inventory turns. When taking Kanban in use one needs to understand that not all inventories and material can be treated the same way; (Branch A., 2010, 28)

“Items placed in supply chain Kanbans could be limited to high inventory such as ‘A’ items and then using regular warehouses for ‘B’ and ‘C’ items. A variation to Kanban is with the import supply chains and differentiating ‘A’ versus ‘B’ versus ‘C’ items, and using a faster mode and faster carrier transit methods for select items. This reduces time and inventory with small batch sizes for select items.” (Branch A., 2010, 28)

4.3.5 The 5 Whys

The 5 Whys (also called as “Root Cause Problem Solving”) gives guidelines for solving problems at the root instead of only on superficial or immediately obvious levels. There can be several potential root causes for problems (for example a late delivery can be caused by a failure in communication or control) and the final choice of the root cause needs to be considered carefully. The actual aim of the 5 Whys method is not what the actual root cause is but how it can be solved most economically and effectively to avoid recurrence. (Bicheno & Holweg 2009, 185)

The method simply requires that when finding out the reason for failure, the word “Why” should be asked five times, as in the following example;

“A door does not appear to close as well as it should. Why? Because the alignment is not perfect. Why? Because the hinges are not always located in exactly the right place. Why? Because, although the robot that locates the hinge has high consistency, the frame onto which it is fixed is not always resting in exactly the same place. Why? Because the overall unit containing the frame is not stiff enough. Why? Because stiffness of the unit during manufacture does not appear to have been fully accounted for. So the real solution is to look at the redesign of the unit for manufacture.” (Bicheno & Holweg 2009, 185)

The questions can be asked even further; “Why did this happen in the first place? As a result of insufficient cooperation between design and manufacturing.” (Bicheno & Holweg 2009, 185)

4.3.6 Runner, Repeater, Stranger

The principle of this analysis is simple. It is often used in manufacturing companies to identify different type of components, tooling etc., and therefore to be able to organise the workplace so that the different components are handled in the best possible way. The components are classified on the basis of the usage;

1. *Runners*, which are used on a daily basis
2. *Repeaters*, which are used weekly and
3. *Strangers*, which are used monthly or even less frequently

By classifying the components it is possible to organize, for example, the daily-used runners closest, and the tools required at the same place, and the repeaters and strangers again can be placed a bit further for the remaining space. (Lean Manufacturing Tools)

5 CORNER STONES FOR LEAN IMPLEMENTATION

5.1 Value Stream Management As A Kaizen Tool

In this chapter one of the Lean tools – Kaizen (presented in chapter 4.3.3) – and the way of implementing Kaizen by means of Value Stream Management (VSM) are introduced more specifically.

“Value Stream Management is a process for planning and linking lean initiatives through systematic data capture and analysis.” (Tapping etc., 2002, 2)

There are eight steps in planning and linking Lean into an integrated part of the company through VSM;

1. Commit to Lean
2. Choose the Value Stream
3. Learn about Lean
4. Map the Current State
5. Determine Lean Metrics
6. Map the Future State
7. Create Kaizen Plans
8. Implement Kaizen Plans

(Tapping etc., 2002)

Commit to Lean

The *first* important issue is to start with making a *true commitment to Lean principles*. Without the commitment from people at all levels of the company, at all stages throughout the Value Stream Management Process, any Kaizen Workshop will turn into only a superficial attempt. It is important for every participant to understand what is being done and why, and to see the need for transformation.

(Tapping etc., 2002)

To be able to map the current state and proceed with the following steps, it is decisive to understand the customer demand thoroughly. A common excuse for not implementing Lean is about having too much variation. (Tapping etc., 2002)

Also, before starting to implement Lean, one must fully understand what is currently being done in relation to cycle times, process communications, people's working standards, machine/equipment capacity etc. (Tapping etc., 2002)

To finally get the whole package working, the key word for throughout the process is communication. (Tapping etc., 2002)

Choose the value stream

The *second* thing to do is to define and select *the value stream(s)* which should be focused on; this can for instance be done either by using different kind of analyses of the stock values, or more simply choosing a small group of suppliers or a small group of operations. (Tapping, Shuker & Luyster, 2002)

Learn about Lean

The *third* task is to *learn about Lean*; after getting an understanding of lean concepts (presented in the chapter 4.), the participants are able to apply the knowledge by identifying non-lean conditions in the current state. (Tapping etc., 2002)

It is important to develop a training plan; list the participants and their available and possible lacking skills, schedule training. Targets should be set and everything should be documented. A good way to tie together all the lean concepts is to set up a simulation, for example, by creating a workshop of the company's own products. Benchmarking is a good way of doing this. (Tapping etc., 2002)

Map the current state

The *fourth* task is to *map the current state* of production (or whatever process is being reviewed); showing the flow of material and information. A necessary way for doing this is first to draw main sketches of the main production operations and then to go to the factory floor to get the data by yourself rather than relying on re-

ports or other data. Before the tour, it is good to create a checklist so that some decisive information is gathered, for example about quantity of parts shipped per month/day, supplier delivery schedule, available production time, cycle time, changeover time, uptime, number of operators and shifts, inventory locations and quantities, time between processes. The scope of the value stream map can be defined in several different ways; defining activities and measuring the time it takes from conceiving a product to launching it or for instance defining activities and required time from receiving raw materials to shipping finished parts to customer. (Tapping etc., 2002)

The mapping will allow you to see the entire manufacturing material and information flow instead of only single, isolated operations, visualize how different operations currently communicate, see problem areas and sources of waste, locate bottlenecks and WIP, notice potential safety concerns, provide a common language for everyone in the process and finally get a impression of how the operation truly is running currently. After this, the next step is to discuss the results and findings with the team participants. (Tapping etc., 2002)

Determine Lean Metrics

Defining the Lean Metrics will help you to achieve the future state goals. There are several metrics, and every organisation ought to find the best for their own purposes, depending on particulars of the situation. Below are listed some basic metrics;

- Inventory turns
- Days of inventory on-hand
- Defective parts per million
- Total value stream WIP
- Total Cycle time/total value adding time
- Total Lead Time
- Uptime (The ratio of the actual production time of a machine to the availability time)
- On-time delivery
- Overall equipment effectiveness
- First-time-through capacity

Before mapping the future state, it is decisive to identify as much waste from the current state as possible. This is often done with a so called Lean Manufacturing Assessment, also named as Gap Analysis. The assessment enables identifying specific areas within the value stream on which improvement efforts can be focused, and identify the best possible metrics. It can also be used to monitor the progress over time. (Tapping etc., 2002)

The assessment starts with identifying the current level of progress related to ten decisive criteria;

- Team Involvement
- Training
- Workplace organization
- Quick changeover
- TPM (Total Productive Maintenance)
- Quality
- Visual controls
- Order leveling
- Material movement
- Flow manufacturing

By setting goals for each criteria, and comparing the current rating with the goals, the “gap” will be well observed. The assessment can also work as a way of communicating the progress and results for a wider range of people within different sites or projects. (Tapping etc., 2002)

Map the future state

The mapping of future state includes three different steps:

“Customer Demand Stage – understanding customer demand for your products, including quality characteristics, lead time and price.” (Tapping etc., 2002)

“Flow stage – implementing continuous flow manufacturing throughout your plant so that both internal and external customers receive the right product, at the right time in the right quantity” (Tapping etc., 2002)

“Leveling stage – distributing work evenly, by volume and variety, to reduce inventory and WIP, and to allow smaller orders by the customer.” (Tapping etc., 2002)

The mapping is to be started with determining the demand – how fast the process needs to run to meet the demand; one may calculate the takt time and pitch to find this out. Also, one needs to find out whether the demand can be met by using current production methods, and whether there is a need for buffer and safety inventories or a Finished-Goods Supermarket. Also, it is to be determined which improvement methods (for instance 5S, kanban etc.) will be used to improve the process capacity. (Tapping etc., 2002)

Step two, flow stage, is to be started with Line Balancing, which optimises the use of personnel and balances the workload, and leads to distributing the work elements evenly to meet the takt time. You may also plan for work cells. Also, for the places where continuous flow can't be achieved, one needs to determine how the control of flow will be managed. The final step again is then to determine which improvement methods will be used. (Tapping etc., 2002)

In the third step one needs to focus on leveling the production; this means evenly distributing the work over a shift or a day. If this is not done, some cells may fall behind in production and some may be waiting for work. (Tapping etc., 2002)

At first one needs to define the best method for monitoring production against the sales. After this comes the determining the route of the runner, and mapping the material and information flow. In the end one needs to determine the methods which will be used. (Tapping etc., 2002)

Create Kaizen Plans

To proceed with the Kaizen planning process, the following steps may be of help;

1. Review the future-state map and create a monthly Kaizen plan
2. Determine milestones for each major kaizen activity
3. Complete the Value Stream Storyboard
4. Obtain management approval for Kaizen plans

(Tapping etc., 2002)

Implement Kaizen Plans

When implementing Kaizen plans, it is important to keep in mind the following advice;

- Communicate!
- Address negative behaviour early during the implementation!
- Don't let one problem stop the process!
- Consider each Kaizen event as an experiment!
- Reward and recognise people's efforts! (Tapping etc., 2002)

5.2 Key Players In Lean Supplier Development

To be successful in the Lean Supplier Development, the role of the team leader in Kaizen is important; the team leader has several roles: supporting the team members throughout the process, scheduling meetings, communicating the team's mission and progress to all parties and, for example, communicating with management. (Tapping etc. 2002, 17)

To succeed in the supplier development, it is also important to gather the right team of people with the right type of knowledge. The key word is the communication between the key players. As different organizations have different kind of priorities, they ought to work closely together to make decisions that are right for the entire company and not just for one organization. Below are listed the key players. (Harris C., Harris R., Streeter C., 2011, 17-26)

Purchasing

Purchasing ought to be involved in the process for two main reasons: Firstly, due to the fact that they are the people actually purchasing the products. Secondly, purchasing is aware of how the suppliers are currently dealt with within the organization. (Harris C., Harris R., Streeter C., 2011, 17-26)

Material Control

The employees in material control know how to move the material inside the facility. They might have knowledge for example about unnecessary repacking once

the component arrives to the facility, which could be avoided with right packing and right quantities at the supplier's facility. (Harris C., Harris R., Streeter C., 2011, 17-26)

“Material control inside of a facility is vital to making the material, or value flow throughout the facility.” (Harris C., Harris R., Streeter C., 2011, 17-26)

Product Engineering

Employees of Product Engineering need to let the rest of the team know precisely what they need from the supplier when it comes to future products, for example. In addition, they ought to know what capabilities the supply base has, for example to design materials with lower costs. Too often this group of employees is not involved in the Lean processes, which often results as assembly employees getting frustrated with materials that are difficult to assemble. (Harris C., Harris R., Streeter C., 2011, 17-26)

Quality

To be able to identify the good suppliers with the potential to deliver good quality products and to develop into partners, it is important to involve the quality department for the Lean process. (Harris C., Harris R., Streeter C., 2011, 17-26)

Transportation

Besides the other supply chain partnerships, also transportation becomes important when it comes to getting the products from the supplier to the facility efficiently. Lower inventories and higher efficiency can be reached with more frequent deliveries. Even though more frequent deliveries might lead to higher transportation costs, the total costs may well go down. For this reason also the people responsible for transportation ought to be involved in the supplier development process within a Lean supply chain. (Harris C., Harris R., Streeter C., 2011, 17-26)

Right suppliers

With the help of the previously described team, the company is able to choose the correct suppliers to start the development with, and gets the input into improving how the supplier interacts with the facility. (Harris C., Harris R., Streeter C., 2011, 17-26)

6 WÄRTSILÄ LEAN



Wärtsilä Lean is a global program the target of which is to deliver customer value through the Lean Principles. The implementation of Wärtsilä Lean (see **Figure 7**), Wärtsilä Lean ohjelman toteutussuunnitelma) was started in the year 2009, and it is now expanding to other divisions as well. (Wärtsilä Intranet)

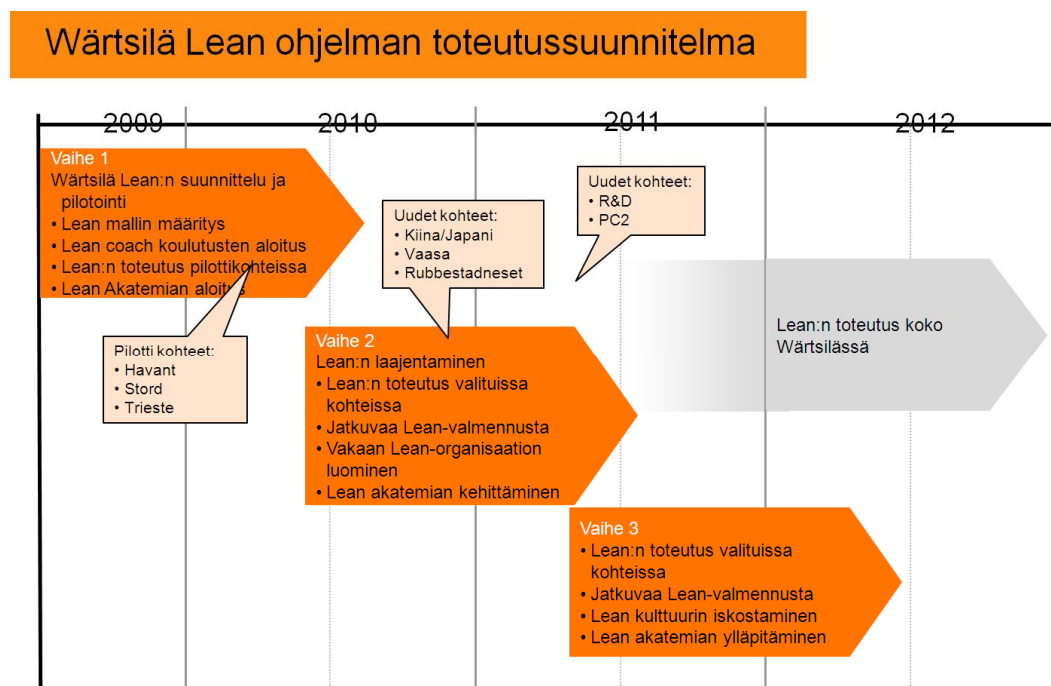


Figure 7. Wärtsilä Lean Implementation Plan (Wärtsilä Intranet)

As can be seen in **Figure 7**, the process of implementing Wärtsilä Lean has started with phase one, by defining the concept, by starting to train the so called Lean Coaches, by starting a Lean Academy and by starting to put Lean into action in the first places, for example, in Italy and Norway. In the second phase Lean has been mobilized in China and Finland (Vaasa), by training the personnel and developing the Lean Academy to create a steady Lean-organisation. In 2011, the implementation of Lean has continued in specified destinations. Also, Lean

Coaching has been continued and the personnel have got acquainted more deeply with the Lean Culture. During 2012 the plan is to put Lean into action at whole Wärtsilä. (Wärtsilä Intranet)

As Lean is to be implemented for the whole process from purchasing different materials into assembling the materials into the engines, it was decided to go through the Lean process in co-operation with the suppliers. (Wärtsilä Intranet)

Lean Thinking is used to improve the global processes within Power Tech. It aims to satisfy customer needs by still using less of everything (capital, inventories, time, human effort) across all aspects of the business. The focus is on the identification and elimination of waste in all global processes so that all activities throughout the business add value to the customer. Lean is a systematic way to understand how to meet the strategic objectives of the company by managing and developing operations. (Wärtsilä Intranet)

By spreading the Lean Awareness throughout the organisation and by training employees to apply the Lean Principles, it is possible for everyone to identify and eliminate waste in all global processes. People are thus more empowered and encouraged to identify the development potential and realise own process improvements. (Wärtsilä Intranet)

6.1 Wärtsilä Lean Framework

The Wärtsilä Lean framework includes five different areas to focus on.

People – The responsibilities should be clear on all levels in the organisation and leaders should be able to motivate and develop their team, and to put people's skills in use the best possible way. (Wärtsilä Intranet)

Strategy Deployment – It is important that the Company's and Divisions' vision, goals and strategy are clearly communicated throughout the organisation with key measures, targets and activities. (Wärtsilä Intranet)

The Way of Working/Value Stream Management - Improvements should be managed through processes and value streams to deliver outstanding customer value with minimum bureaucracy and waste. (Wärtsilä Intranet)

Extended Enterprise - The organisation should develop integrated strategies & trusting relationships with the best external partners to deliver customer value and eliminate waste across boundaries between organisations. (Wärtsilä Intranet)

Tools and Techniques - The organisation should have continuous improvement as a “daily habit”. Simple visual tools and techniques should be chosen and adapted for effective use in everyday functions. The tools and techniques for doing this can be, for example, Value stream mapping, 5S, or Kanban (pull systems). (Wärtsilä Intranet)

6.2 The Methods of Implementing Lean In Wärtsilä

The global five guidelines introduced in chapter 4 are also used when putting Lean into action at Wärtsilä (see figure 4). The first (1) thing is to define what the customer appreciates. The second (2) thing to do is to define all the stages in the value stream, and identify which stages create value for the customer and which stages do not. Typically after having mapped a value stream it is found that on average only 5% of the activities are value-adding. The next step (3) is to create the flow of value adding activities, by removing the unnecessary waste. After removing the waste, the company should find out which stages in the process can be customer demand driven (4) (pull principle, for example Kanban, bulk containers etc.). However, a certain amount of push will occur as well. The final (5) stage is to start the process all over again, and to remember that there is always room for improvement. (Wärtsilä Intranet)

One of the purposes of Wärtsilä Lean is to help people to use their time better. In **Figure 8**, it can be seen that the typical situation is that a lot of the working time goes to extinguishing fires; to solving the critical situations which come up, for example the lack of material which would cause the whole production assembly to stop. Also, the daily work takes a lot of time and effort, and there is very little

space for focusing on improving the processes. The ideal target then again is that there will not be situations which need the fire extinguishing, and the daily work amount will be in balance. (Wärtsilä Intranet)

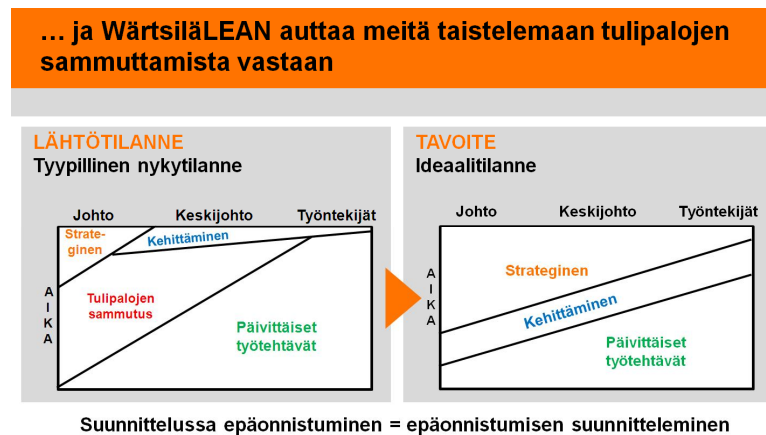


Figure 8. Working Time Usage (Wärtsilä Intranet)

Lean aims to profitable growth by creating value with faultless deliveries, the faster and more reliable service, by bringing new products and services fast to the market, by providing with products which correspond to the customer need, by enabling the customer to grow the profitable way and by exceeding the customer's expectations. (Wärtsilä Intranet)

6.3 Wärtsilä Lean Wastes

As mentioned in chapter 4, important ways to create profitable growth are removing waste by eliminating bottlenecks, unnecessary waiting and mistakes, by eliminating the steps in the value stream which do not actually create any value, by making sure that all value-creating steps are done correctly at the first time, and just on the right time, and still by delivering more with the same amount of work. (Wärtsilä Intranet)

According to Wärtsilä Lean, 7 + 1 (see Figure 8) Lean wastes can be found, for example, in the production assembly or in the office environment. Also, waste can often be found in between the different departments. (Wärtsilä Intranet)

The first waste is the possible faulty items. In the office environment this might be faulty material drawings, which needs to be corrected, or in the factory it would be a faulty component, which needs to be scrapped or fixed. (Wärtsilä Intranet)

The second waste is the talent and competencies that people have, but which is not utilised. This might mean both in the office and in the factory that people have good development ideas, but they are not listened to. (Wärtsilä Intranet)

The third waste which can be identified is unnecessary waiting. In the office this might be that people are waiting an approval from a higher level in order to be able to continue working. In the factory this could mean that the employees are waiting for components to arrive. (Wärtsilä Intranet)

The fourth waste mentioned is transportation. The components need to be moved and transported from one place into another in the warehouse or factory even if this could be avoided. In the office this might mean sharing unnecessary information. (Wärtsilä Intranet)

The fifth waste is overproduction. In the office this might mean creating reports which nobody actually needs. In the factory this would mean production which is done to use the whole capacity and time, even if there is no need for the production. (Wärtsilä Intranet)

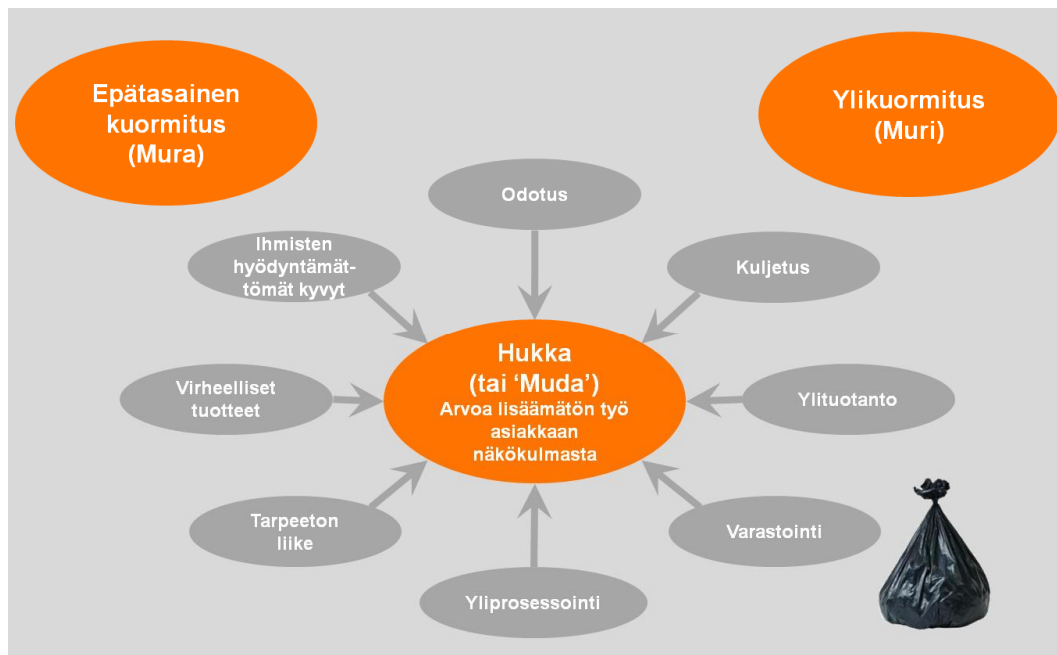


Figure 9. Lean Wastes (Wärtsilä Intranet)

The sixth waste is in storing. In the office it would mean to have several tasks unfinished and not being able to finish any. In the factory there can either be overstock, or then not enough items in stock when something goes wrong. (Wärtsilä Intranet)

The seventh waste is over processing. In the office this could be inserting the same information into several different places, and in the factory this could mean that, for example, such a high quality is required that actually it is not necessary, or that there is some sort of inspection at every assembly stage. (Wärtsilä Intranet)

The eighth waste is the unnecessary movement. In the factory this could mean that the workers need to search and get the tools from a distance, and in the office it could mean that employees search for information from several different places. (Wärtsilä Intranet)

6.4 Supplier Involvement In Lean Process

The Lean implementation has been put into action with two different companies (company X and company Y). A 3-day-meeting (Supplier Lean Awareness Workshop) was organised with these two suppliers. Wärtsilä employees from different departments, purchasing and logistics, were invited to the same meeting with the suppliers. On the first day all the persons were introduced with the basics of Lean theory, and at the end of the day all participants took part into a Lean Simulation Game (StickleBricks) to demonstrate the impact of Lean implementation (better performance). (Wärtsilä Internal Minutes of Meeting, 22.3.2012/10.2.2012)

After the Simulation Game, all the participants made a so called “waste walk”. The meaning of the walk was to go through all the phases and places where the products go through; the goods reception, warehouse and storing, the assembly line etc. By this way it was possible to find some areas in the process where some development could be made, and in the end some potential development ideas came up. (Wärtsilä Internal Minutes of Meeting, 22.3.2012/10.2.2012)

The issues which were brought up in the meeting are presented in the next chapter.

6.4.1 Company X

Regarding the goods from the supplier X, from Wärtsilä’s goods reception’s point of view the problem in the deliveries was that there weren’t enough of information in the packing lists; there was no count of the platforms, which made it more difficult and time consuming to report the goods arrived. Thus, it was decided that this information will be added to the packing list from the supplier’s side. (Wärtsilä Internal Minutes of Meeting, 10.2.2012)

Also a problem from the supplier’s point of view came up. Normally the supplier has been provided with a forecast of the material needs for one year ahead every two months. Because during two months the situations and needs from Wärtsilä’s side can vary a lot, it is more difficult for the supplier to react to the changes,

Thus, it was decided that Operative Purchasing will send the forecasts from now on to the supplier every month. (Wärtsilä Internal Minutes of Meeting, 10.2.2012)

One issue concerned the flow of the materials when taking them into use in the production assembly. The supplier always washes the products before packing and sending them. This was new information for Wärtsilä's assembly personnel, as the materials have always been washed in the Vaasa factory before taking them into use. Therefore it was decided that the washing in the Vaasa factory is not necessary, and by removing this phase the goods can be taken into use faster with less work. (Wärtsilä Internal Minutes of Meeting, 10.2.2012)

6.4.2 Company Y

The first problem which occurred regarding the products of the supplier Y was the readability of the bar code. The components are marked with the bar code, but it seems that the bar codes can't be easily read. As a corrective action, the bar code should be inspected in the future by supplier. (Wärtsilä Internal Minutes of Meeting, 22.3.2012)

Another issue concerned the long pipes delivered to the factory. Due to the length of the pipes, they are often at the risk of getting somehow damaged, especially during transportation, but also in the warehouse. As a corrective action, options for a better way of storing and transporting should be investigated. The possible ways could be packing the pipes into a wooden box, or creating a special trolley for the pipes to store and transport them. (Wärtsilä Internal Minutes of Meeting, 22.3.2012)

The next thing which was brought up was the pipes that are today both welded and mounted into the engine at Wärtsilä. It was agreed that there is a need to find out if some of these pipes (identified as runners, see chapter 0.) could also be welded by the Supplier Y. This was first to be discussed with Wärtsilä's Product Engineering department, tested with the pilot components at Wärtsilä and finally accepted by Product Engineering. (Wärtsilä Internal Minutes of Meeting, 22.3.2012)

The supplier mentioned that as they are pressure testing all the produced pipes, as a result the lead time of the production is naturally longer. However, according to the supplier rarely any problems occur in the pressure test, and it was questioned whether the pressure test is needed in every case. Due to this it was decided that the requirements are checked from Wärtsilä's side, and the supplier will send some statistics of the occurred problems. (Wärtsilä Internal Minutes of Meeting, 22.3.2012)

One topic was the raw-materials of the pipes. It was decided that it should be checked whether rolled-up pipe material can be used when the pipe diameter is 12mm. If the rolled up material could be used, the space required for storing the material would decrease. (Wärtsilä Internal Minutes of Meeting, 22.3.2012)

A so called "Wärtsilä Data Cleaning" was among the topics that were brought up. Wärtsilä has increased the revisioning of the drawings a lot lately, but in data cleaning no changes are made to the actual component in the drawing. The change might, for example, be the increased quality of the drawings. However, the revisioned drawings are always sent to the supplier. Due to the increased revisioning, both Wärtsilä (Operative Purchasing) and the supplier need to spend a lot of time handling the drawings. It was decided that some feedback will be given to Product Engineering Department, and also the background for the revisioning should be checked. Also, it was to be checked if a so called Supplier Portal could be taken into use in sharing this kind of knowledge. (Wärtsilä Internal Minutes of Meeting, 22.3.2012)

The last eye-catching issue was found during the waste walk at Wärtsilä premises. It was noticed that the Kanban shelf for storing the pipes was rather disorganised, and, therefore, the quantification of the reorder-point was probably challenging. This was to be discussed in the next meeting between the Purchasing and Logistics Department at Wärtsilä. (Wärtsilä Internal Minutes of Meeting, 22.3.2012)

7 EMPIRICAL RESEARCH

This chapter focuses on the empirical research which is done to find out the wanted information regarding the Lean Co-Operation. First some main research methods are presented, and after choosing the best suitable method for this specific research, the chapter goes through the planning and execution of the collection of the material and the results of the study.

The empirical research mainly focuses on the Supply Chain Operations, which was presented in chapter 3 (Decision Phases in Supply Chain). As described in chapter 6 (Part Supplier Involvement in the Process), a Kaizen type of a workshop was organised between Wärtsilä and the chosen two suppliers. The empirical research is done regarding this Lean workshop.

7.1 Methods

Research can be done by using a quantitative or qualitative method. These methods are often seen as methods complementary to each other, not as opposing methods, and they can often be used in parallel with each other. Quantitative research is often done by using a questionnaire for a number of a people, and it is said to concern numbers, as the qualitative research is said to be more about meanings. Qualitative research is often executed by interviewing a small number of people. (Hirsjärvi etc. 2001)

The essential features for quantitative research are often conclusions from previous researches, former theories, and the conclusions are often done on the basis of statistics. Typical feature for a qualitative research is often a comprehensive acquisition of information; the use of qualitative methods (such as theme interview and group interview), where the perspective of the interviewed people is in decisive role, and the interviewer is not the one defining what is important and what is not. (Hirsjärvi etc. 2001)

The research material can be collected from different sources; one can use already existing material, for instance, from different articles or old researches, from dif-

ferent ratings and statistics (for which one should always take a critical look). It is also possible to make the researcher's own survey which is a more or less structured, and the questions will be asked exactly in the same way from each person. The survey can include either open or multiple choice questions. It is also possible to interview people face to face, which enables a deeper view of the subject. (Hirsjärvi etc. 2001)

The best research method depends mainly of the current research problem – what kind of information is needed. Also, the available resources (time, money etc.) should be taken into account when choosing the method. (Hirsjärvi etc. 2001)

7.2 Selecting The Method

It was decided to use the quantitative research method and to produce a survey for this study. The questionnaire was provided for each person participating into the earlier described Lean Workshop at Wärtsilä, and was produced on the basis of the theoretical part of the work, and the information gathered from Minutes Of Meetings of the Workshop.

The questionnaire was done as an e-form sent by email, and by using multiple choice questions, which were completed with the opportunity to give personal, additional comments. The respondents were given a bit more than a week to reply to the questionnaire.

When specifying the wanted information, it was seen that there is no need for such deep or detailed information but more for a general view of the situation and impacts of the organised workshop. Also, it seemed that better suitable results would be gained if more answers were received by using the questionnaire and same questions, rather than interviewing only a few people and getting fewer opinions. Therefore, instead of choosing interviewing participants, a questionnaire felt as a suitable option. Also, due to the limited time and possible difficulties in organising an actual interview as the participants were from different parts of Finland, a questionnaire was defined as the most appropriate method.

7.3 Validity & Reliability

Reliability

The reliability of the research, with other words repeatability of the research should be evaluated. “Mittauksen tai tutkimuksen reliabelius tarkoittaa siis sen kykyä antaa ei-sattumanvaraisia tuloksia” which was defined by Hirsjärvi, Remes and Sajavaara (Tutki ja Kirjoita, 2001).

The aim is to avoid mistakes in the research, which would endanger the reliability of the results. However, the mistakes still occur sometimes. Reliability can be confirmed in a few ways; for example when two different surveyors will come into the same conclusion, or if the same person is being researched in two different times, and the result is the same, the research can be confirmed as reliable. For example with quantitative researches, different kind of statistical procedures have been developed. (Hirsjärvi etc. 2001)

Regarding this thesis and research, a sufficient number of replies was received, to confirm the reliability of the research, and if the questionnaire was repeated within the same conditions and at the same point of progress, the results most probably would be the same.

Validity

Validity of the research is another thing which ought to be confirmed. The aim is to find out that the research is measuring the exact thing it is supposed to measure. (Hirsjärvi etc. 2001)

It can happen, that for some reason the indicators and methods do not match with the reality, what the researcher thinks to be exploring; for example with questionnaires, the respondents and the researcher might understand the asked questions on a totally different way. (Hirsjärvi etc. 2001)

However, validity can be evaluated by asking whether the explanation matches with the description. (Hirsmäki etc. 2001)

To secure the validity of the research, the respondents were given the background information of the research in the beginning of the questionnaire. In addition, before the questionnaire was published, the questionnaire was given for a few external people who didn't take part into the project, and they were asked to see through the questionnaire and present if there was something which didn't seem so clear. After this, some improvements took place and after the questionnaire was published.

The results of the questionnaire also show that the used methods, achieved benefits and replies of the participants correspond to the background material written in the theory part of the thesis. Consequently, the criteria of validity are fulfilled.

7.4 The Questionnaire

7.4.1 The Planning And Execution

The participants in Lean Workshop were gathered from the 'Minutes of Meeting' Templates which were written about the Lean Workshop. To receive a better reply percentage for the questionnaire, at first an email was sent from Wärtsilä's email, to give all the recipients information about the questionnaire which they were going to receive, and this way motivate the people to give their answers regarding the project. All the participants were Finnish-speaking and a covering letter explaining the purpose or the study, was attached to the questionnaire

The participants had week 43 and the beginning of week 44 to reply to the questionnaire, and a reminder was sent for the people who had not responded to the questionnaire during the first four days.

The questionnaire was built to consist of five different sections:

- First to start with the basic information of all the respondents; if they were employed by Wärtsilä and on which department or if they were suppliers.
- The next part gathered information about the possible knowledge of Lean all in all and before the organised workshop.

- The third part of the questionnaire focused on the actual Lean Workshop and the ways of executing the whole project.
- The fourth part was about the results of the project; what kinds of results were achieved and what kind of effects did the co-operation bring.
- The fifth part provided the respondents with an opportunity to give open development proposals regarding the Lean Workshop, the whole project or the questionnaire.

8 RESULTS AND CONCLUSIONS

8.1 Analysing The Results

The total number of people participating into the actual Lean Workshop at the time was 15, and the questionnaire was sent for all of them. In total 11 people out of the 15 answered the questionnaire, so the reply percentage was 73,3.

The people filling in the questionnaire were mainly from Wärtsilä's Purchasing (55%), but also from Wärtsilä Production Development (18%) and from the two supplying companies who were present (27%).

To start with the general knowledge of the Lean itself, all of the participants stated to have information about Lean already before the Workshop; 36% of the participants thought to have good knowledge and 46% of the participants thought to have a little bit of knowledge about Lean, but everyone knew at least something. 63% of the participants had already taken part into some sort of Lean training (at the University before work or in trainings organised by the company or an outside organisation; seminars, Lean Awareness-training, Problem Solving, VSM –Event – learning by doing, LCT 1-3 etc.) before this Workshop.

The questionnaire also surveyed how well the participants recognised different concepts of Lean (see Figure 10). The respondents were asked to check off which of the listed concepts belonged to Lean; 5 Why's, Big Stocks, Kanban, Push, Pull, Kaizen, Lean, Mass Production, Runner, Repeater, Stranger, 7 wastes, 3 Why's, Muda and 5S. The concepts push, mass production, big stocks and 3 Why's did not belong to Lean, of which Mass production was chosen two times and big stocks for one time. Of the correct concepts, Kaizen, Lean and 5S were the most known ones, but also other concepts seemed to be quite well known as shown in **Figure 10**.



Figure 10. The Knowledge of Lean Concepts

The next part of the questions focused on the actual Lean Workshop and the ways of executing the whole project.

Commitment

As commitment in the Lean process is a decisive factor (see chapter 5) to making things work, the commitment of the participants was to be examined. From **Figure 11** it can be seen that 45% of the respondents informed their commitment to the project was good, another 46% moderate and 9% poor.

In addition, most of the respondents felt that the other participants' commitment had been either good or at least moderate. A small part (9%) of the participants felt that the commitment of other participants was poor, due to the big amount of the daily work. The proposals to get people to commit better into the project in the future were to choose suppliers who are not currently implementing Lean, and especially plan the continuity and follow up of the project better, as some of the participants felt that the project stopped after the workshop.

3.1. Leaniin Sitoutuminen: 3.1.1. Miten sitouduit koko Lean projektin läpiviemiseen asteikolla 1-4?

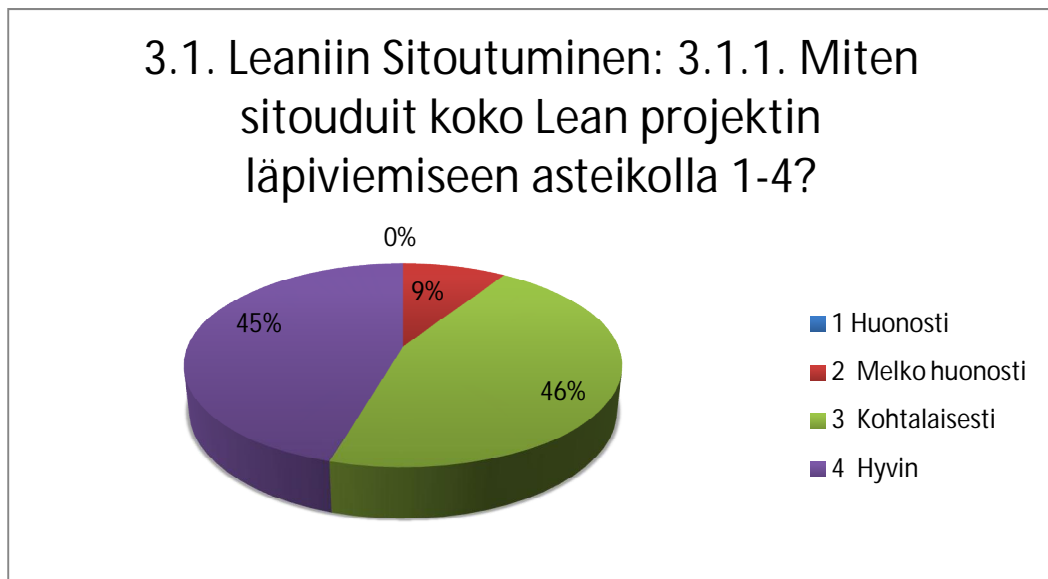


Figure 11. Commitment To Lean Project

Another proposal for improving the follow-up was to set up a portal where ideas and realization of the improvements could be updated and through which participants could communicate.

When surveying what kind of a role the participants had during the workshop, most of the participants (8 people out of 11) stated to have participated actively in the conversation in the Lean workshop, which can be seen from **Figure 12**.

3.1.4. Kuinka osallistuit Lean workshopiin?

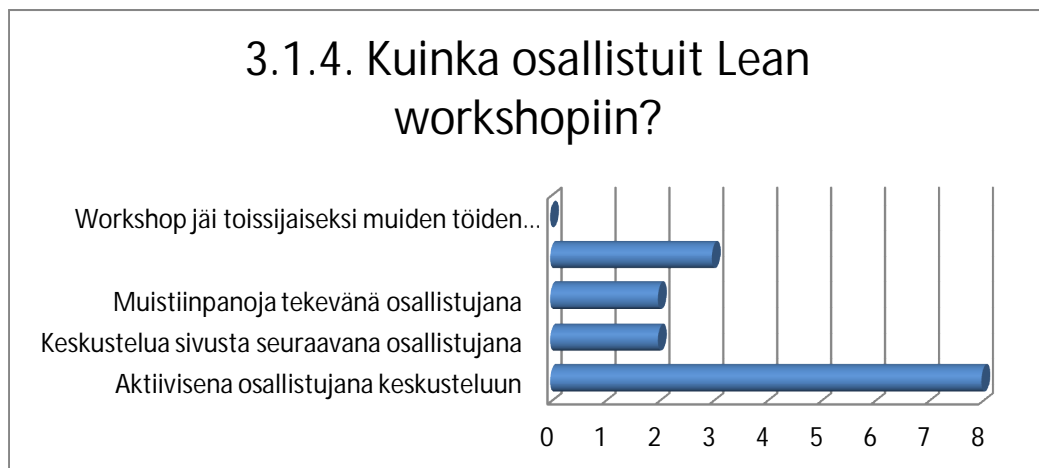


Figure 12. Participation In Lean Workshop

Key Players

As described in chapter 0, it is decisive to have the correct people involved in the improvement process, and therefore the following question was asked in the survey (see Figure 13); were the right number of people and the right organisations present at the Workshop? Most of the respondents (73%) thought the group of participants was exactly correct. However, some respondents also thought that some fundamental people were missing from the Workshop, such as employees from operative purchasing, from production planning and from production itself.

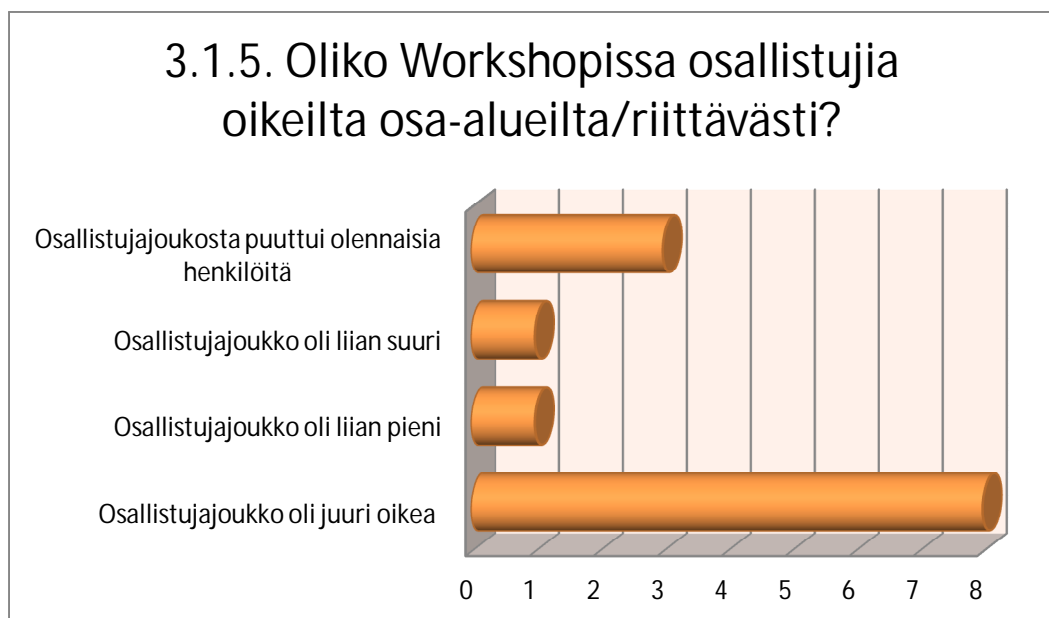


Figure 13. Workshop Participants

Key Factors

Key Players In Lean Supplier Development Also, the survey aimed to find out which parts of the workshop were the most useful ones (whether it was the team work itself, the lean theory, the waste walk, the commitment of the people, the follow-up or perhaps a good team leader is in decisive position), and at what point the important findings were done.

As can be seen from **Figure 14**, the respondents were given options to evaluate the importance of each mentioned factor from 1 to 4. Each of the factors was evalu-

ated to be important by most of the respondents, apart from the Lean Theory, which got least estimation as “very important”. However, also Lean theory was estimated to be quite important by most of the respondents. The commitment to the project, team work itself and a proper follow-up were evaluated to be the most important of all factors, in succeeding in the project. Also the Lean theory and the organised waste walk were seen to be quite important. The role of the good team leader divided opinions, as it was on the other hand seen as very important, quite important and even meaningless.

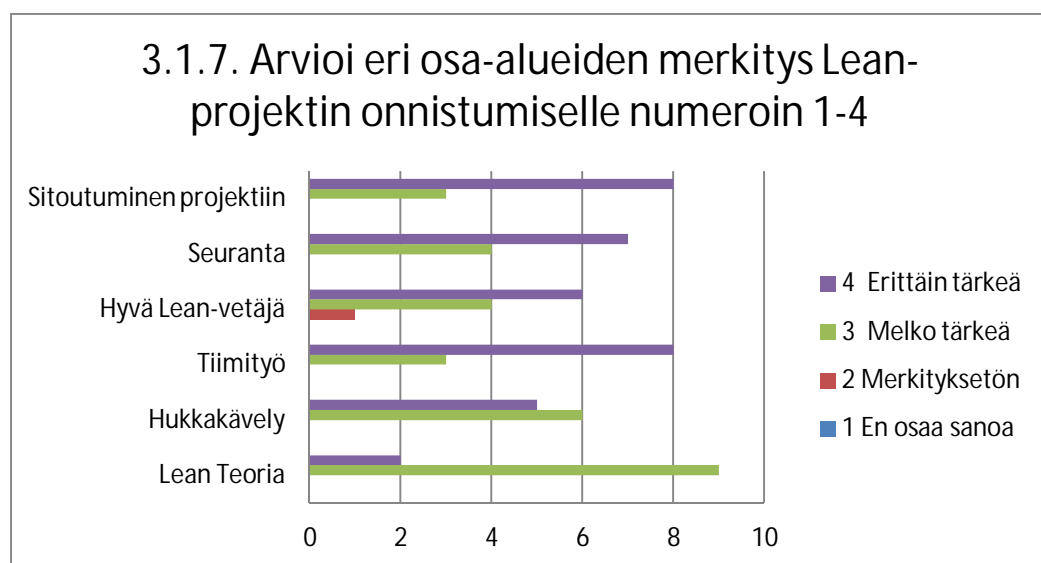


Figure 14. The Importance of Different Parts In Lean Project

Focus area and the targets

As explained in the theoretical study, it is important to define which area the Lean improvement is focusing on, so as to be able to define also what the target is. For most of the participants (64%) the focus area was defined quite well, and 27% of the participants felt the focus area was defined very well. 9% thought that the focus was defined quite poorly, which can be seen from

Figure 15.

3.2. Kohdealueen rajaus: 3.2.1. Määriteltiinkö kohdealue kuinka selkeästi asteikolla 1-4?

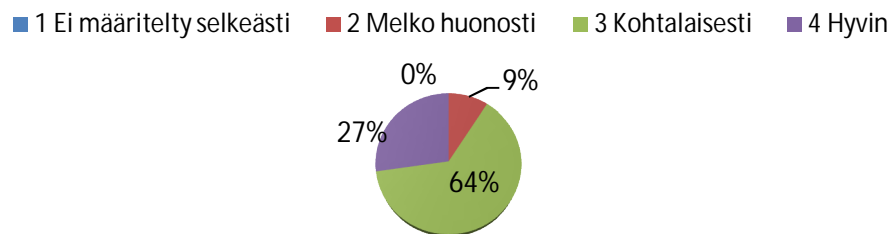


Figure 15. The Definition of The Focus Area

As can be seen from **Figure 16**, according to 18% of the respondents, the objectives of the workshop and the whole project were defined very clearly. 46% thought the objectives were defined quite clearly, but also quite a notable number of the respondents (36%) thought that the objectives were defined quite unclearly.

3.3.2. Määriteltiinkö workshopin ja projektin tavoitteet?

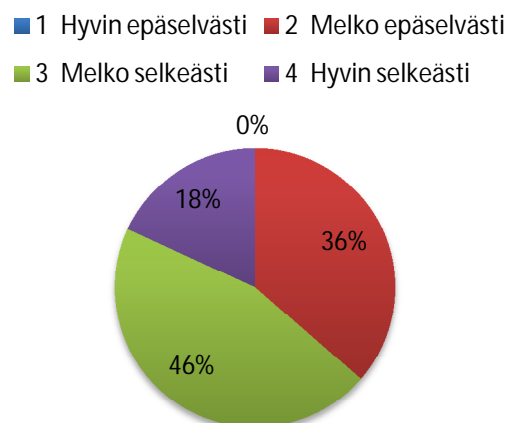


Figure 16. The Definition of The Project Targets

The respondents were also asked to write down the defined objectives in their own words, and the answers were as follows;

- the shortening of the production throughput time
- the future lead time reduction from 14 days to 7 days with some components
- the reduction of the total lead time from the design of the component into the delivery
- increase of the number of automated purchase orders and kanban-products
- better exploitation of EDI (Electronic data interchange) and finding out the possibilities of using a Supplier Portal
- getting an overview of the total processes and increase the supplier-purchaser-co-operation
- increase the Lean awareness in order to get the processes between Wärtsilä and the supplier to flow as smoothly as possible, and remove the wastes from the processes (for example double work).

It was also mentioned that the actual improvement targets were found during the workshop and they have been upgraded after that.

Lean Theory

Regarding the presented theoretical study in the workshop, the respondents were asked to estimate if the Lean theory was explained clearly or not; 64% thought the theory part was quite clear, 18% thought it to be very clear, and another 18 % of the respondents answered the theory to have been a bit unclear.

In addition the purpose was to find out how well the participants thought to have got use of the Lean theory itself. As presented in **Figure 17**, the majority (64%) of the respondents thought that the Lean theory gave a better capacity to recognise development areas in the order-delivery-process than before.

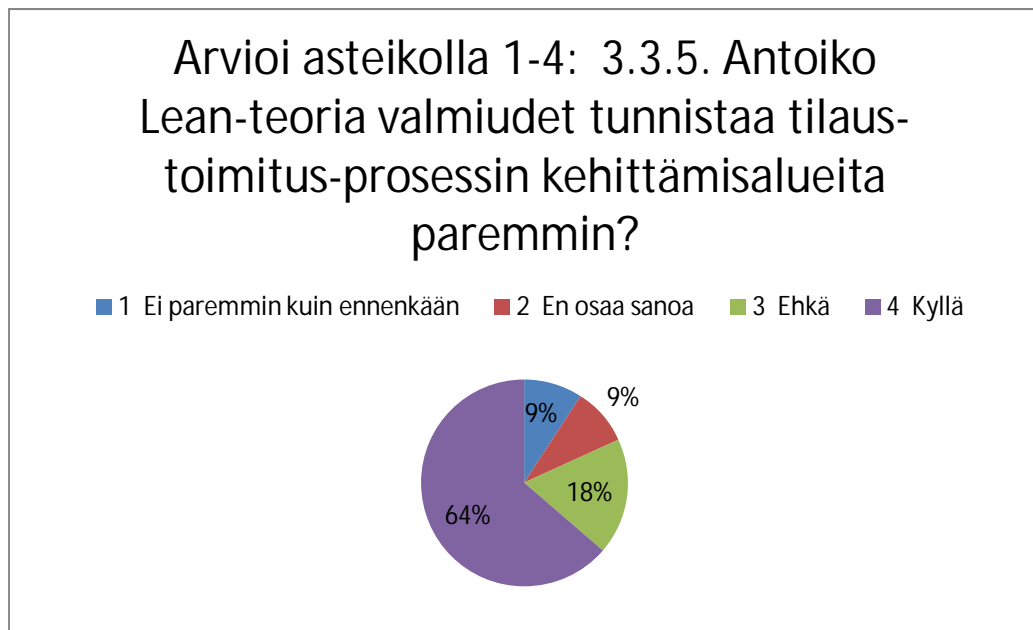


Figure 17. The Individuals' Capacity to Recognise Development Areas After Lean Theory

In addition, as the **Figure 18** shows, 46% of the respondents informed to have recognised development areas in their own work after getting familiar with the Lean theory. 27% replied "Maybe", and 9% informed that the knowledge of Lean did not make them recognise development areas in their own work any better than before.

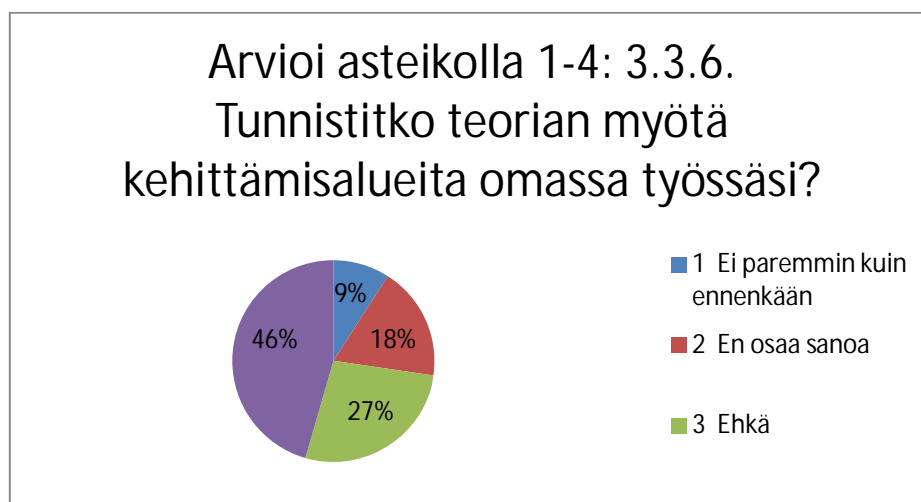


Figure 18. Recognition of Development Targets

The respondents were also asked to specify what kind of development areas they found in their own work, and the findings were as follows;

- Different kind of “wastework”
- Communication and the right timing of the communication
- ”We have a lot of waste and waiting; for example when creating the forecasts for suppliers, each person is taking the same production program from the system and modifying it separately when this could be done by one person, and everyone could utilise the same production program.”
- When handling big amounts of material and orders, the wider usage of “Runner, Repeater, Stranger”

Regarding the development ideas, 8 respondents out of 11 (73%) stated to have made development proposals for the project. The development proposals seemed to have come quite evenly from the different participating organizations - purchasing, production development and suppliers.

Time usage

Regarding the usage of time during the workshop (presented in **Figure 19**), most of the participants felt the time was spent well between theory, waste walk, problem discussion, development proposals and other issues all in all. 5 out of 11 thought that too little time was spent on the development proposals, and 3 out of 11 thought that too little time was spent on the discussion of the problems. Two people out of 11 thought that too much time was spent on the theory.

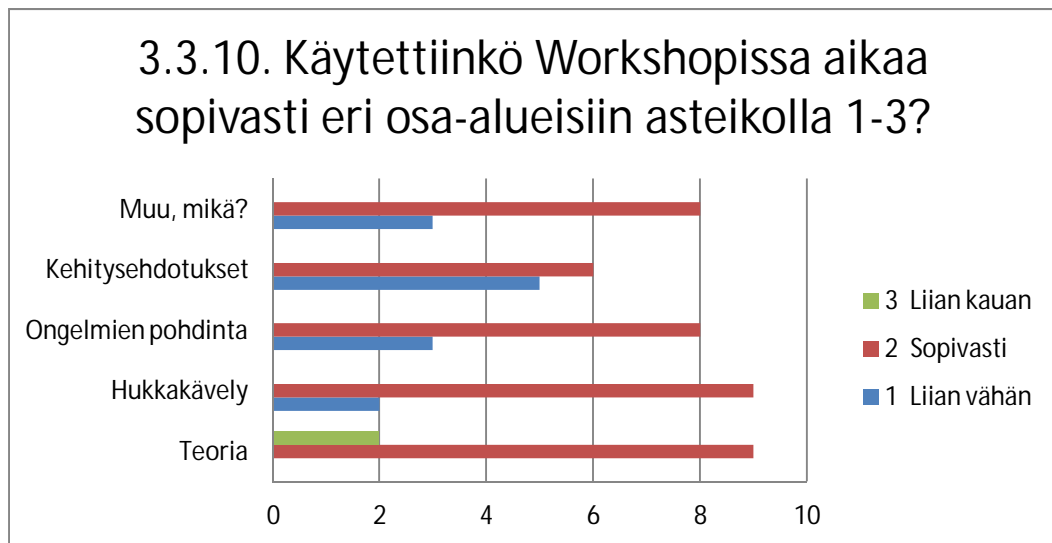


Figure 19. Time Usage During the Workshop

The other things on which the time was spent in the workshop were exchange of thoughts, group work and free discussion.

Mapping the current state

Regarding the situation of which the improvement project was started from and the mapping of the problems in the starting point, as can be seen from the **Figure 20. Problem Mapping At the Starting Point**, 55% of the participants estimated that the starting point and the existing problems were covered quite thoroughly. However, quite a big number of the respondents (5 out of 11) thought that the starting point and existing problems were only skimmed.

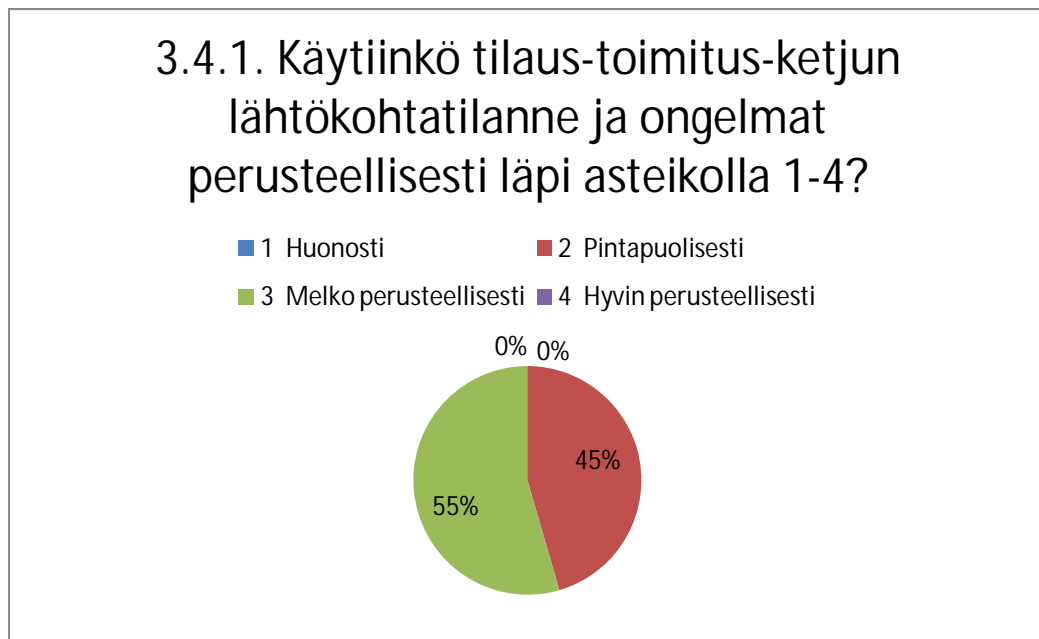


Figure 20. Problem Mapping At the Starting Point

Documentation

As one of the issues belonging to Lean is the documentation of each step, the questionnaire also included a question about how the existing order-delivery-process and the flow of materials were documented. The most common answer was by using a process chart. In addition, some simple Lean tools were used such as flap board and post-it pieces of paper of which one took photos. One observation was that this was not the best way to put the documents into electronic format.

Waste walk

A part of mapping the current state is to gather as much information (checklist) on paper before the waste walk regarding the decisive information related to the order-delivery-process; batch sizes, lead times etc. (see chapter 5 Corner stones for Lean Implementation). It seemed that besides processing times, delivery times, sizes of stock, throughput times and batch sizes, also information about notifications, process stages and failure notifications was gathered.

As presented in **Figure 21**, the respondents were asked to evaluate the importance of the waste walk from 1 (meaningless) to 4 (big importance), and every respondent thought the waste walk had either a big importance (36%) or a quite a big importance (64%).

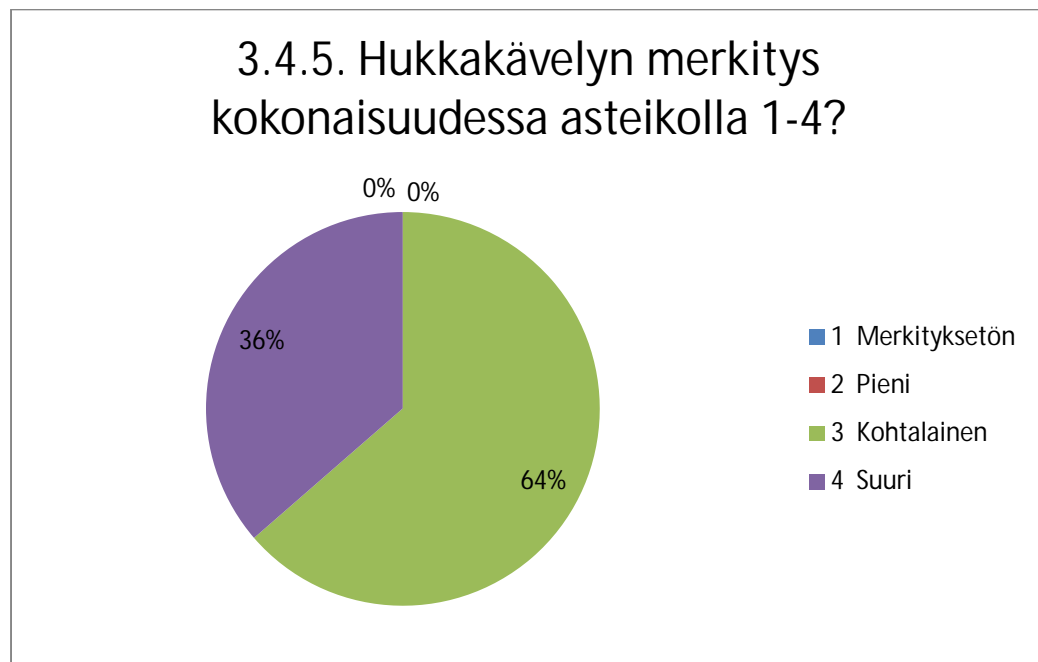


Figure 21. The Importance of the Waste Walk

Wastes (Development Targets)

It was considered important to find out at which stage of the workshop the existing wastes were found, and according to the respondents the two most important stages were mapping the current state and the waste walk at the factory (presented in **Figure 22**). In addition, some development targets were already known beforehand.

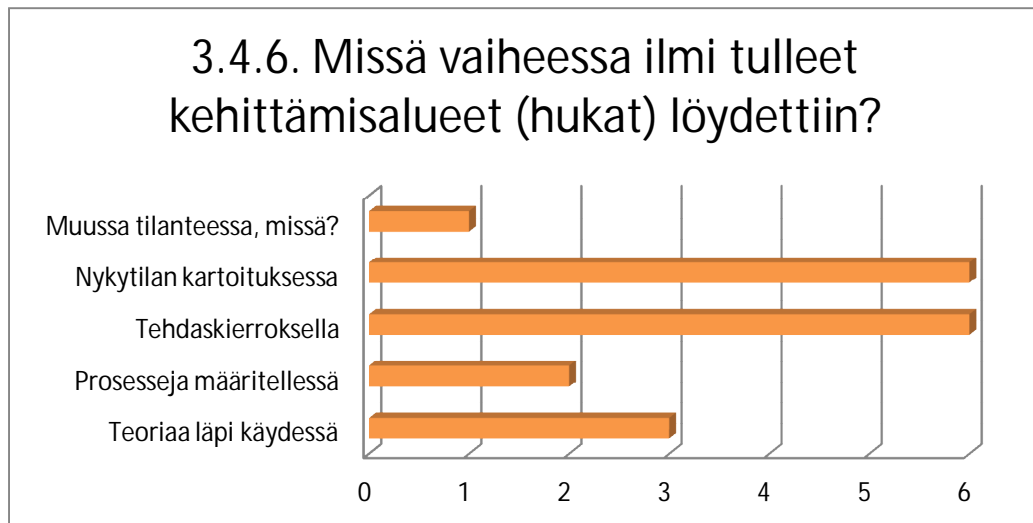


Figure 22. The Place For Findings

As can be seen from **Figure 23**, the wastes that were found were mostly related to transportation, waiting and unnecessary movement, but also other wastes such as overproduction, over processing and too big stocks;

- Faulty items: the number of goods in stock was not correct
- Talents not put into use: "Runners" not used as much as they could, designers not visited at the component supplier
- Waiting: instead of waiting during machining, the machinist is able to prepare the next work stage, and unnecessary waiting during notification processes and when returning non-conformity products
- Transportation: unclear packing lists missing information
- Over processing: double certification and washing of the components and
- Big stocks: shorter lead time could be used
- Overproduction: double checking of component quality
- Unnecessary movement: components moving to quality department even if checked already by supplier
- Other things: forecast frequency

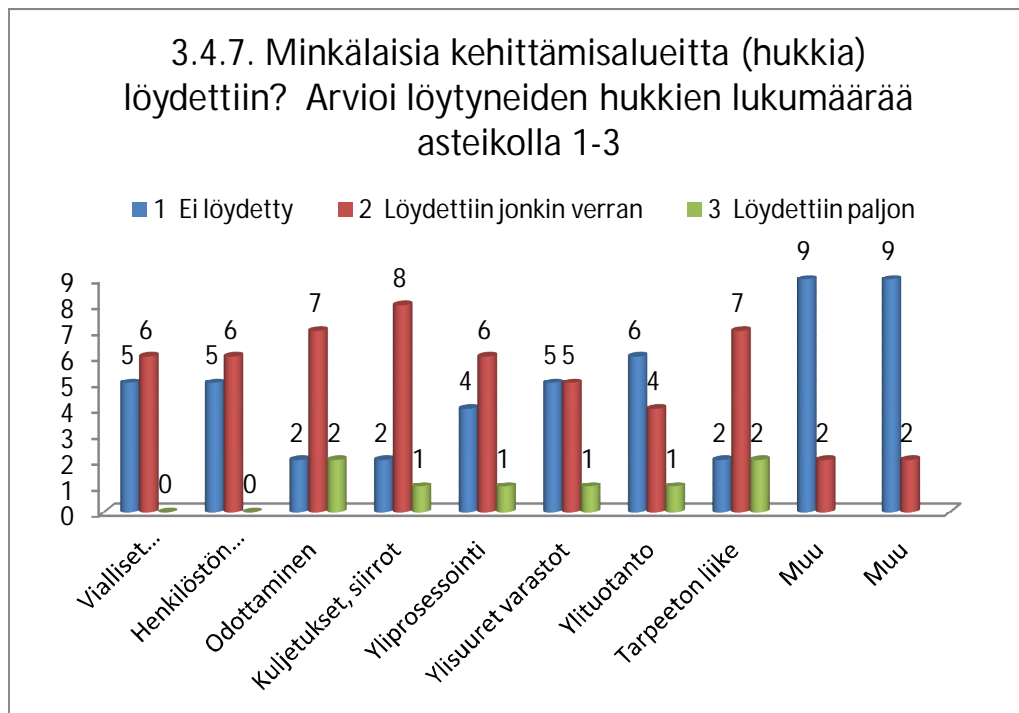


Figure 23. Found Wastes

Lean metrics, follow-up and the results

As the continuous follow-up has also been determined as one key factor for being successful, it was important to find out how the progress has been followed up after the workshop. Eight people out of the 11 responded that it was defined how the follow-up of the project is going to be done, when three people replied this was not defined. The follow-up was done by using the Lean Manufacturing Assessment (Gap Analysis, see chapter 5), but also by organising follow-up-meetings and by checking whether the changes will affect on the delivery reliability. In addition, an excel sheet was created with divided tasks, on the basis of the estimated effects and the required schedule.

The next significant issue to find out was how the results would be measured. As can be seen from **Figure 24**, 45% of the respondents answered that it was not defined how the results will be measured.



Figure 24. Measurement of The Results

There was also scattering in the opinions of how the measurement of results was done; five people out of 11 said by measuring delivery reliability and delivery time, but most of the respondents did not choose any of the other proposed options; number of mistakes, throughput time nor processing time (see **Figure 25**).

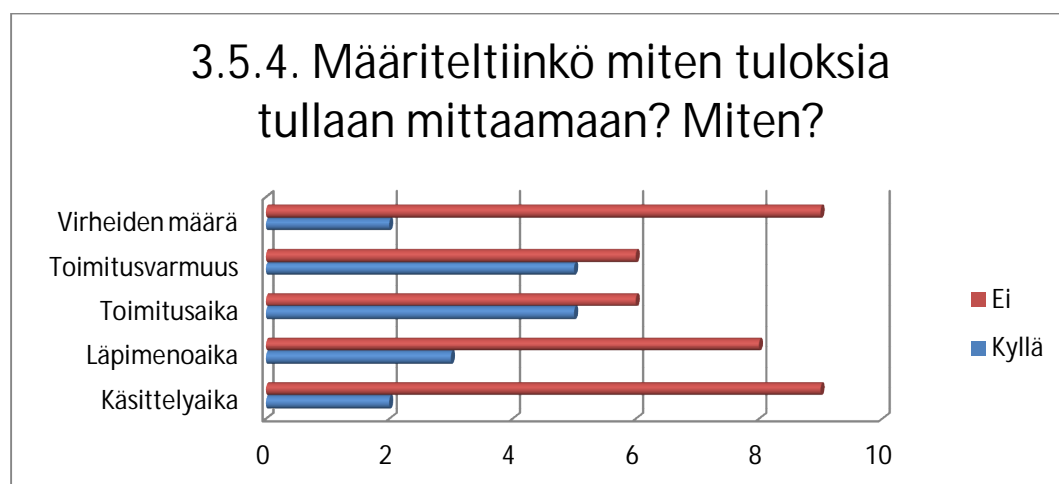


Figure 25. The Ways of Measuring the Results

About the whole progress of the project, as presented in **Figure 26**, most of the respondents (64%) thought that the settling and implementation of the development proposals went on quite well, but also 18% thought they went forward badly.

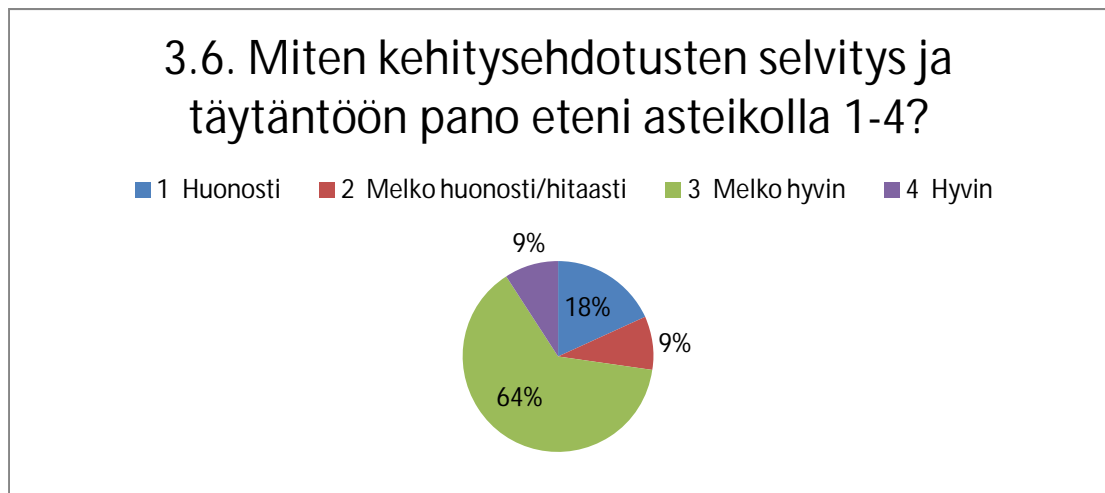


Figure 26. The Settling And Implementation of The Development Proposals

The questionnaire also surveyed whether for the workshop and the whole project enough of time and other resources was reserved, and a little more than half of the respondents (55%) thought that there was enough of both reserved for the Lean workshop and the whole project (see **Figure 27**). Three people out of 11 (27%) thought that not enough of other resources were reserved for the project, but also 27% of the respondents thought that too much time was spent.



Figure 27. The Used Resources

The fourth part of the questionnaire focused on the achieved results. 55% of the respondents thought that the results have been followed moderately, 18% well, and another 18% badly.

To summarize what kind of effects the Lean project has had so far, the respondents were asked to specify whether the amount of different wastes has increased, decreased or stayed at the same level. As can be seen from **Figure 28**, with all wastes, there were several amount of replies according to which there has been no effect. Most decrease was found to be in unnecessary movement and transportation (45%), and in the amount of unnecessary work (55 %). In addition, what was positive, the respondents (45%) thought that the usage of people's talents and new ideas has increased. The other wastes (over processing, too big stocks, overproduction, unnecessary waiting and mistakes) had decreased slightly. Some of the respondents informed to have replied "no effects", as some of the work is still in progress.

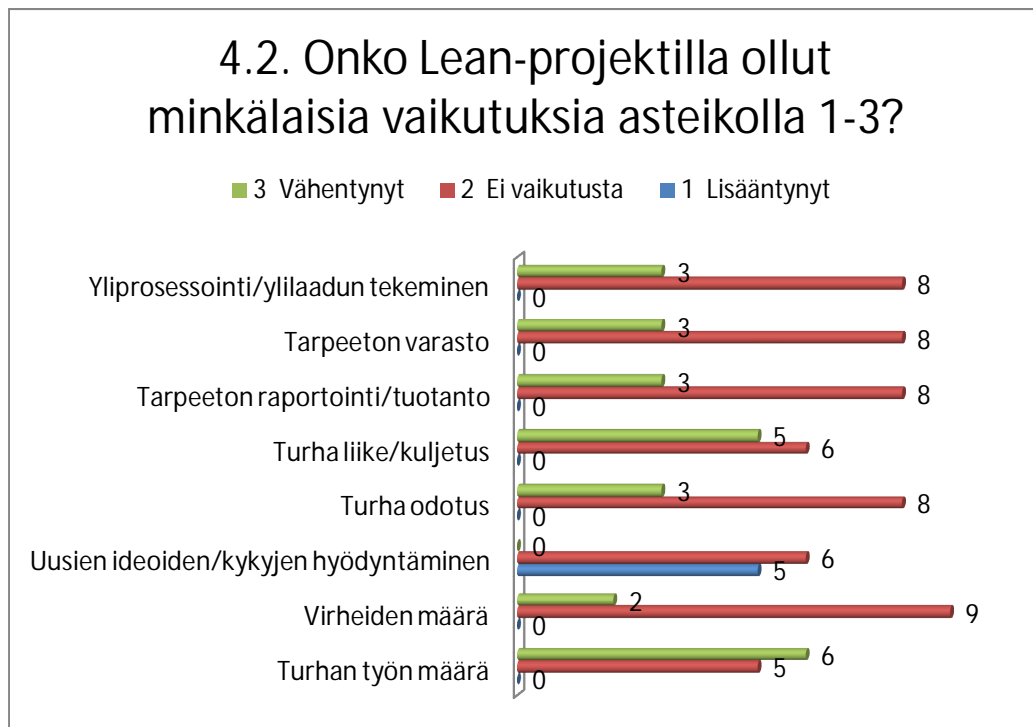


Figure 28. Effects of the Lean Project

The respondents were also asked to define what specifically in the Lean-project has had the biggest influence on the development, and the conclusions were as follows;

- The decrease of unnecessary work in general
- The increase in co-operation between different organisations: between Wärtsilä and the supplier in general, and also between different organizations and departments inside Wärtsilä
- The focusing on doing things properly and right the first time
- The increase of Lean awareness, and with it the focusing on the right issues and doing things more efficiently

In case the respondents did not see any significant changes, they were asked to estimate what might be the reason for not getting results; can it be the lack of time, concentration in the wrong things, or if Lean is not a correct tool for making this kind of development, or something else. None of the respondents replied that Lean would not be a right tool for the development, or that the project would have

concentrated on wrong things. 45% thought the reason was the lack of time, and 18% though the reason was something else.

The next thing to survey was to measure how big an input the respondents thought to have spent on each of the ten development targets (presented in

Figure 29), and also how big of a benefit they thought to have achieved case by case (presented in **Figure 30**). The respondents were given five different options to reply; 1 if the work was still in progress, 2 if the input or achieved benefit was rather small, 3 if the input or achieved benefit was moderate and 4 if the input or benefit was big. Option 5 was given to mark if the respondents were not participating into this specific development case. In each case, people thought that the process is still more or less in progress.

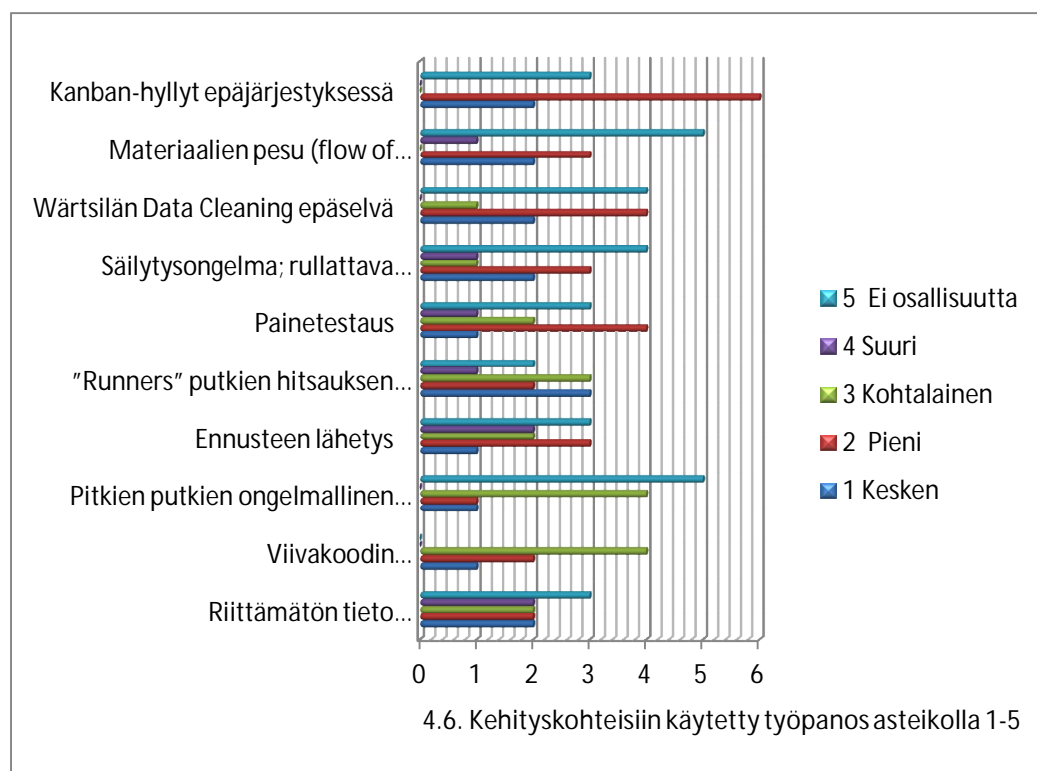


Figure 29. The Used Input per Development Target

To start with the first case; disorganised Kanban-shelves, 6 people out of 8 (who were involved with this case), thought that the used amount of work was small, and all participants thought the received benefit was either moderate or small.

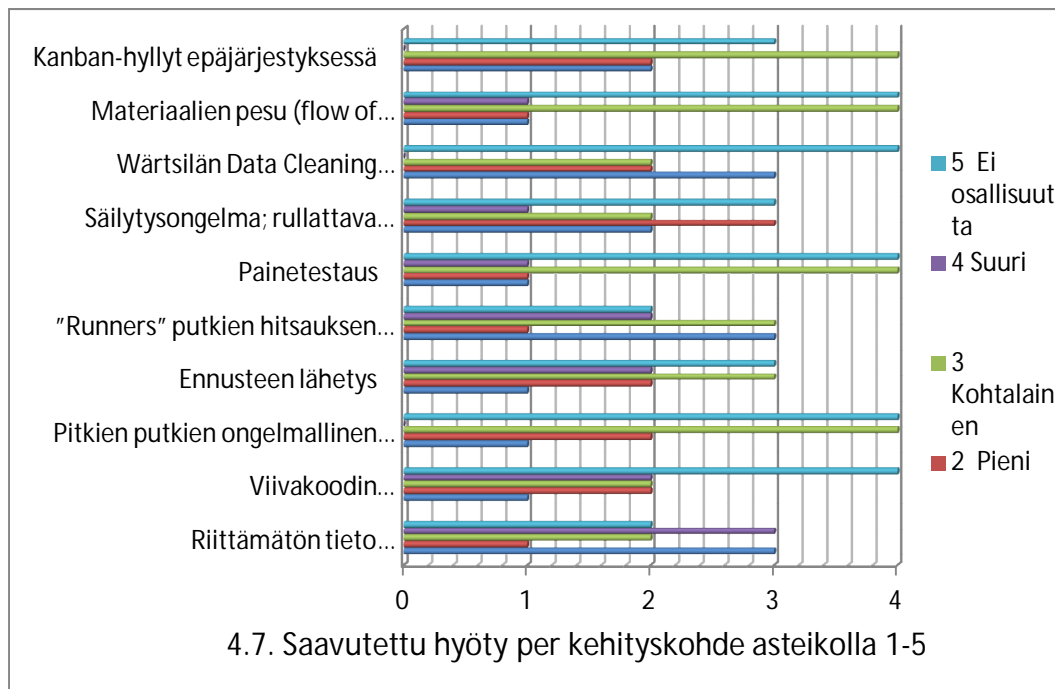


Figure 30. The Received Benefit per Development Target

What comes to the double washing of components, for most of the respondents the used input seemed to be rather small, as one person thought the input was big. For most of the people the achieved benefit seemed to be moderate.

Regarding the unclear data cleaning messages, the work seems still to be in progress, but until now the used input seemed to be rather small, and the benefit received from small to moderate.

The issue with the usage of rolled-up pipe material seemed to have required a rather small input (thought by 3 people out of 5), and the received benefit was replied to be from small to moderate.

According to the involved respondents, the development target with the pressure testing of the pipes has mainly required small input, as the received benefit has been moderate for most of the respondents.

The welding of the "runners" pipes already at the supplier's premises has been implemented for three different pipes, and obviously there is more still to come.

For now it seems that the required input has mainly been from small to moderate, and the received benefit from moderate to significant.

One issue was the frequency of sending out forecasts to the supplier, regarding the coming need of material. This was changed from every two months to every month. In this matter the respondents had quite different views of both the required input and the received benefit; 43% thought the required input was small, when 29% thought it to be moderate and 29% big. Of the received benefit, 29% thought it to be big, 43% moderate and 29% small.

For the problematic storing of long pipes, the input seemed to have been mostly moderate, and the received benefit from small to moderate.

The development of the unworkable bar code in components was mainly replied to have required a moderate input, and the impression of the received benefit seemed to vary a lot; 2 people out of 6 thought the benefit was small, 2 people saw it to be moderate and 2 people thought the benefit has been significant.

Also the improvement of the information in the packing lists divided opinions regarding the required input; 2 out of 6 thought the input has been small, 2 thought it to be moderate and 2 thought the input has been significant. Regarding the received benefit, it was estimated to be mainly significant (43%) but also moderate (29%).

Usefulness of the project

To summarize how useful the participants evaluated the whole project to be all in all, the respondents were asked to evaluate the usefulness from 1 (not useful) to 4 (very useful). Most of the respondents (46%) thought the Lean project has been very useful, and 36% thought it to be quite useful. As presented in **Figure 31**, none of the respondents thought the project to have been worthless and 18% thought it to have been only somewhat useful. Of the participating groups, the suppliers were the group who seemed to value the project the most.

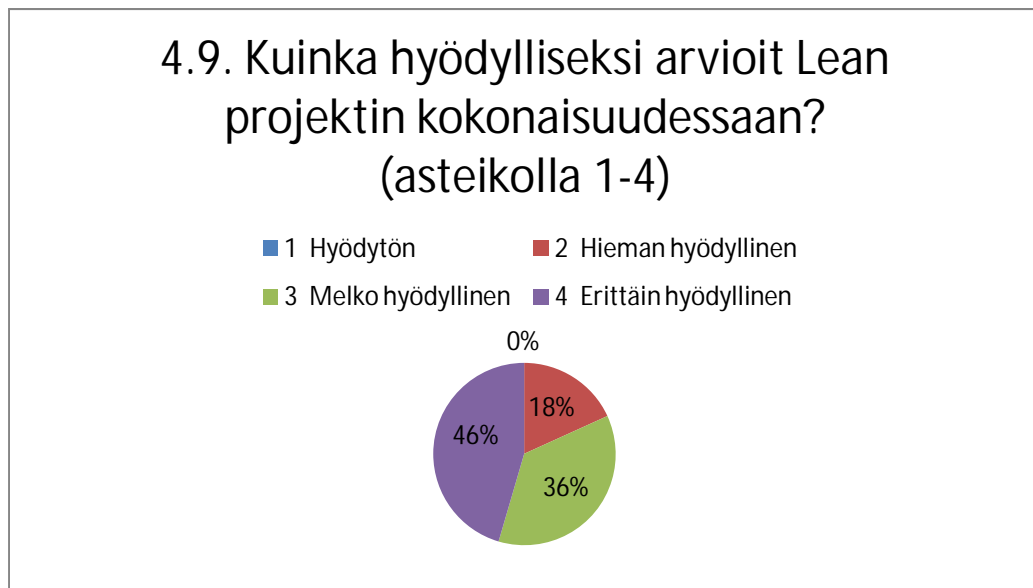


Figure 31. The Usefulness of The Lean Project

As can be seen from **Figure 32**, the respondents were also asked how useful they estimated the project to have been for their own work, and in that sense 36% responded very useful, 37% quite useful and 27% only a bit useful. There did not seem to be any significant differences between the opinions of different participating groups.

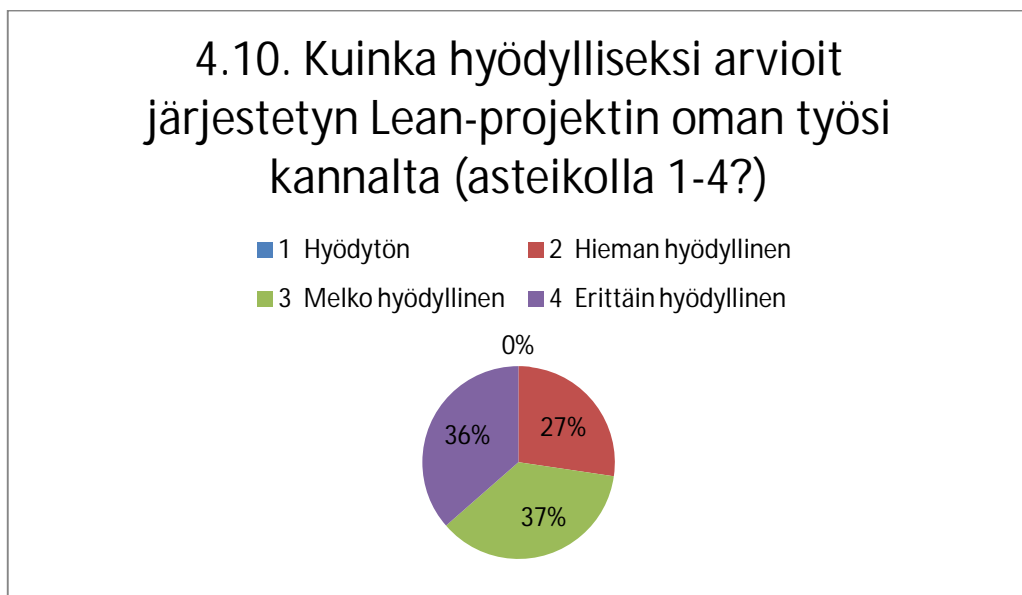


Figure 32. The Usefulness of The Lean Project for Individuals

As presented in **Figure 33**, when asked about the usefulness of the project in relation to the time and resources what were used, the most common answer (55%) was “A little bit useful – the resources were used quite a lot in relation to the received benefits.” 27% thought the project to be quite useful and 18% very useful. Also in this question the different opinions seemed to be divided quite evenly between different participating groups.

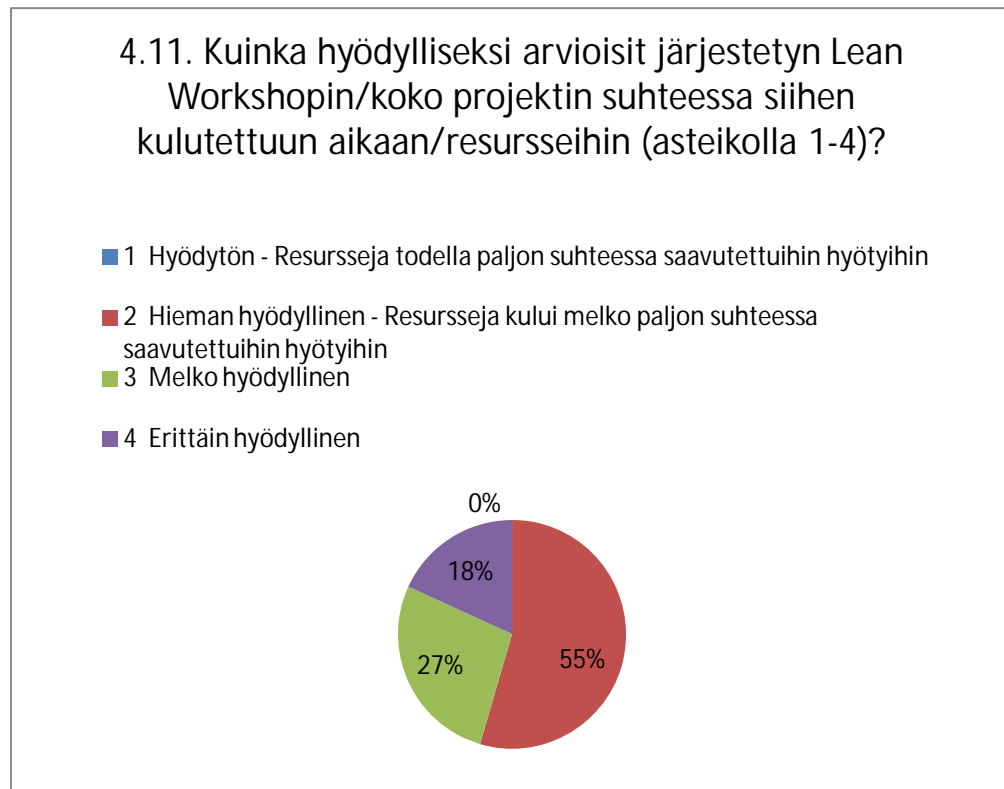


Figure 33. The Usefulness of The Lean Project In Relation To the Used Resources

When asking if the participants think that the gained development would have been achieved also without the Lean workshop and project, a clear majority (73%) estimated that without the Lean project the improvements would probably not have been achieved. 18% thought that the improvements would probably had achieved also without the Lean project, as can be seen from **Figure 34**.

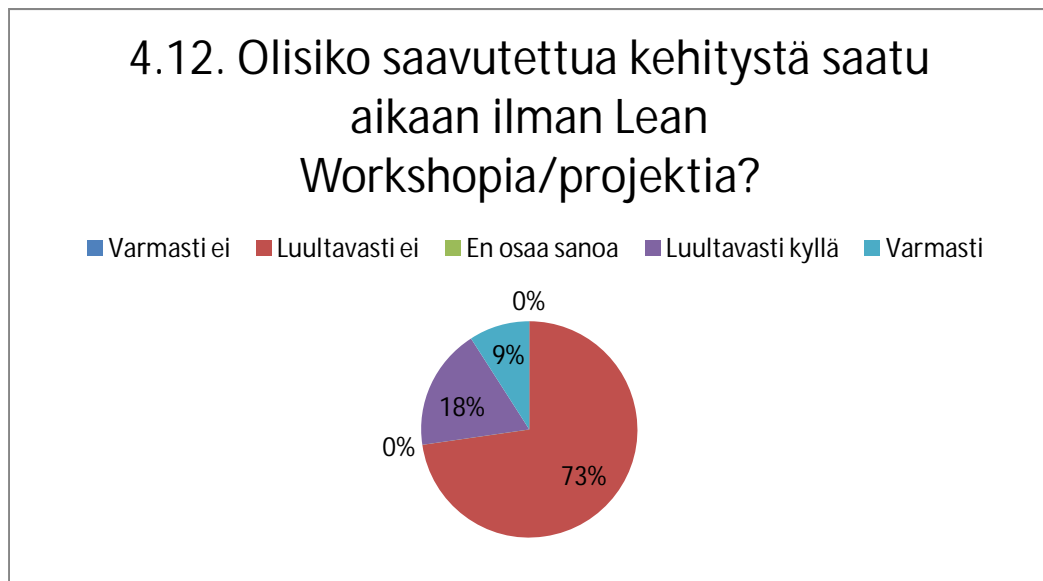


Figure 34. The Usefulness of The Lean Project

To get improvement ideas directly from the participants, the questionnaire included a question if the project could have been still improved.

The survey also included a question whether the project could have been further improved, for which 73% of the respondents answered yes. In addition the respondents were given an opportunity to propose their ideas for improvement, and the answers were as follows;

- The right persons should be attending. Also the supplier selection is important. Also the supplier's processes should be gone through during the workshop, to see how they can be connected to Wärtsilä's processes.
- The development work should have continuity. Also the development tools should be improved so that it would be easier to develop and execute projects over organisation limits.
- The next time the people participating already know the basics and what will be done, and the group can go faster into the actual improvement work. Therefore the investment/efficiency will be better.
- The group sizes were quite big, and momentarily the usage of time could be more efficient

- More resources and time would be needed for Lean. Also more training would be needed.

8.2 Conclusions And Improvement Ideas

The aim of this thesis was to research the way how Lean Project has been organised, implemented, followed up and what kind of benefits has the case company Wärtsilä had of the Lean co-operation. In addition the aim was to find out which methods could be utilised also in the following Lean projects, and which issues could be improved to get the project to be more efficient. The questionnaire also measured how well the commonly known important issues of Lean were realized.

The research went through the actual follow-through of the Lean Workshop and the whole project, and surveyed the different parts of it; the commitment to the project, the involved participants, starting point and problems, the focus area and the targets of the project, theoretical study, documentation and every stage in the project; how was the time divided between different stages, what kind of and at which point the findings were done.

To start with the organised Workshop, according to the replies, the target area was defined quite clearly. However, the objectives of the project could have been defined and clarified better to the participants.

Many of the participants had already had some training about Lean before this project, and as measured after the Lean Workshop, the overall knowledge of Lean and its concepts seemed to be on a good level.

The Lean theory was clarified quite well to the participants, and the Majority (64%) of the respondents thought that the Lean theory gave a better capacity to recognise development areas in the order-delivery-process than before. In addition 46% of the participants immediately recognised development areas in their own work, which, of course, in the long run will improve everyone's own efficiency at work. Therefore, it can clearly be seen that the knowledge of Lean and its principles is definitely useful for individuals and the whole company.

When examining which were the most productive situations where the decisive findings were found (besides knowing them already beforehand), it came up that the most important stages for finding the existing problems (wastes), were the mapping of current state and the waste walk at the factory. As quite a big number of the respondents thought that the starting point and existing problems were only examined on the surface, these could be given more time in the following projects.

The commitment to the project, team work itself and a proper follow-up were evaluated to be the most important of all factors in succeeding in the project. Also, the Lean theory and the organised waste walk were seen to be quite important. Therefore, these issues ought to be focused on so that the best use of the project will be received. The whole project (settling and implementation) seemed to be advancing quite well.

As some of the stages of the project were valued differently, also the usage of the time and other resources was to be examined; whether there was enough of time and other resources reserved all in all, and if they were shared the right way between the different working stages.

A little more than half of the respondents (55%) thought that there was enough of both reserved for the Lean workshop and the whole project. Three people out of 11 (27%) thought that not enough of other resources were reserved for the project, but also 27% of the respondents thought that too much time was spent. In the following projects, it should be figured out how the time could be used more efficiently.

Results Of the Lean Co-Operation

To find out what kind of benefit the case company has had from the Lean co-operation, it was important to see what has been achieved with the project.

When asked from the participants, quite a big number replied that it was not defined how the results will be measured, which also came up as scattering of replies when asked how the results would be measured. Five people out of 11 said

by measuring delivery reliability and delivery time, but most of the respondents did not choose any of the other proposed options; amount of mistakes, throughput time nor processing time. The question is, does Wärtsilä have proper tools for measuring the results and are they being used?

A little more than half of the participants thought that the results have been followed up moderately, when also 18 % thought they have been followed up poorly, so there clearly seems to be room for improvement in this sense.

The research brought up that a lot of waste and things to be improved came up during the project; most of all related to transportation, unnecessary waiting and unnecessary movement, but also other wastes such as overproduction, over processing and too big stocks, which were to be reduced. The question is if the wastes have decreased and if there has been any changes in comparison with the starting point.

As the project is partly still ongoing, in many cases the respondents informed not to have seen any changes yet. However, most decrease was found to be in unnecessary movement and transportation (which was also one of the areas where most waste was found), and in the amount of unnecessary work. Many also thought that as a result of the project, new ideas and people's talents are now being utilised better. All in all, in all areas of waste, some improvements can be seen already. The increased communication between different organizations has been seen as one of the significant improvements. The major reason for not getting any results was estimated to be the lack of time.

When the participants were asked to evaluate the used input and received benefit case by case, the received answers varied quite a lot, which shows that different people had very different views. However, in most of the cases the required input was seen to be from small to moderate, and only rarely very big. The received benefits in most cases seemed to vary from small to moderate, but with some cases it seemed that even significant benefits were achieved with small input.

As a feedback of the project, the majority (46%) of the participants estimated the project to have been very useful. Of the participating groups, the suppliers were the group who seemed to value the project the most. Also a high number (36%) of the participants thought the project has been very useful for their own work. 37% estimated it to have been quite useful. There did not seem to be any significant differences between the opinions of different participating groups, so benefit can be seen to be achieved in every working area, which encourages at least the same organisations to be involved in the future. Most of the respondents thought that in relation to the used time, the project has been somewhat useful. However, a clear majority (73%) estimated that without the Lean project the improvements would probably not have been achieved.

When considering the objectives of Lean in general (eliminating wastes, improving productivity, achieving the continual improvement in targeted activities and processes, significant improvements in long term by making small changes and maintaining the improvements), on the basis of the research so far the target can be seen achieved. In the long run, the research could be repeated to see if the improvements have been maintained, and if really significant improvements have been achieved when all the cases have been closed.

Improvement proposals

As the participants clearly also thought that there is still room for improvements in the project, below the proposals of the participants, and the issues that came up from the replies of the participants have been gathered.

All in all, a better follow-up ought to be used in order to get people to commit better and to motivate them to continue the development, even though it felt that the commitment of most of the people was on a good level.

In the future Lean projects, also (more) employees from production planning, production assembly and operative purchasing could be involved in the project, and also the supplier's processes should be examined during the workshop, to see how they can be connected to Wärtsilä's processes.

The group sizes were commented to be quite big, and momentarily the usage of time could have been more efficient.

As, according to the replies, too little time was spent on the development proposals and on the discussion of the problems and perhaps too much time was spent on the theory, on the basis of this, the used time could be transferred from discussing the theory into the discussion of the problems and development proposals.

As quite a big number of the respondents thought that the starting point and existing problems were examined only on the surface, they could be given more time in the following projects.

The documentation was done using the process charts, flap board and post-it pieces of paper, but it was mentioned that this was not the best way to put the documents into electronic format. Therefore, the documentation ought to be improved in order to share the progress and results better with the participants and also to make it easier to communicate the progress to the management level. When the progress and results are clear for everyone, it is easier to motivate the people and also show how things are actually improving.

8.3 Self Assessment

First of all, the whole process of writing the thesis has taught me a lot about Lean itself; first by getting familiar with the theory and finally by creating the questionnaire and interpreting the results. In addition, supply chain management has become more familiar along with the background research, and the received knowledge is surely of use at my work also in the future.

As the subject was very wide, it was difficult to decide what ought to be included in the theoretical study, as it was possible to start go through the subject from many different point of views, and due to the fact that there is a massive amount of material available.

One of the most challenging things has been managing with the schedules which were set to this thesis by me. It was also very surprising to see how long it takes

first to familiarize oneself with a lot of ground information, and only after that, choose what is the best for the subject, and then get it all on paper in a good, understandable form.

In addition, probably the biggest the challenge was to combine the full-time work and the writing project, and to cope with the frustration when you simply do not have energy to sit down and think, but you also do not have the possibility of not doing it. However, somehow the work just progressed.

One backlash was the fact that after doing the research plan, doing some background research and writing a part of the theory, in the end it became necessary to change the subject. Luckily, I was still able to use a part of the work that was already done.

Regarding the end result of the thesis, in my opinion the aim of the thesis was reached and I am satisfied with the result. All in all the writing and research project has been a very educative experience, especially in the sense of time usage, and has given a good glance of the features of research work. Big thanks should be given to my family members, friends and colleagues for supporting and encouraging me in the process.

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ATTACHMENTS

Attachment 1 – Questionnaire

Lean Workshop-kysely 19.10.2012

Hei!

Tämän opinnäytetyön tutkimuksen kohteena on Keväällä 2012 (6.2-8.2.2012) toimittajien ja Wärtsilän henkilökunnan kesken järjestetty Lean Workshop ja sen perusteella aloitettu kehitysprojekti.

Tutkimuksessa on tarkoitus selvittää missä vaiheessa projektia mennään, onko projektin myötä saavutettu hyötyjä, millä keinoin kyseiset hyödyt on saatu aikaan, ja kuinka hyödyllisenä kyseinen Lean -projekti kaiken kaikkiaan nähdään. Kysely on lähetetty kaikille Lean Workshopiin osallistuneille.

Kysely koostuu viidestä osiosta ja sen täyttäminen kestää noin 15 minuuttia. **Kyselyyn on aikaa vastata Perjantaihin 26.10.2012 asti.**

Mikäli kyselyä täyttäessä tulee kysymyksiä, minuun voi ottaa yhteyttä joko sähköpostitse tai puhelimella; ---

Toivon että mahdollisimman moni käy täyttämässä kyselyn ja saadaan arvokasta tietoa jatkoa varten!

Kiitos etukäteen vastauksista!

1.0 Perustiedot

1.1. Valitse yksi alla olevista vaihtoehdoista

- Työpaikka/Toimialue**
- Toimittaja
 - Wärtsilä Osto
 - Wärtsilä Logistiikka
 - Wärtsilä Tuotannonkehitys
 - Wärtsilä Tuotetehdas
 - Muu
- Mikä?

2.0. Lean-tuntemus

2.1. Lean-tuntemus ennen Lean Workshopia asteikolla 1-4

- 1 Ei tietoa
- 2 Vähäiset tiedot
- 3 Kohtalaiset tiedot
- 4 Hyvät tiedot

2.2. Oletko käynyt Lean-koulutuksessa ennen tätä Workshopia?

- Ei
- Kyllä

2.3. Jos vastasit kyllä, missä koulutuksessa?



2.4. Mitkä seuraavista käsitteistä tunnistat Leaniin kuuluviksi?

- | | |
|--|---|
| <input type="checkbox"/> 5 Why's | <input type="checkbox"/> Suuret varastot |
| <input type="checkbox"/> Kanban | <input type="checkbox"/> Työntöohjaus |
| <input type="checkbox"/> Kaizen | <input type="checkbox"/> Lean |
| <input type="checkbox"/> Mass Production | <input type="checkbox"/> Runner, Repeater, Stranger |
| <input type="checkbox"/> 7 hukkaa | <input type="checkbox"/> Imuohjaus |
| <input type="checkbox"/> 3 Why's | <input type="checkbox"/> Muda |
| <input type="checkbox"/> 5 S | |

3.0 Lean Workshop ja projektin läpivienti

3.1. Leaniin Sitoutuminen

3.1.1. Miten sitouduit koko Lean projektin läpiviemiseen asteikolla 1-4?

1 Huonosti, projekti jäi toissijaiseksi muiden töiden ohella

2 Melko huonosti

3 Kohtalaisesti

4 Hyvin

1 Huonosti, projekti jäi toissijaiseksi muiden töiden ohella

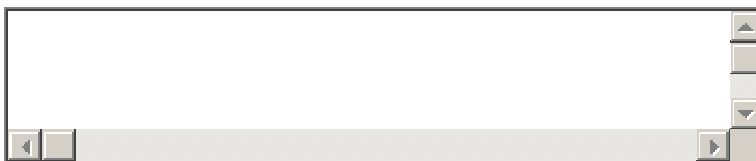
3.1.2. Miten koit muiden työryhmän jäsenten sitoutuneen projektiin?

2 Melko huonosti

3 Kohtalaisesti

4 Hyvin

3.1.3. Jos koit että sitoutuminen oli heikkoa, mikä olisi mielestäsi saanut osallistujat sitoutumaan projektin läpiviemiseen paremmin?



3.1.4. Kuinka osallistuit Lean workshopiin?

Aktiivisena osallistujana keskusteluun

Keskustelua sivusta seuraavana osallistujana

Muistiinpanoja tekevänä osallistujana

- Käytännön tilanteita miettivänä osallistujana
- Workshop jäi toissijaiseksi muiden töiden ohella

3.1.5. Oliko Workshopissa osallistujia oikeilta osa-alueilta/riittävästi?

- Osallistujajoukko oli juuri oikea
- Osallistujajoukko oli liian pieni
- Osallistujajoukko oli liian suuri
- Osallistujajoukosta puuttui olennaisia henkilöitä

3.1.6. Minkä työalueen edustajia ryhmästä puuttui?

3.1.7. Arvioi eri osa-alueiden merkitys Lean-projektin onnistumiselle numeroin 1-4:

	1 En osaa sanoa	2 Merkityksetön	3 Melko tärkeä	4 Erittäin tärkeä
Lean Teoria	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hukkakävely	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tiimityö	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hyvä Lean-vetäjä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Seuranta	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sitoutuminen projektiin	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3.2. Kohdealueen raja

- 1 Ei määritelty selkeästi
- 3.2.1. Määriteltiinkö kohdealue kuinka selkeästi asteikolla 1-4?**
- 2 Melko huonosti
- 3 Kohtalaisesti
- 4 Hyvin

- Kohdealue oli liian laaja
- 3.2.2. Jos vastasit ei, mikä meni pieleen?**
- Kohdealue oli sopiva Tarkenna
- Muuta, mitä?

3.3. Tavoitetilan kartoitus ja Leanista oppiminen

3.3.1. Määritettiinkö tavoitteet mitä projektilla pyritään saavuttamaan?

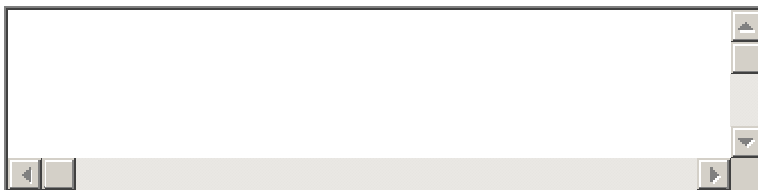
- Kyllä
- Asiakasarvon näkökulmasta?**
- Ei
- En osaa sanoa
- Kyllä
- Materiaalivirtaa koskevat tavoitteet?**
- Ei
- En osaa sanoa
- Työkuorman jakaminen?**
- Kyllä

- Ei
- En osaa sanoa

3.3.2. Määriteltiinkö workshopin ja projektin tavoitteet?

- 1 Hyvin epäselvästi
- 2 Melko epäselvästi
- 3 Melko selkeästi
- 4 Hyvin selkeästi

3.3.3. Kerro mainitut tavoitteet omin sanoin:

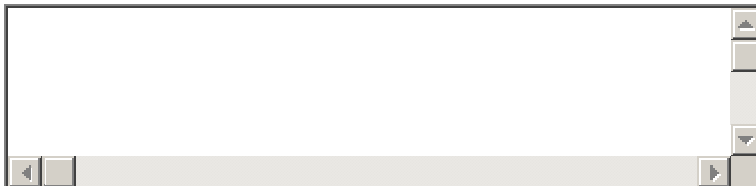
An empty text input field with a light gray background and a thin black border. It features standard scrollbars on the right and bottom edges, indicating it is a multi-line text area.

3.3.4. Kuinka selkeästi Lean teoria käytiin läpi asteikolla 1-4?

- 1 Hyvin epäselvästi
- 2 Melko epäselvästi
- 3 Melko selkeästi
- 4 Hyvin selkeästi

Arvioi asteikolla 1-4

- 1 Ei paremmin kuin ennenkään
- 3.3.5. Antoiko Lean-teoria valmiudet tunnistaa tilaus-toimitus-prosessin kehittämisalueita paremmin?**
- 2 En osaa sanoa
- 3 Ehkä
- 4 Kyllä
- 1 Ei paremmin kuin ennenkään
- 3.3.6. Tunnistitko teorian myötä kehittämisalueita omassa työssäsi?**
- 2 En osaa sanoa
- 3 Ehkä
- 4 Kyllä

3.3.7. Jos vastasit kyllä, minkälaisia kehittämisalueita löytyi?**3.3.8. Kuinka moni osallistuja teki ”aloitteita” ilmitulleista kehitysehdotuksista?**

- Vain harva osallistuja
- Puolet osallistujista
- Lähes kaikki osallistujat

3.3.9. Teitkö itse kehitysehdotuksia projektiin?

- Ei
- Kyllä

3.3.10. Käytettiin Workshopissa aikaa sopivasti eri osa-alueisiin asteikolla 1-3?

	1 Liian vähän	2 Sopivasti	3 Liian kauan	Tarkenna
Teoria	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Hukkakävely	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Ongelmien pohdinta	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Kehitysehdotukset	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Muu, mikä?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>

3.3.11. Muita kommentteja?

3.4.1. Käytiinkö tilaus-toimitus-ketjun lähtökohtatilanne ja ongelmat perusteellisesti läpi asteikolla 1-4?

- 1 Huonosti
- 2 Pintapuolisesti
- 3 Melko perusteellisesti
- 4 Hyvin perusteellisesti

3.4. Lähtökohtatilanteen ja ongelmien kartoitus

3.4.2. Miten tilaus-toimitus-prosessin kulku ja materiaalivirrat dokumentoitiin workshopin aikana?

- Prosessikaavioin
- En osaa sanoa
- Ei dokumentoitu
- Muuten

3.4.3. Mitä tietoa kerättiin paperille ennen tehdaskierrosta (hukkakävelyä)?

- Eräkokoja
- Lämpimenoaikoja
- Varastojen määriä
- Toimitusaikoja
- Käsittelyaikoja

3.4.4. Muuta, mitä?

3.4.5. Hukkakävelyn merkitys kokonaisuudessa asteikolla 1-4?

- 1 Merkityksetön
- 2 Pieni
- 3 Kohtalainen
- 4 Suuri

3.4.6. Missä vaiheessa ilmi tulleet kehittämisalueet (hukat) löydettiin?

- Teoriaa läpi käydessä
- Prosesseja määritellessä
- Tehdaskierroksella
- Nykytilan kartoituksessa
- Muussa tilanteessa, missä? (voit vastata alla olevaan ruutuun)

3.4.6.

**3.4.7. Minkälaisia kehittämisalueita (hukkia) löydettiin?
Arvioi löytyneiden hukkien lukumäärää asteikolla 1-3.**

	1 Ei löydetty	2 Löydettiin jonkin verran	3 Löydettiin paljon	Mikä?
Vialliset tuotteet/virheet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Henkilöstön osaamisen hyödyntämättä jättäminen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Odottaminen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Kuljetukset, siirrot	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Yliprosessointi	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Ylisuuret varastot	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Ylituotanto	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Tarpeeton liike	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Muu	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>

Muu

3.5. Lean mittarit ja seuranta

Ei Kyllä

3.5.1. Määriteltiinkö miten projektin etenemistä tullaan seuraamaan?

3.5.2. Jos vastasit kyllä, miten?

Lean Manufacturing Assesment/Gap Analysis

Muu analyysi, mikä?
(voit vastata alla olevaan kenttään)

Muuten, miten?
(voit vastata alla olevaan kenttään)

3.5.2.

3.5.3. Määriteltiinkö miten tuloksia tullaan mittaamaan?

Ei

Kyllä

3.5.4. Jos vastasit kyllä, miten?

Käsittelyaika

Läpimenoaika

Toimitusaika

Toimitusvarmuus

Virheiden määrä

Muu, mikä? (voit vastata alla olevaan kenttään)

3.5.4.

3.6. Täytäntöönpano

3.6.1. Miten kehitysehdotusten selvitys ja käytäntöönpano eteni asteikolla 1-4?

- 1 Huonosti
- 2 Melko huonosti/hitaasti
- 3 Melko hyvin
- 4 Hyvin

3.6.2. Varattiinko Workshopille/projektille tarpeeksi aikaa ja resursseja asteikolla 1-3?

1 Liian vähän 2 Sopivasti 3 Liikaa

Aikaa käytettiin

Muita resursseja

4.0 Tulosten tarkastelu

4.1. Kuinka projektin tuloksia seurattu asteikolla 1-5?

- 1 Huonosti
- 2 Melko huonosti
- 3 En osaa sanoa
- 4 Kohtalaisesti
- 5 Hyvin

4.2. Onko Lean-projektilla ollut minkälaisia vaikutuksia asteikolla 1-3?

	1 Lisäänty- nyt	2 Ei vaikutus- ta	3 Vähenty- nyt
Turhan työn määrä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Virheiden määrä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Uusien ideoiden/kykyjen hyödyntämi- nen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Turha odotus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Turha liike/kuljetus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tarpeeton raportointi/tuotanto	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tarpeeton varasto	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yliprosessointi/ylilaadun tekeminen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4.3. Mikä Lean projektissa on mielestäsi vaikuttanut kehitykseen eniten?

4.4. Muuta kommentoitavaa?

4.5. Jos et ole huomannut merkittäviä vaikutuksia, mikä voi olla syynä? (voit merkitä useamman vaihtoehdon)

- Ajanpuute
- Keskittyminen väärin asioihin
- Lean ei ole oikea työkalu kehitykseen
- Muu, mikä? (voit vastata alla olevaan kenttään)

4.5.

4.6. Tapauskohtaiset kysymykset; Kehityskohteisiin käytetty työpanos asteikolla 1-5

(1=Työ kesken, 2=Pieni työpanos, 3=Kohtalainen työpanos, 4=Suuri työpanos
5=Ei osallisuutta) ?

1 Kes-	2	3 Kohtalai-	4	5 Ei osalli-
ken	Pieni	nen	Suuri	suutta

Riittämätön tieto pakkauslistoissa

Viivakoodin luotettavuus/toimivuus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pitkien putkien ongelmallinen säilytys/kuljetus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ennusteen lähetys	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
”Runners” putkien hitsauksen siirto W:ltä toimittajalle	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Painetestaus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Säilytysongelma; rullattava materiaali käyttöön	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wärtsilän Data Cleaning epäselvä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Materiaalien pesu (flow of materials)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kanban-hyllyt epäjärjestyksessä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4.7. Tapauskohtaiset kysymykset; Saavutettu hyöty per kehityskohde asteikolla 1-5

(1=Työ kesken, 2=Pieni työpanos, 3=Kohtalainen työpanos, 4=Suuri työpanos 5=Ei osallisuutta) ?

	1 Kesken	2 Pieni	3 Kohtalainen	4 Suuri	5 Ei osallisuutta
Riittämätön tieto pakkauslistoissa	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Viivakoodin luotettavuus/toimivuus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pitkien putkien ongelmallinen säilytys/kuljetus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ennusteen lähetys	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

”Runners” putkien hitsauksen siirto W:ltä toimittajalle	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Painetestaus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Säilytysongelma; rullattava materiaali käyttöön	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wärtsilän Data Cleaning epäselvä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Materiaalien pesu (flow of materials)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kanban-hyllyt epäjärjestyksessä	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4.8. Kerro omin sanoin mikä on tilanne per kehityskohde (pystyttiinkö toteuttamaan, jos ei, miksi jne.)

1 Hyödytön

2 Hieman hyödyllinen

3 Melko hyödyllinen

4 Erittäin hyödyllinen

4.9. Kuinka hyödylliseksi arvioit Lean projektin kokonaisuudessaan? (asteikolla 1-4)

4.10. Kuinka hyödylliseksi arvioit järjestetyn Lean-projektin oman työsi kannalta (asteikolla 1-4?)

- 1 Hyödytön
- 2 Hieman hyödyllinen
- 3 Melko hyödyllinen
- 4 Erittäin hyödyllinen

4.11. Kuinka hyödylliseksi arvioisit järjestetyn Lean Workshopin/koko projektin suhteessa siihen kulutettuun aikaan/resursseihin (asteikolla 1-4)?

- 1 Hyödytön - Resursseja todella paljon suhteessa saavutettuihin hyötyihin
- 2 Hieman hyödyllinen - Resursseja kului melko paljon suhteessa saavutettuihin hyötyihin
- 3 Melko hyödyllinen
- 4 Erittäin hyödyllinen

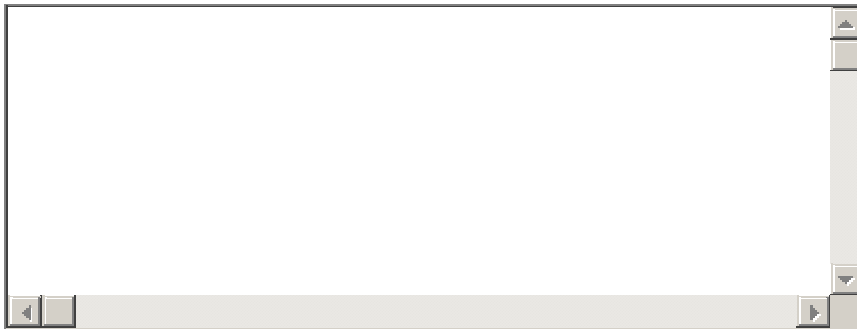
4.12. Olisiko saavutettua kehitystä saatu aikaan ilman Lean Workshopia/projektia?

Varmasti ei Luultavasti ei En osaa sanoa Luultavasti kyllä Varmasti

-

4.13. Olisiko Lean-projektia voitu kokonaisuutena vielä parantaa?

- Ei
- Kyllä

4.15. Jos vastasit kyllä, miten?An empty rectangular text input field with a thin black border. It features a vertical scrollbar on the right side and a horizontal scrollbar at the bottom, both with standard arrow and track icons.**5.0 Kehitysehdotuksia projektiin/kyselyyn - sana on vapaa**A large empty rectangular text input field with a thin black border. It features a vertical scrollbar on the right side and a horizontal scrollbar at the bottom, both with standard arrow and track icons.