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Improving a Material Purchasing Process for the Case Company

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Preface

In the fall of 2015 a large development program started in the organisation I am working in. One sub-project was assigned to me, which was about introducing a pull system to the organisation's purchasing. Immediately I recognised that this is a good subject for a Master's Thesis.

The subject was practical, interesting and something where I could make difference for the better. I'm very pleased of the interest and support that I have received inside the case organisation during the whole project, which we are still developing and implementing. A special thanks goes to my instructor and closest colleagues who have given essential support and ideas to make all this happen.

I would like to thank also my instructor in Metropolia, Dr Thomas Rohweder, for all the help and guidance during the thesis process. Great thanks also to Dr Satu Teerikangas and other lecturers in the program for all the positive and encouraging support that was given during the whole program.

Last enormous thanks for all the study friends that participated to the program this year. All the thoughts that we shared in the classrooms and the time spent with you after the classes has been absolutely wonderful.

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This Master's Thesis includes a real life business challenge of improving a process for a case company. This study was done to improve the case company's material purchasing process by introducing a pull system. The unit in this case study is designing and manufacturing low and medium voltage frequency converters. The unit is having challenges with their current material purchasing process, which is highly dependent on sales forecast. Errors in the forecast are causing material shortages and excess inventory.

The study started by identifying the business challenge. In the current state analysis the strengths and weaknesses of the current process were identified by studying the company's current process descriptions and by workshops with relevant stakeholders. The current state analysis indicated that the current process is too dependent on the sales forecasts and that the changes in demand are difficult to handle. Based on these weaknesses, best practice from the literature was studied to identify suitable purchasing processes that can be executed efficiently based on the real customer demand.

Based on the findings from the best practice and conversations with stakeholders a proposal for the improved material purchasing process was developed. The outcome of this study is an improved material purchasing process, which is based on the reorder point system. The process enables the case company to order materials based on the real demand and automatically from their ERP system.

This study was validated internally and considered as a good basis for more concrete testing and subsequent implementation.

Keywords	Kanban, Lean, Material purchasing, Process Improvement

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1 Introduction

The subject of this Master Thesis focuses on the improvement of the current material purchasing process in the case company. The target is to propose more efficient purchasing methods to improve the current material purchasing process. The case company is currently focusing a lot to their inventory management and purchasing is a key function in inventory management.

By developing purchasing processes into a more reliable and efficient direction, inventories can be significantly reduced. The case company's target is also to be more agile in their operations and towards their customers. Due to these reasons, lean practices are having more and more focus in many different functions, also in purchasing.

1.1 Case Company Background

The case company of this Master Thesis is a global electronics manufacturing company. The company is designing and producing low and medium voltage frequency converters and software related to them for different kinds of industries, for example, Marine industry, Paper industry and Oil & Gas industry.

More specifically, the Thesis is conducted for one of the business units and the business unit's operative purchasing unit in Helsinki factory. The case company's business unit has about 5000 employees in 80 countries. In Finland the unit has a factory in Helsinki where is 1300 employees, of which about 400 persons in R & D. In the operative purchasing, there are six employees in Finland and 11 employees in Estonia.

The mission of the case company's SCM unit is *to achieve significant competitive advantage by reducing total delivered cost, driving best-in-class quality and optimizing supply chains to ensure on-time deliveries and availability as well as minimal inventories.* In

practice this means that the unit needs to ensure good material availability, quality and cost competitiveness of all purchased components in its material purchasing process. (Zhang, 2015: 6,7)

1.2 Key Concepts

Material purchasing is an activity which target is to buy goods to meet the organisation's goals. The most important objectives for purchasing are to fulfil the organisation's requirements for the products quality and value, to have optimal inventory levels, keeping up the organisations material flow, and to strengthen the company's position in the market. (Businessdictionary.com, 2016)

Currently, the case organization is using SAP Material Requirements Planning (MRP) tool to execute purchasing for internal production units. Kanban is a method that can enable organization to change its purchasing process more towards Lean principle in the future.

Lean is a method that is based on the Toyota Production System created in 1950s as Toyota's production strategy, especially for car industry. Womack J. P. et al. introduced the term Lean in The Machine that Changed the World in 1990 where the authors are comparing lean production versus mass production.

The basic idea of Lean is to eliminate everything that does not create value for the customer or for the supplier. Lean is based on customer centricity instead of optimizing company's internal resources. In lean the focus is in the unit that is fixed or refined. (Modig & Åhlström, 2013)

1.3 Business Challenge

Presently, the company is using SAP MRP tool to execute purchasing for internal production units. SAP MRP approach is strongly based on the budget-based demand forecasts. The problem with this type of planning and forecasting lies in its accuracy, and it is

not optimal for parts that are ordered with short lead-time. In the case context, forecasting mistakes tend to be expensive. If the forecast is too high compared to real demand, there will be excess inventory. If the forecast is too low, the case company will face material shortages.

Against this background, the case organization wants to move away from the budget based forecasting towards an internal customer pull type of logic that suits better for parts that are purchased with a short lead-time. With the pull method the purchasing is rather based on a true immediate customer need than budget-based theoretical planning.

1.4 Objective and Scope

The *objective* of this thesis project is to propose an improved material purchasing process that will be based on a pull method, such as kanban.

The expected *outcome* will be an improved material purchasing process. The scope in the case company is limited to parts that are purchased from external sub-contractors with a short lead-time and with a stable and medium/high volume.

To achieve this objective the researcher has analysed and measured the current situation with the purchasing process and proposes an improved material purchasing process. To support the proposal the researcher has studied existing knowledge related to Process improvements and Lean practices. The researcher has also done multiple interviews and workshops inside the case company with the stakeholders that are involved in the current purchasing process.

The choice of approach in this study is partly decided by the case company that has done pre-research concerning alternative approaches that enable a customer pull in purchasing and has decided to use lean and kanban related pull systems in purchasing.

Based on that decision, the scope of this Master Thesis is limited to purchasing improvements based on lean methodology.

This Thesis is written in seven sections. Section 1 is the introduction. Section 2 describes the research approach, research design, methods and material used in the Thesis. Section 3 presents the results of the current state analysis of the material purchasing process in the case company. Section 4 discusses the findings from existing knowledge related to Process improvements, Pull methodology and kanban. Section 5 contains a proposal for an improved material purchasing process. Section 6 contains testing results of the improved material purchasing process. Section 7 contains a summary and conclusions of the thesis.

2 Method and Material

This section describes how the research approach and the research design that are conducted in this study. This sections also shows how the data of the study was collected and analysed. Last, there is a plan how to secure the reliability and validity of the study.

2.1 Research Approach

The research approach in this study is a case study. Case studies are useful when a small-scale research is done. In a case study the focus is on one or just a few topics. In this study the researcher is focusing on a certain process that is best supported by a case study approach. In a case study ideas are gathered related to the business challenge and then combined to get the best solution for the problem. The target is to get to the detail level of the researched process. In this study ideas are gathered from certain stakeholders in three stages to get the best possible overview of the problem and a suitable solution for it. (Denscombe, 2003)

Strength of a case study is that the researcher is able to use a lot of different kind of data, research methods and sources. In this thesis there will be used interviews and workshops as research methods. Data is gathered from people and also from existing process descriptions. (Denscombe, 2003)

By a case study the researcher seeks to find an answer for a certain question. A case study also seeks for evidence related to the research question. Using multiple sources and searching for strengths and weaknesses of the evidence is usual in a case study. Other basic character of a case study is that the current state of the researched topic is analysed first and theory is studied after that. (Gillham, 2000)

In this thesis the researcher has decided to use qualitative research method. Qualitative research focuses on evidence that researcher gets form other people. Strength of qualitative methods is that it enables researcher to get explanations to the researched topics.

Qualitative methods are well connected to scientific research. Weakness in qualitative research is that the researcher needs to rely on the evidence that might be faulty. Because of this several sources need to be used. (Gillham, 2000)

2.2 Research Design

The research design describes the steps that are needed to complete the study. The research study of this study is described in Figure 1. The blue boxes are describing the topics that are researched. The orange boxes are describing the data that is going to be analysed. The green boxes are describing the expected outcome of each step.

The case company has determined the business challenge. The company has decided to reduce their current inventory levels remarkably during next two years. One way to reduce the inventory levels is to improve the purchased material turnover by developing the material purchasing process.

The first step is defining the objective of the thesis. After the objective is defined the current state of the topic is analysed. The Current State Analysis (CSA) is based on the data collected in the case company. After the current state is analysed, its results point to the topics to search from the best practice and literature. Based on the best practice found, a conceptual framework is formulated that is later used as a basis for the proposal building.

In the proposal-building step, the findings of the current state and search for best practice create a foundation for building the proposal for the improved material purchasing process. After the proposal is drafted together with the stakeholders, it is validated and tested, and modified based on the collected feedback. After that the final proposal is done for the improved material purchasing process for the case company.

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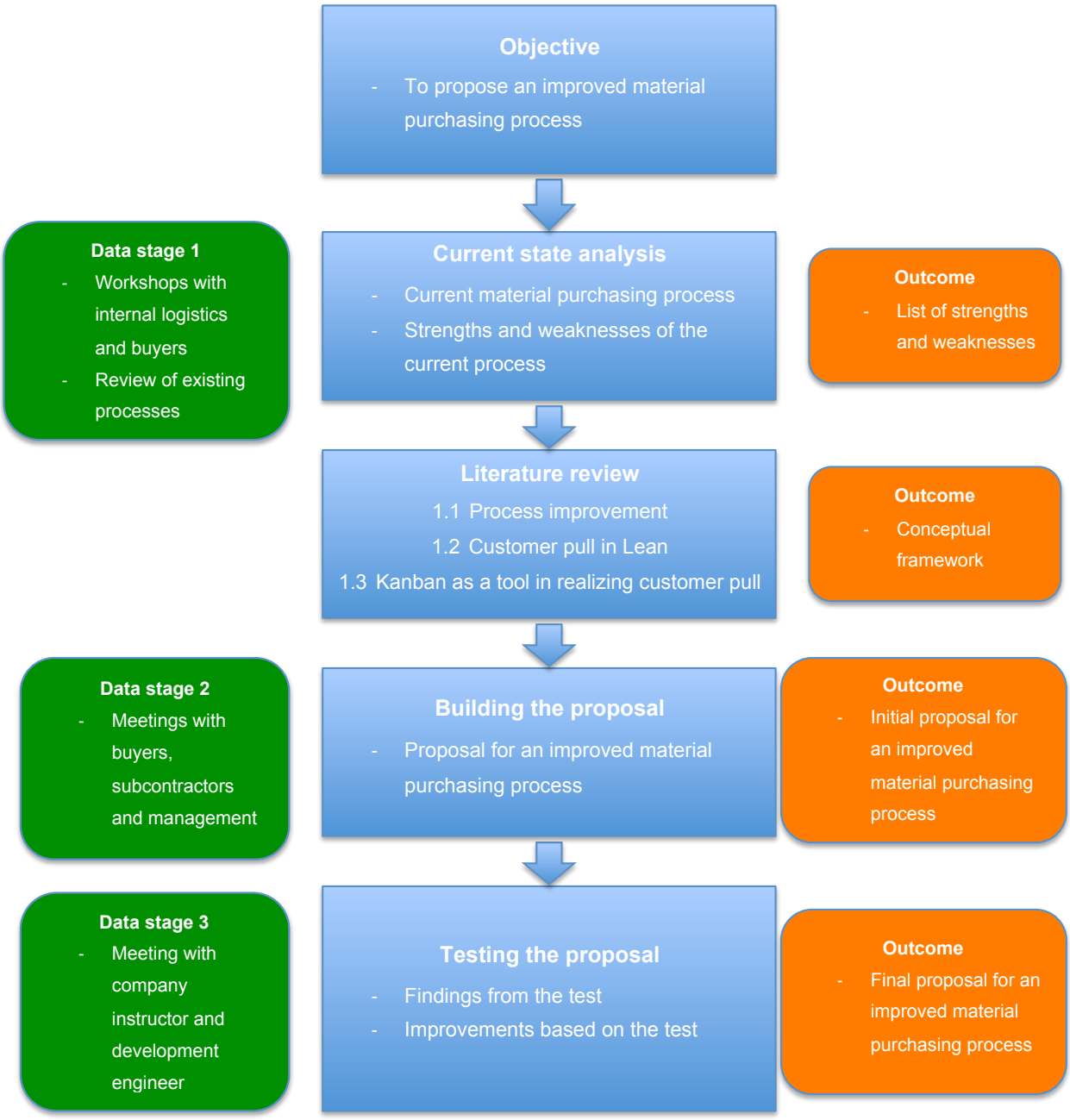


Figure 1. The research design in this study.

As it can be seen from Figure 1, this study looks for a concrete proposal for an improved purchasing process based on empiric data and relevant theory.

2.3 Data Collection and Analysis

In this study the data was collected in three stages: Data 1 for the current state analysis; Data 2 for Building the proposal and Data 3

for Testing the proposal. Data is collected by conducting workshops with internal stakeholders, reviewing internal documentation and by researcher making own observations. Data sources and collection methods are described more detailed in Table 1.

Table 1. Data sources in this study.

Workshops and discussions	Internal documents	Observations
- Workshops with stakeholders involved in Purchasing	- Process descriptions - SCM manuals	- Experiences of persons involved with the problem solving in the study

Workshops and discussions

Data collection involves persons from three functions inside the case company, management, purchasing and logistics, and from an external subcontractor. These functions were chosen because purchasing and logistics are the main functions that are involved with the purchasing process in the case company, the subcontractor is physically handling the case company's material storage and movements and management opinion is needed to verify the proposed process in the end.

Data collection 1 is conducted in two workshops. Workshops were chosen because several stakeholders have experiences and opinions about the current process. The advantage of a workshop is also that it creates open discussion that might lead to good development proposals. Face-to-face interviews would have been also too time consuming. Data collection 1 also included reviewing the current material purchasing process descriptions that were relevant for the topic.

The persons and functions that were presented in the workshops are presented in Table 2. The specific process involves highly these two functions so it was essential to have the insights from both of them. The key questions in the workshops were: What are the strengths and weaknesses of the current purchasing process? and How the current process could be improved?

Table 2. Workshops of Data collection 1 for the current state analysis.

Participants	Date and duration	Documented as	Topics
1. Lead Buyer 2. Buyer 1 3. Logistics Manager 4. Development Engineer, Purchasing	Workshop 1, 3.2.2016, 2 hours	Meeting notes, Appendix 1	Current material purchasing process, strengths and weaknesses of the current process, how to improve the current process
1. Lead Buyer 2. Buyer 2 3. Buyer 3 4. Buyer 4	Workshop 2, 5.2.2016, 2 hours	Meeting notes, Appendix 1	Current material purchasing process, strengths and weaknesses of the current process, how to improve the current process

Workshop 1 was held in Helsinki in the Finnish language. Workshop 2 was held in Tallinn, Estonia also in the Finnish language. The topics for the workshops were kept same to get more reliable results. The gathered data was analysed by the researcher based on the meeting notes. As it can be seen in Appendix 1, many similar weaknesses was noticed by the participants in the two meetings, which is confirming the importance of the weaknesses.

Data collection 2 was also done in two meetings. The functions involved and topics discussed are detailed in Table 3. The first meeting was held in Helsinki in Finnish language. The purpose of the meeting was to get ideas what kind of pull system would be suitable and how to test it.

The second meeting was held also in Helsinki in Finnish language. In that meeting management representatives were participating and the idea of the meeting was to present the proposal that was done in the first meeting. The output of the meeting was a permission to proceed with the proposal and a few requirements regarding the testing were also received.

The gathered data was analysed by the researcher based on the meeting notes. The agenda of the two meetings was totally different. The first meeting was focusing on the concrete operating of the proposal and the second one was focusing on approving the proposal. In the first meeting the opinions of the participants were noted and based on them the suitable pull method was chosen. The decisions and proposals from the participants were supporting the objective of the study and the project that the researcher was working with in the company. Also the management approved the proposal in the second meeting.

Table 3 below shows details of Data collection 2 conducted for the proposal building.

Table 3. Meetings of Data collection 2. For the proposal building.

	Participants	Date and duration	Documented as	Topics discussed
1.	Buyer	Meeting 1, 14.4.2016, 1 hour	Meeting notes, Appendix 2	What kind of pull method would be the most suitable, testing plan, testing requirements from different functions
2.	Development Engineer, Purchasing			
3.	Operations Manager, subcontractor			
4.	Development Manager, subcontractor			
5.	Implementation Manager	Meeting 2, 20.4.2016, 1 hour	Meeting notes, Appendix 2	Proposal of the pull method that could be implemented, how the testing has been planned
6.	Production Unit Manager 1			
7.	Production Unit Manager 2			
8.	Production Unit Manager 3			
9.	Head of SCM			
10.	Inventory Manager			
11.	Purchasing Manager			
12.	Team Leader, Planning & Inventory Management			

In the first meeting the initial proposal was created and the steps for the testing were planned. In the first meeting there was participants from external subcontractor, which are operating the Company's external warehouse. In the second meeting the proposal presented and accepted by the management.

Data collection 3 was collected in a meeting where an implementation manager and a development engineer from the case company were involved. The meeting was held in Helsinki with Finnish language. The purpose of the meeting was to review the initial proposal for the improved material purchasing process, to give feedback of the proposal and give more improvement ideas. The participants and topics are detailed in Table 4 below.

Table 4. Meeting of Data collection 3 for the testing of the proposal.

Participants	Date and duration	Documented as	Topics discussed
1. Implementation Manager 2. Development Engineer, Purchasing	13.5.2016, 45 minutes	Meeting notes, Appendix 4.	Review of the initial proposal. What is good? What needs improvement? What are next steps?

Based on the feedback and improvement proposals received in the data collection 3 meeting, the final proposal for the improved material purchasing process is built. The validation of the final proposal was done in the same meeting. The gathered data was analysed by the researcher based on the meeting notes. The meeting brought up some immediate actions that were relevant for the study and also important actions for the next steps after the study.

Internal documents

Three relevant internal documents were reviewed for the current state analysis. The documents are detailed in Table 5. The documents are basic instructions and process descriptions, which describe the case organisations roles and responsibilities in the case company. The documents were analysed by the researcher. The strengths and weaknesses discussed in the current state analysis are the researchers own thoughts.

Table 5. Internal documents analyzed for Data 1.

	Name of the document	Description
1.	3AFE004168. Supply Chain Management operational model	Operational model for case company's sourcing and purchasing activities
2.	3AFE000337. Purchase ordering methods in the case company	Describes different methods of executing a purchase orders in the case company
3.	3AFE003306. Case company purchasing process	Overview of the case company's purchasing process

Based on the findings from the two workshops and internal documents, the key strengths and weaknesses of the current material purchasing process were identified. The weaknesses are identifying the challenges at the moment in the company's purchasing.

2.4 Validity and Reliability Plan

Validity and reliability are needed to proof that the data and results of the study are trustworthy. Validity and reliability are generally used in quantitative research but they can be applied in qualitative research also (Golafshani, 2003). *Validity* in qualitative research means that the findings and data presented in the study are correct. A valid study demonstrates what really exists (Brink, 1993).

In this study, the stakeholders in the case company are planned to be involved to proof the authenticity and review the test results. The outcome of the study also needs to match with the objective.

Reliability means that the findings and data can be trusted and they are authentic. Testing and evaluating data generally proof reliability (Golafshani, 2003: 5). Reliability is shown by achieving the same test results several times by using same testing methods (Brink, 1993).

In this study, testing the proposal in practice will proof the reliability of this study. Also using workshops, interviews and reviewing documentation is planned as a measure to gather data from several sources and thus prove the reliability. The best practice that are gathered from relevant theory will give reliability to the final proposal.

3 Analysis of the Current Material Purchasing Process in the Case Organization

In this section the company's current material purchasing process is described and analysed. First, the Supply Chain Management (SCM) organisation of the company is introduced. Next, the current material purchasing process is described and finally the strengths and weaknesses of the current material purchasing process are identified.

3.1 SCM Organisation of The Case Company

Presently, the organization consists of four Sourcing categories, a SCM Development team and two Purchasing teams. Overview of the SCM organisation and the responsibilities are in Figure 2. (Zhang, 2015)

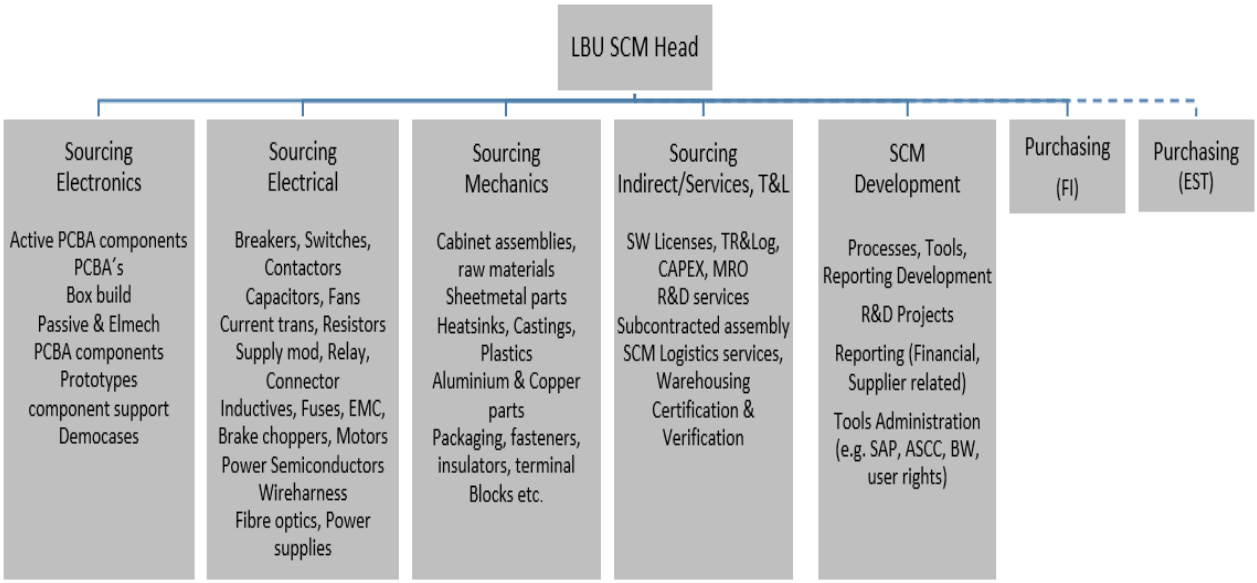


Figure 2. SCM organisation chart in the case company. (Zhang, 2015: 8).

Sourcing and Purchasing processes in the case company consist of Sourcing & Category strategies, Supplier selection, Supplier management and Operational purchasing as described in Figure 3. The main actor in the first three process phases is the Sourcing within the Supply Chain Management function. Purchasing is

participating in supplier management process phase and is main actor conducting operational purchasing. (Zhang, 2015)

3.2 Description of the Current Material Purchasing Process

As seen in Figure 3, Sourcing and purchasing processes in the company are designed so that sourcing and purchasing activities are conducted aligned with the company core processes, namely the Product Creation process and Offer-Order-Delivery process. In practice this means that sourcing and purchasing processes define the tasks conducted by Supply Chain Management personnel, which deliver outputs to the company core processes based on the inputs of these processes. (Zhang, 2015)

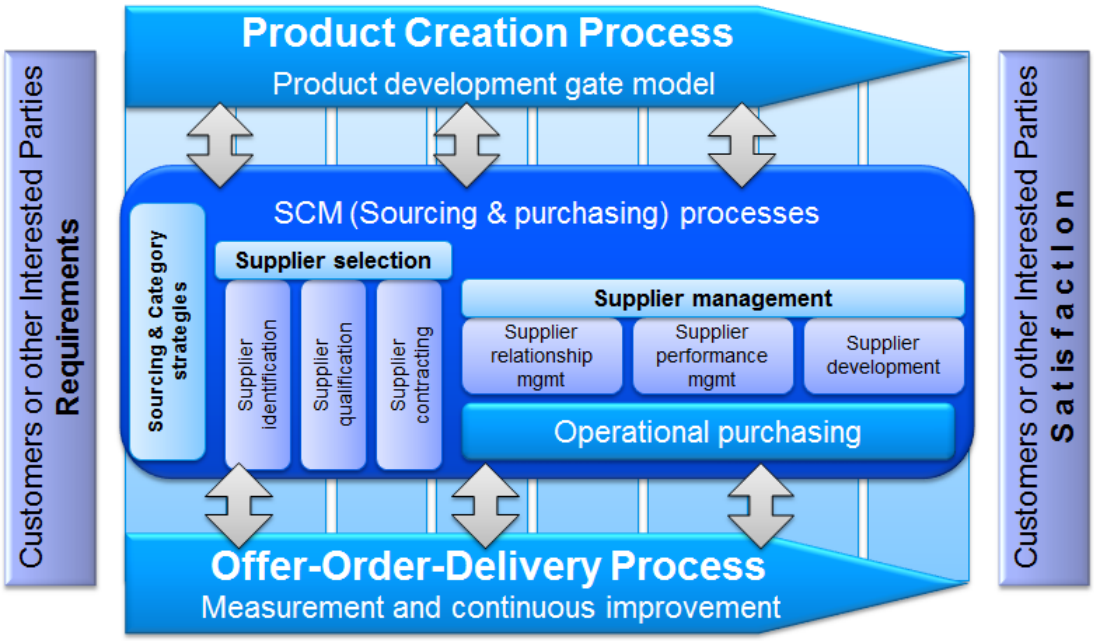


Figure 3. The role of Operational purchasing in the case company. (Zhang, 2015: 26)

The owner of the purchasing process is the Purchasing Manager. The customers of purchasing in the process are company's production lines and central warehouses. The demand is indicated by purchase requisitions in the SAP. They are generated by sales orders or demand forecast. (Lampinen, 2014)

The purchasing process normally starts when buyer makes a purchase order into SAP. The purchasing process is described more detailed in Figure 4. (Lampinen, 2014)

As shown in Figure 4, the purchasing process starts the sales forecast and ends when the supplier has delivered the goods and invoice of the delivered materials has been paid. (Lampinen, 2014)

The most critical factors of the process are suppliers' delivery accuracy, component quality, transportation arrangements and the flexibility of the suppliers. The company has defined special situations when the normal purchasing process should not always be used. Those are for example new product ramp ups and when the company is facing significant quality defects. The company has separate instructions for those situations. (Lampinen, 2014)

All purchase orders in the company are done by SAP but the information can be shared to suppliers in different ways. Majority of the purchase orders are shared to suppliers by the company's extranet that is designed for sharing different kind of information to company's suppliers. The company shares also information about purchase forecasts, complaints, supplier performance and general topics in the extranet. Suppliers are confirming purchase orders and giving responses to complaints in the extranet. (Lampinen, 2014)

A lot of purchase orders are informed to supplier by EDI. With EDI the information is transferred from the company's ERP system directly to suppliers ERP system. Also purchase order confirmations are transferred directly from suppliers ERP system to the company's ERP system. Purchase orders can be sent to supplier by e-mail but this is quite rear. Some suppliers for bulk materials are using Vendor Managed Inventory (VMI) in the company. (Lampinen, 2014)

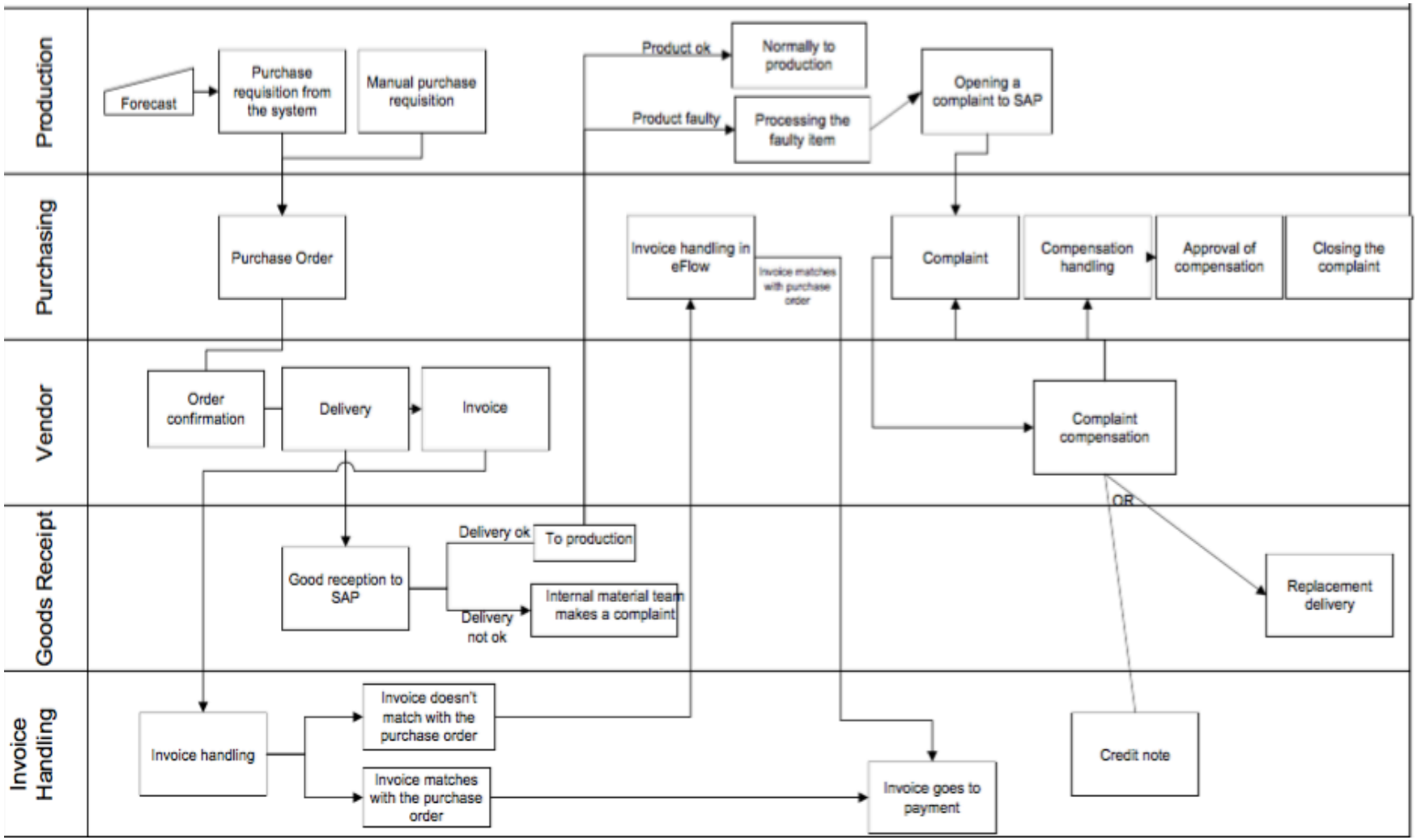


Figure 4. Case company's material purchasing process. (Lampinen, 2014: 3)

By reviewing the current process descriptions critically and analysing the current inventory turnover of parts in the scope of the study, and by conducting two workshops, the strengths and weaknesses of the company's current material purchasing process were identified. The strengths and weaknesses of the current purchasing process are discussed next.

3.3 Current Inventory Turnover

As the focus in this study is in improving the material turnover for short lead-time and medium/high volume parts, the researcher has done calculations for them in the current state analysis. This calculation is done based on 45 parts that fit the criteria. The parts are listed in the Appendix 3. The analysis results are discussed below. Inventory turnover (ITO) is calculated in the company by using the pattern below

$$\text{ITO} = \frac{Consumption\ per\ year}{safety\ stock + \frac{maximum\ stock - safety\ stock}{2}}$$

The parts lead-times vary between 4 and 14 days and all of them have potential to be purchased with just 2-3 days delivery time if agreed with the subcontractors. The current inventory turnover for those parts varies between 0,8 and 11,7, the average of 5,4. The company's general target for inventory turnover is over 10 and with these kind of short lead-time parts the potential is significantly higher.

In the list there is also shown the previous three month usage data of the parts, short term (1-3 months) and long term (4-6 months) forecast and the current delivery time. Only four items are fulfilling the company's inventory turnover target. The data is gathered from the company's SAP system.

3.4 Identifying the Strengths and Weaknesses of the Current Material Purchasing Process

The strengths and weaknesses of the current material purchasing process are important to identify so that the researcher is able to focus on the critical improvement points of the process. The idea is to keep the current strengths and select certain weaknesses that need the most improvement.

The strengths and weaknesses of the company's current material purchasing process were identified by reviewing the current process descriptions critically and by two workshops. The participants and topics of the workshops were detailed in Table 1 in Section 2.3. The field notes of the strengths and weaknesses found in the workshops are detailed in Appendix 1.

The strengths are summarized in Table 6. and weaknesses and their business effects are summarized in Table 7. The strengths and weaknesses were identified during the workshops. It means that both functions have noticed the same problems with the current process and they also see the same positive aspects and possibilities that the process can provide. It enables the researcher to focus on some key development areas.

The basic purchasing process that was described in Figure 3 is defining clearly how the need for the purchase order is indicated in the company's system and how it is handled by different functions in different stages. It makes a well-detailed overall process description that contains both information flow and material flow, which are the important flows from purchasing point of view.

The current material purchasing process was handled more detailed in the workshops. The strength that was identified by all buyers was that the current way of working is sufficient to execute the daily purchasing. If the production demand is as planned and there is no major quality problems the process is efficient. The current process

enables a steady material flow to the material suppliers with high volume items and it is efficient when purchasing low volume items.

The weakness according to the buyers on the other hand is that the current process is quite vulnerable for distractions. The current process is slow in reacting to significant changes in demand and errors in forecast. The company has products that are sold in projects with short delivery time and many times they are really difficult to forecast.

Another weakness according to the buyers is that the current way of executing the purchase orders is really manual. In some item categories there are a lot of low volume products that are purchased maybe once a month so it is smart to purchase them manually. On the other hand the company has many high volume product also that are usually purchased from local suppliers finished goods stock in small lot sizes and with short lead-times. They might be purchased several times a week. The manual purchasing is not an efficient way of executing that kind of purchases.

The company has an automatic Kanban purchasing system in use for some items where the purchase orders are done by RFID (Radio Frequancy Identification) system. The problem with the system according to the buyers and the Logistics Manager is that the software is not working reliably, which means that purchase orders are not always executed when they should have. To use the RFID system the company needs to design and make an investment for kanban boxes for the items and the boxes are usually expensive and it is difficult to monitor the movements of the boxes. Also the supplier changes are really difficult to execute.

Also the company does not have an owner for the current kanban system. The company has several warehouses and production plants that are manufacturing the same products. The goods are moved from warehouses to production plants in smaller lot sizes than they are purchased to the warehouse. According to the

Logistics Manager, using kanban boxes in such a large network is not efficient.

According to the buyers, the inventory levels and internal safety stocks are easy to adjust. The company has a report that is provided to purchasing monthly that provides the purchasers needed data to adjust the minimum safety stock levels. The company also has a SAP function in use that enables purchasers to define safety stocks automatically to system. According to the Development Engineer, the weakness of this system is that it works reliably only for items with steady demand.

3.5 Summary of the Strengths and Weaknesses of the Current Material Purchasing Process

The case company has a described and working process for material purchasing. The targets and critical factors of the process are identified. Responsibilities inside the SCM organisation and also inside the purchasing unit are defined. This means that the overall process is on a sufficient level for a large professional company. But there is always room for improvement and making the process working more efficiently.

Figure 5 below shoes the current process is based on push method, which is creating excess stock.

In Figure 5, the following acronyms are used:

- PO = purchase order
- WH = warehouse
- POQ = production order quantity

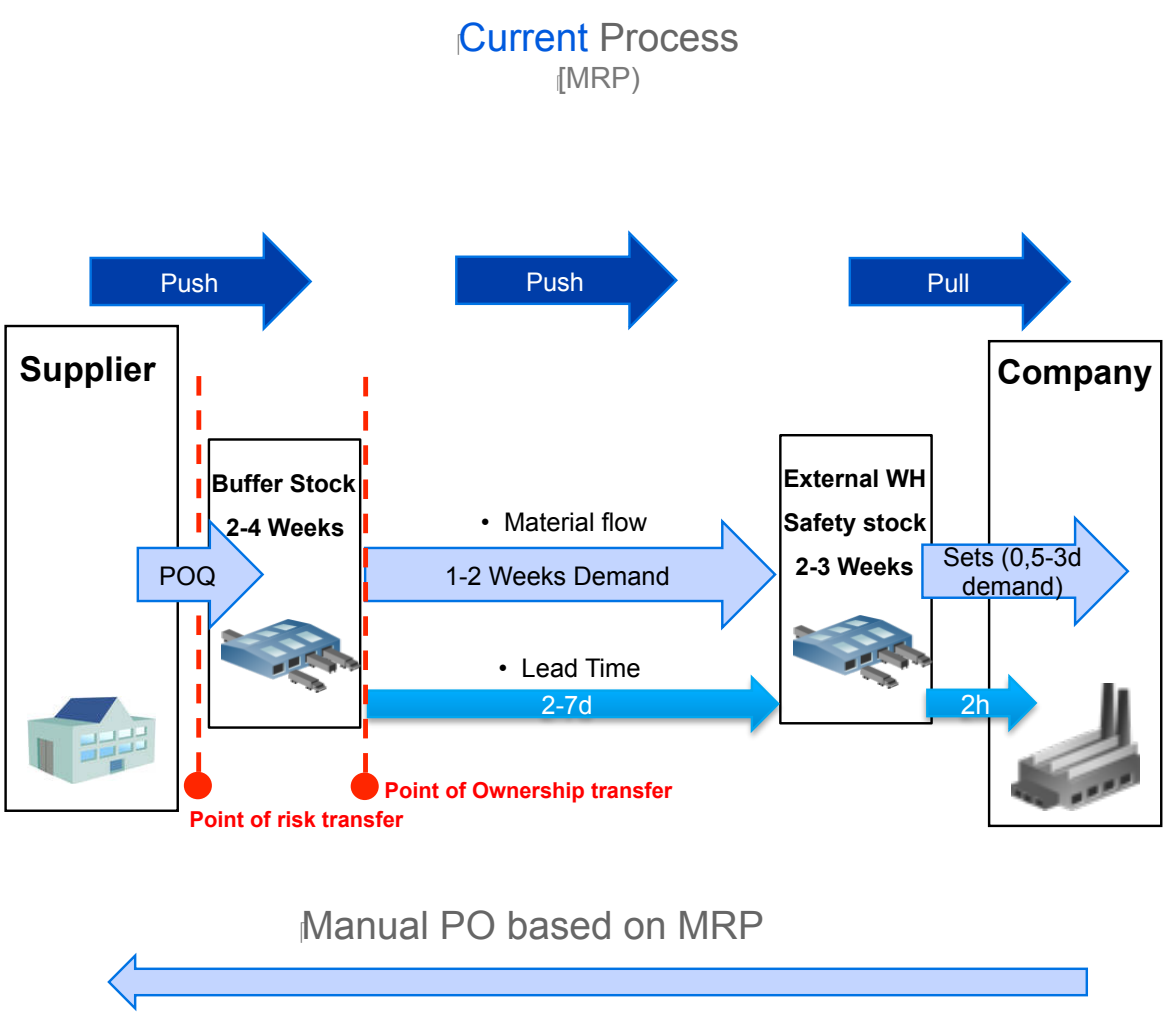


Figure 5. Current purchasing process based on push method in the case company (Retsja, 2016)

However, the current process is sensitive to several distractions and it requires a large amount of manual work, which is time consuming. The case company is facing seasonal changes and also high demand peaks from project sales, which are difficult to handle because the sales forecasts in system are based on quite steady volume. All these weaknesses are creating either excess inventory or material shortages. The company wants to avoid both of them.

Table 6 summarizes the strengths of the current process identified in the current state analysis.

Table 6. Summary of strengths identified in the current state analysis.

	Strengths
1.	Efficient when process works without distractions
2.	Enables steady material flow from suppliers
3.	Enables efficient purchasing with low volume items
4.	Inventory levels are easy to adjust
5.	The general process is clearly described

In addition to the strengths summarized in Table 6, the current state analysis also identified a number of weaknesses in the current process and their impacts.

Table 7. Development priorities and their business impacts.

	Development priorities based on key weaknesses	Impact
1.	Current purchasing process is too vulnerable to distractions	Slow reaction to changes in demand, which is causing material shortages and excess stock.
2.	Too manual purchasing, automated systems are not reliable enough	The process is time consuming and inefficient especially when purchasing high volume parts.
3.	Supplier changes are difficult to execute	Handling supplier changes is time consuming and it often creates material shortages and quality problems.
4.	Seasonal changes and demand peaks are difficult to handle	Sudden demand changes or single demand peaks cannot be handled in an efficient way, which causes extra work and material shortages.
5.	Too dependent on the sales forecasts	Creates excess stock and material shortages.
6.	Internal material movements are not aligned with purchase orders coming from suppliers	A lot of unnecessary picking in warehouses and it often creates excess stock to certain plants.

The effects of the weaknesses are described in Table 7 above. Based on these findings the researcher will focus on certain weaknesses in the process and the objective is to keep the strengths as they are. Two development priorities that will be the main focus in this thesis are marked with red.

The company and the researcher have decided to concentrate in this study to improve the purchasing process so that two weaknesses, *(a) Seasonal changes* and *(b) demand peaks* that are difficult to handle and too dependent on the sales forecasts, would have a smaller impact on the daily purchasing and operations inside the company.

Those priorities were chosen because they support the case organisation's strategy the best. Creating a purchasing process that is based on a pull method is one way to prevent excess stock and material shortages that are caused by errors in sales forecasts. The target is to create a process that works more according to the real demand from the internal customer than the current one and it would create more steady material flow from suppliers. In that way the company can minimize material shortages and operate with lower inventory.

The next section describes some best practices from the literature related to process improvement and material pull methods in purchasing. Process improvements are needed to develop the current process to a better level and material pull methods are studied to create a pull method to purchasing so that the two mentioned weaknesses could be eliminated. Based on the best practice a proposal for the improved material purchasing process can be build.

4 Best practice for Improving Processes in Material Purchasing

In this section best practice in literature are reviewed to find ways to improve the weaknesses defined in Section 3. First process improvement and process management topics are discussed. Second part is about customer pull and lean and third part is more detailed about kanban. In the last part the conceptual framework is introduced.

4.1 Process Improvement

Process improvements are necessary for every organisation to develop its performance in competitive markets. Process improvements can be done in large projects or in small pieces by continuous improvements and problem solving. In this chapter some of the most common process improvement and problem solving methods are introduced.

4.1.1 Continuous process improvement

There are multiple approaches to process improvement. The most noticeable methods are described below.

Kaizen

Kaizen comes from Japanese, change (kai) and for the better (zen). It is the basis of continuous improvement. Today kaizen is many times an event or a relatively short improvement project, which is focused on a certain problem that needs to be solved. (Liker & Franz, 2011)

PDCA

PDCA comes from words Plan, Do, Check and Adjust. It has been Toyota's main problem solving method since the 1950s. It is a method to identify and solve problems immediately when they are found, one at a time. The method is described in Figure 6 below. All starts from planning where the problems root cause is defined and the difference between the current state and the ideal state is identified. (Liker & Franz, 2011)

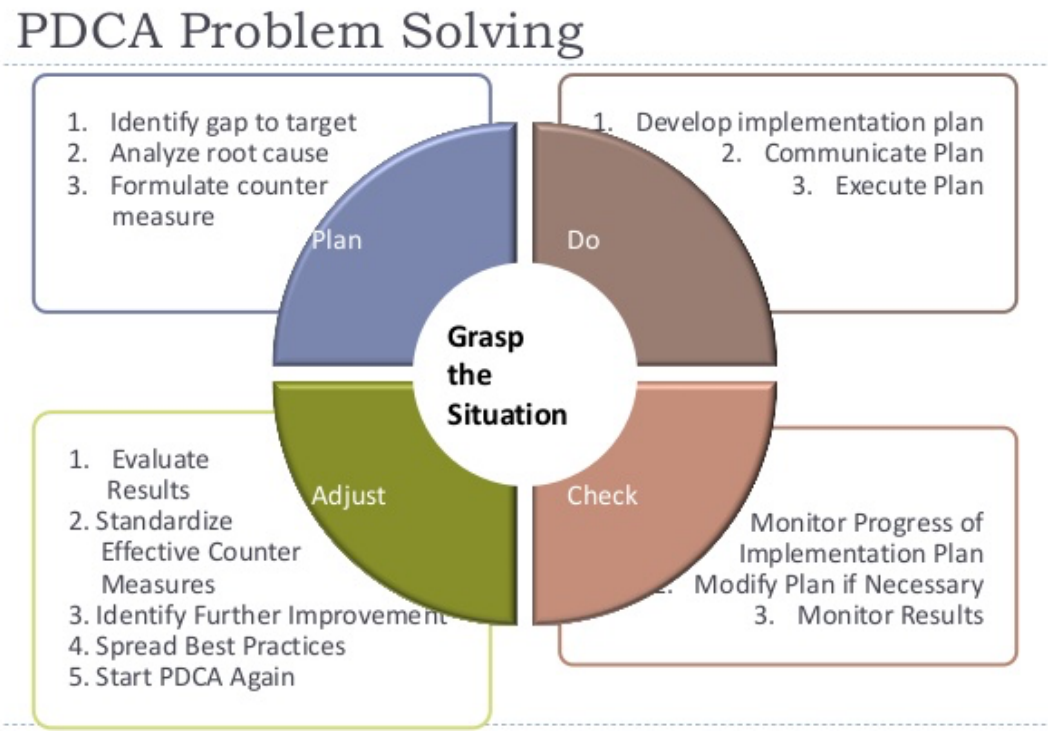


Figure 6. PDCA problem solving method. (Liker & Franz, 2011: 27)

After the root cause is identified efforts for solving the problem can be done. After that the effectiveness of the actions done need to be checked and if needed adjusted to be more effective. In the end the actions are standardized and the best practices are shared within the organisation. After that a new planning starts to improve the current situation once again. (Liker & Franz, 2011)

The Five Whys

The Five Whys problem solving method is used when the root cause of a certain problem needs to be discovered. The idea is simple; the researcher asks why certain defect or problem occurred. When the first answer is received, why is asked another time. Why will be asked as many times it is needed to discover the real root cause of the defect or problem. Then a solution to the root cause needs to be figured out. (Liker & Franz, 2011)

DMAIC

DMAIC comes from words Define, Measure, Analyse, Implement and Control. It is quite similar to PDCA and it is often used by Six Sigma Black Belts. The major difference to PDCA is the Control, which means that after the standardisation the process is not improved anymore, it is only controlled and sustained. The DMAIC process is described in Figure 7. (Liker & Franz, 2011)

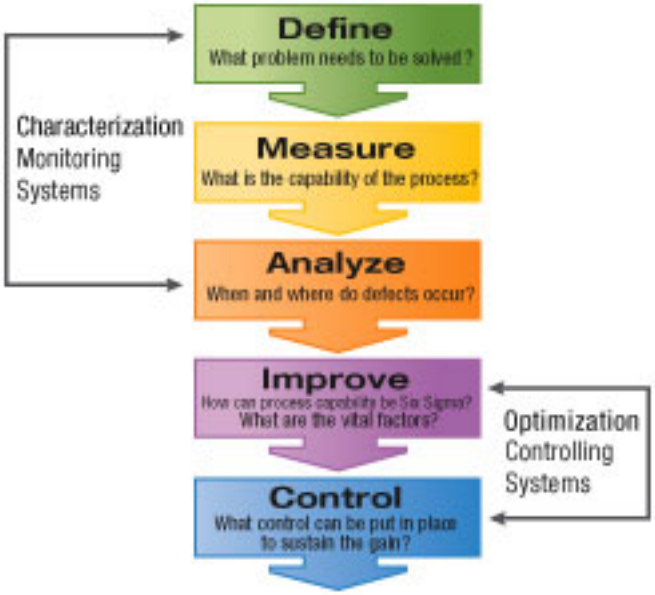


Figure 7. Six Sigma DMAIC process. (Six Sigma Qualtec, 2016)

8D

Eight disciplines problem-solving method is commonly used in industry when for example quality problems occur. The idea is the same as in PDCA and DMAIC. A difference is that in 8D the preventive actions are detailed in the process but ideal state is not defined like it is in PDCA. The 8D process is described in Figure 8. (Liker & Franz, 2011)

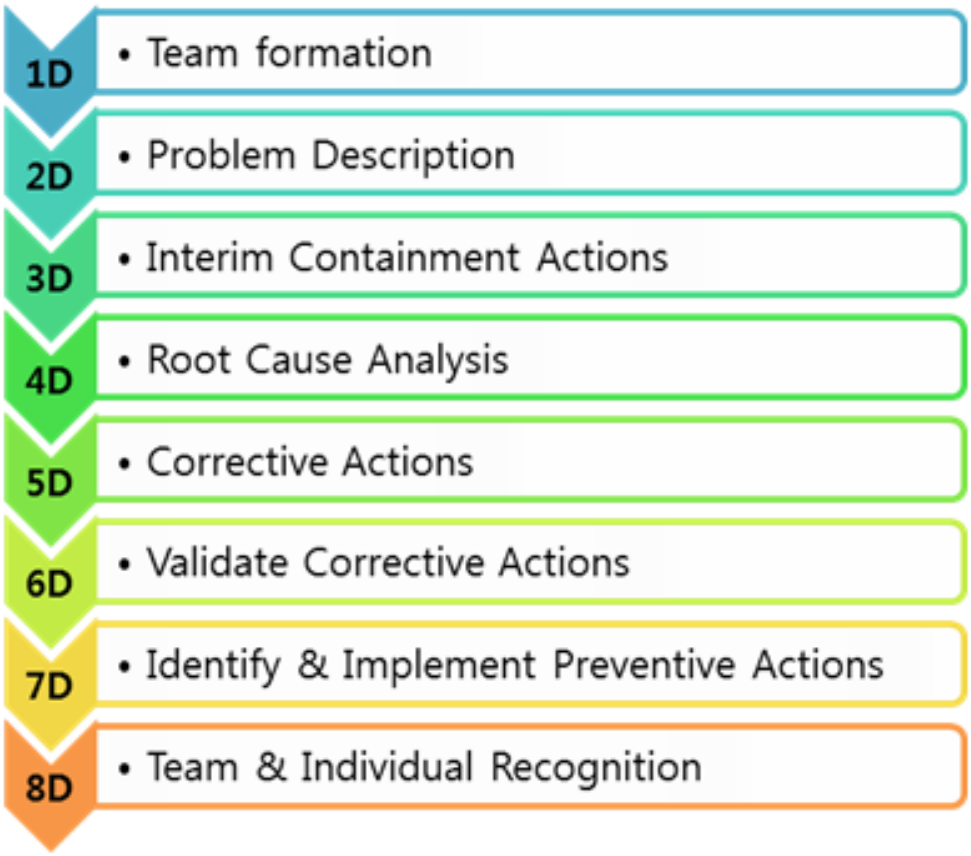


Figure 8. Eight disciplines problem solving process. (What is six sigma?, 2016)

SIPOC Diagram

SIPOC diagram is a problem-solving tool used in Six Sigma methodology. SIPOC comes from Suppliers, Inputs, Process, Outputs and Customers. The idea of the SIPOC tool is to define all needed elements of a process improvement project before starting the work. Example of a SIPOC Diagram is detailed in Figure 9 below. (SIPOC Diagram, 2016)

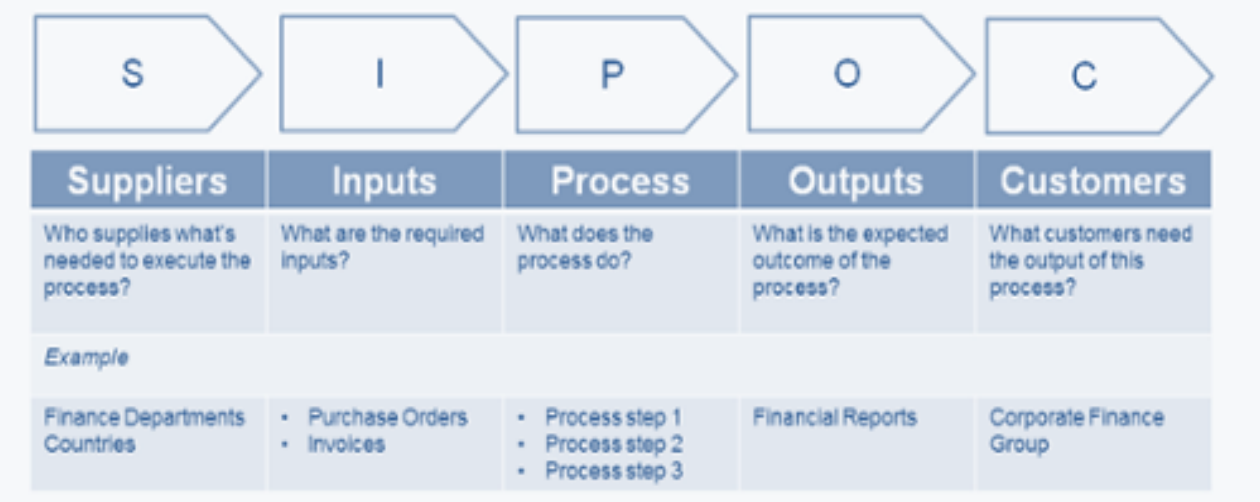


Figure 9. A SIPOC Diagram. (Kipstor blog, 2015)

It is sometimes used together with for example DMAIC tool in the Measuring stage. SIPOC tool helps the project team to understand the big picture of the improved process better. It is useful when it is not clear who are the suppliers or customers, what are the specifications for the inputs and if customer requirements are not clear. (SIPOC Diagram, 2016)

4.1.2 Process Management

Improving the processes is very important but also managing the process and the changes in it requires for attention. This section describes some principles of process management.

The targets of good process management are good financial results, customer satisfaction, high productivity and employee satisfaction and productivity. Key points to achieve the targets are cost efficiency, agility and flexibility. Co-operation is done within the company with different stakeholders and customers and suppliers are considered as partners. (Laamanen & Tinnilä, 2009)

In process thinking the value for the customer is done in a chain of actions. In process management the chains need to be identified and described. After that the process outputs need to have targets and the process needs to be constantly improved. Properly created

processes create efficiency and co-operation within the organisation. (Laamanen & Tinnilä, 2009)

4.2 Customer Pull in Lean

There are many different pull systems available in industry and in theory. Here is described some of the most general pull systems that are used and what are advantages of pull systems compared to push systems. Based on the findings the researcher is able to choose the most suitable pull system for the company needs.

4.2.1 Pull versus push systems

Pull systems enable an organisation to deliver parts faster to the internal customer and with a just-in-time principle, when customer needs them. Pull signals can be electronic messages or physical messages. Traditionally pull systems have been used in a certain dedicated production lines like in auto industry. Pull system is effective system there because of the stable and predictable demand. Pull systems can also be used in industries where the demand is fluctuating. Then the traditional pull system is not working so more dynamic pull system, which is based on short-term forecast, is more applicable. (Baudin, 2004)

The idea of the pull system is that it is moving parts from a location to another when the destination signals that it can take the parts. The parts are delivered Just-In-Time. The idea of a pull system is shown in Figure 10. In a push system parts are moved to the destination when the sending location gets the parts ready. The weakness of the push system is that it creates unnecessary buffers. (Baudin, 2004)

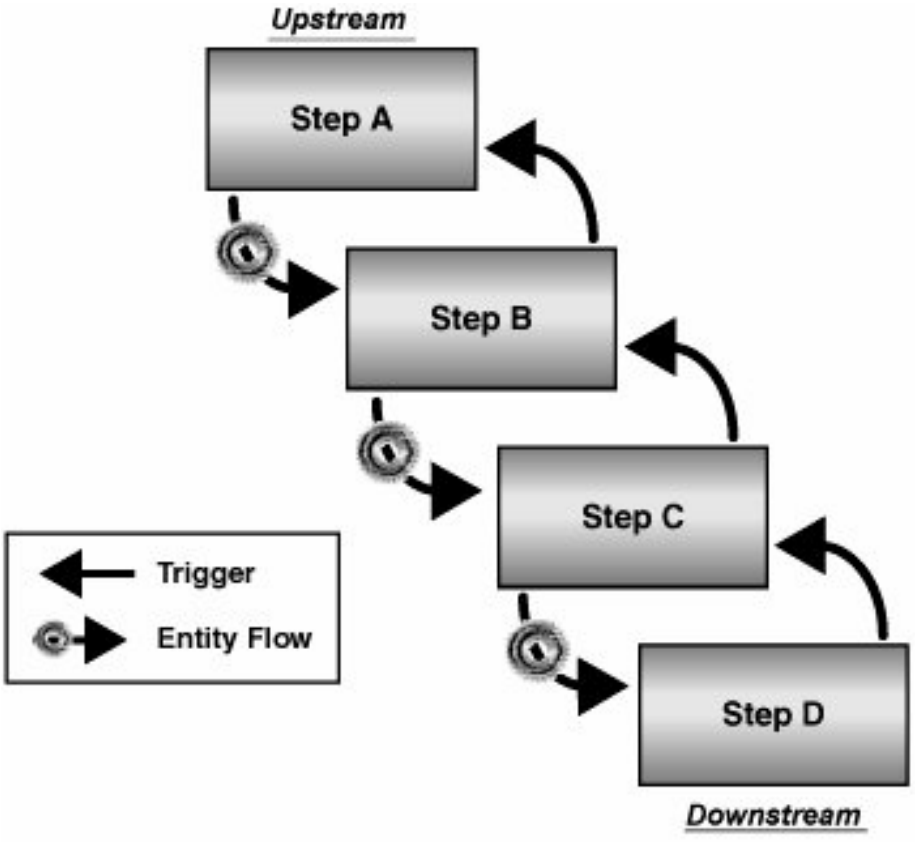


Figure 10. A pull system. (Flylib.com, 2016)

Pull systems enable a company to keep availability all the time without excess or too low inventory. It is based on short term planning where every day is planned to be similar to previous day. If demand changes remarkably on a short notice the pull system shows an immediate signal that there is too much or too less inventory in the system. (Schragenheim et al., 2009)

Push system is a useful option in a business that is based on high volume production and low cost products. By making to stock a company can optimize their production costs. Also if stock-outs are causing a significant business risk a push system is considerable. The characteristics of pull and push systems are detailed in Figure 11. (Schragenheim et al., 2009)

	PUSH	PULL
Objective	Minimize Cost	Maximize Service Level
Complexity	High	Low
Focus	Resource Allocation	Responsiveness
Lead Time	Long	Short
Processes	Supply Chain Planning	Order Fulfillment

Figure 11. Characteristics of push and pull systems of the supply chain. (Simchi-Levi et al., 2003: 50)

Combinations of push and pull systems, a Push-Pull system, can also be used. In push-pull system some parts of the supply chain are working with a push system and some with a pull system. Push system is useful in the beginning stages of the supply chain such as raw material processing. A combination of push and pull systems is decribed in Figure 12 below. (Simchi-Levi et al., 2003)

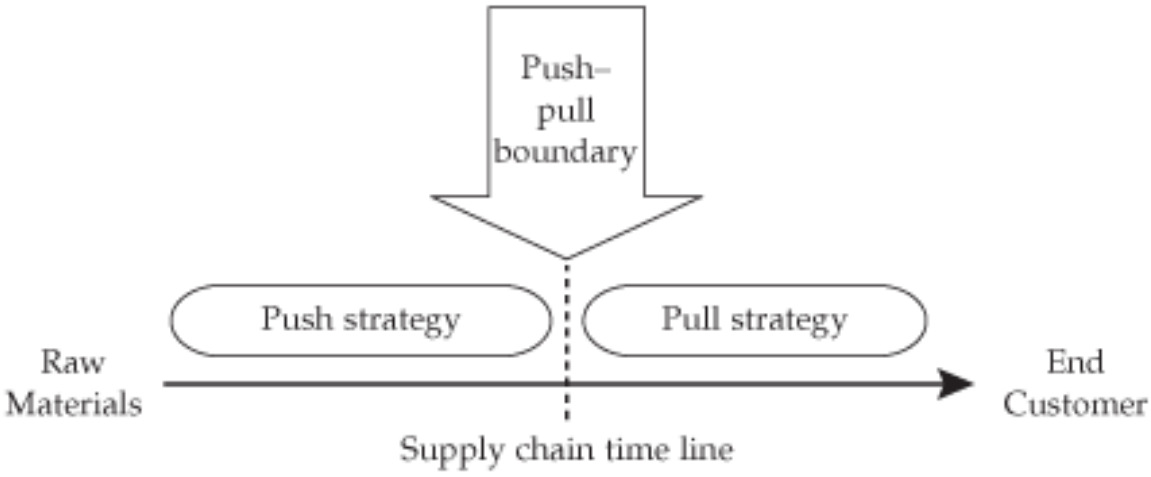


Figure 12. A push-pull system. (Simchi-Levi et al., 2003: 45)

The stages closer to the end customer are using a pull system. The excess inventory can be handled better because it is located only in

one place, right after the push stage. The strength of this system is that the expensive process can be operated on a high capacity in certain stages and some other stages can be kept lean. (Simchi-Levi et al., 2003)

4.2.2 Manual pull systems

The reorder point system is commonly used with bulk products that are purchased with high quantities. It can be based on visual management or it can be done by an ERP system. It can be used for example with liquid products, where the reorder is done when the amount of the liquid in a container gets below a certain level, or with single parts when the order is done when the quantity of the parts goes under certain level. The level can be for example two weeks average consumption. The idea of the reorder point system is described in Figure 13. (Baudin, 2004)

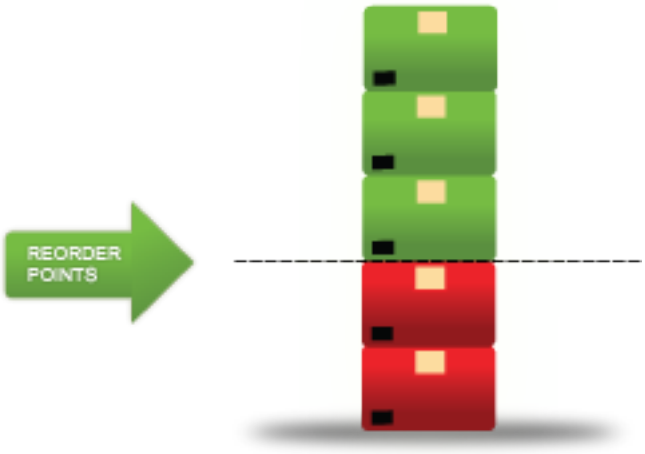


Figure 13. The reorder point system. (APSense Ltd.: 2016)

The two-bin system is a traditional pull system. There are two bins for a part and only one bin is used at a time. When the bin goes empty a new one is ordered and the other bin is taken to use. The size of the bin needs to be big enough to cover the replenishment time of the new bin. The empty bin can work as a pull signal so that it returns to the previous work phase to be filled. (Baudin, 2004)

Kanban is a small physical pull signal, which contains information. Many times kanbans are cards but other signals are also used in industry. The information in the card can be readable for human or a machine, such as a bar code. An example of a kanban card is shown in Figure 14 below. (Baudin, 2004)

Figure 14. A kanban card. (Kanban Box, 2016)

The information that kanban includes are what needs to be moved or made, when, where and how much. Inside a factory kanbans are moved according to rules decided in the company. The idea is that kanbans include all the needed information for the movements and all other information, such as delivery notes, can be taken out of use. (Baudin, 2004)

4.2.3 Advanced pull systems

Vendor managed inventory (VMI) is useful with parts that customer does not want to follow closely. The supplier in the customer's premises handles the management of the stock levels and the replenishment. (Baudin, 2004)

In industry VMI is often used with bulk parts such as screws, nuts and other small parts. The parts are used in high volume and they are really cheap. VMI may not require an information system to support the use and deliveries. In the simplest form the supplier visits customers production site regularly and takes notes of the parts that need to be delivered during the next visit. The payments are done based on the delivery notes provided by the supplier. (Baudin, 2004)

Consignment stock is similar to VMI. The difference is that in consignment stock system the payments to suppliers are done when customer takes the parts to use. Before that the supplier owns the parts in customer's premises. (Baudin, 2004)

4.3 Kanban as a Tool in Realizing Customer Pull

Kanban method can also be applied with suppliers. Kanbans are very easy to use in internal material movements but with suppliers there are always commercial issues involved, which need to be considered while planning the kanban system.

The kanban system with suppliers was the first used by Toyota to control the material flow on daily basis within the supply chain. The idea at Toyota was that every supplier would deliver only the amount needed in the production at a moment. The system eliminated much of the inventories, which caused in the beginning a lot of material shortages, but it also brought up the real problems in the supply chain. In Toyota's case it took more than twenty years to make the system function in an extremely productive way. (Womack et al., 1990)

4.3.1 Supplier kanbans

Kanbans can be used with suppliers also. The difference is that supplier kanbans include a commercial aspect. The supplier kanban system is described in the Figure 15. (Baudin, 2004)

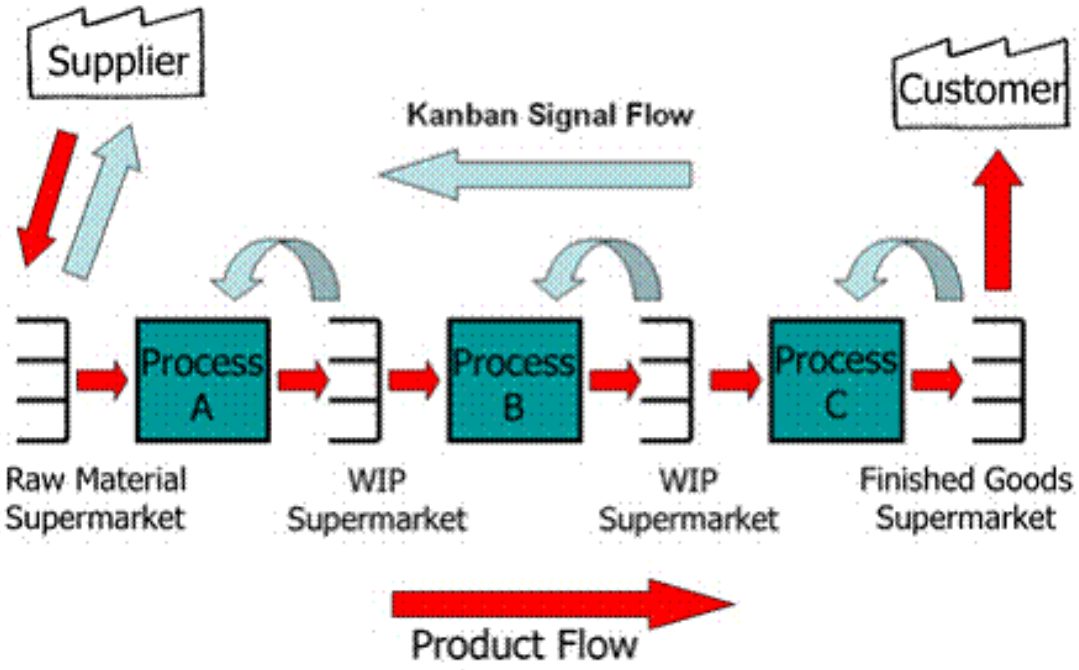


Figure 15. A supplier kanban system. (Functional Guy – Devendra Gulve, 2016)

Supplier kanbans are usually in an electronic form; usually it is a bar code that is scanned by supplier to get the needed shipping information. One way to use the kanbans with the suppliers is that the customer collects kanban cards in the plant and the customer scans them. That generates the purchase orders to the supplier. (Baudin, 2004)

Another way to use kanban with suppliers is to use containers for the parts and attach RFID tags to the containers. The tags include all the needed information for the supplier to deliver the goods. When the container gets empty at the customer's site a scanner, manual or a separate gate, which generates the purchase order to the supplier, reads the RFID tag. (Baudin, 2004)

Supplier kanbans can be also in a physical form. In this case containers need to be used to deliver the parts. The containers will have for example a plastic pocket, which is used to deliver the kanban card to the supplier. The card has the information of what needs to be delivered, when and where. (Baudin, 2004)

4.3.2 Kanban policies

Using kanban requires high commitment from all the involved operations. Kanban system works only when everyone is working according to the rules. This section describes the basic kanban policies.

The management of operations need to be committed to use kanbans to bring up problems in the supply chain, to improve the performance of the supply chain and designate a function to be responsible of the kanban process. There needs to be control of the amount kanban boxes or containers that are in circulation and processes to fix and manage the amount of boxes or containers. (Baudin, 2004)

The operations need to set a clear rule when the new pull signal by kanban is done. It can be when the first part is taken form the container, when the last part is taken from the container or something in between. The decision must be clear to everyone and it needs to be applied. Otherwise there will be excess stock or possibly material shortages. (Baudin, 2004)

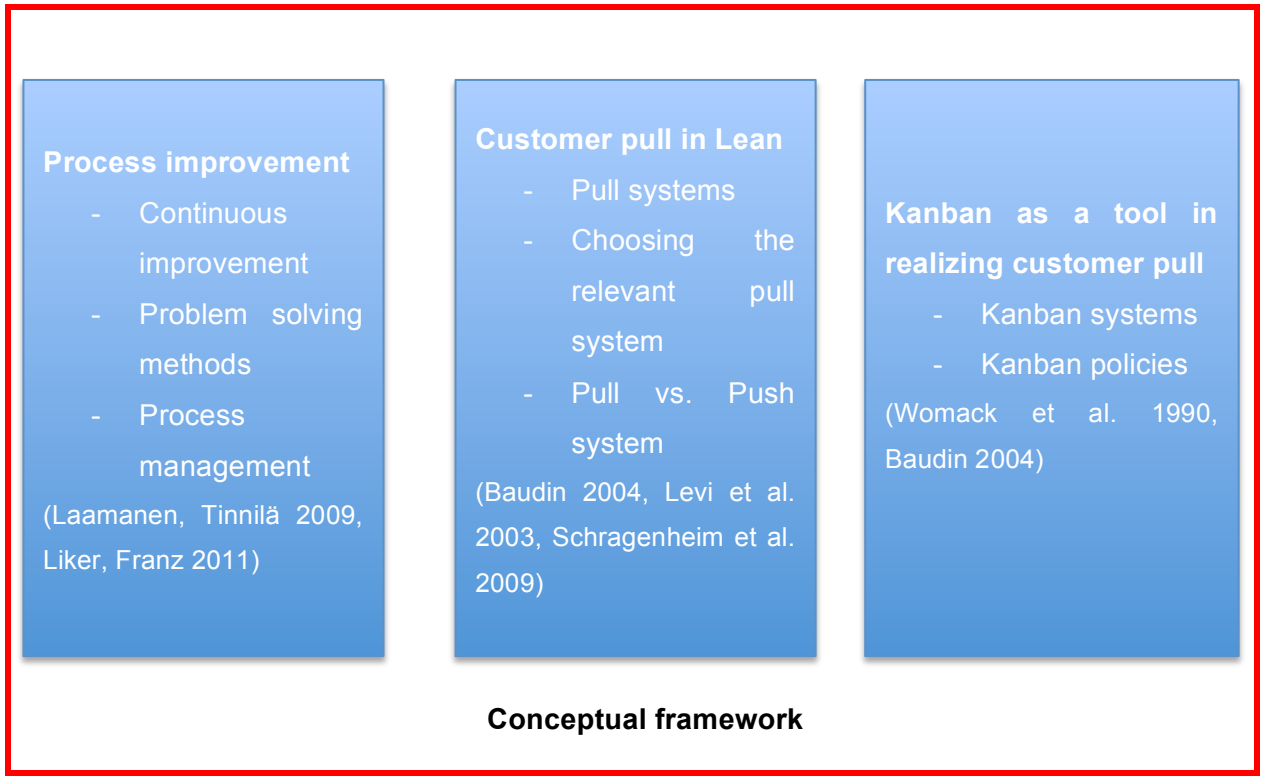
The kanban signal is done only from downstream operations, like in the Figure 10. Every kanban signal generates specific actions in the upstream. The kanban signal must have the following information: what needs to be done, part number, amount of parts needed, where parts need to be delivered and when they need to be delivered. Kanban materials are always handled by first in- first out system. (Baudin, 2004)

The kanban rules must be communicated properly to the operations. Also sanctions of breaking the rules must be communicated. The process must be constantly improved by taking extra kanbans out from the circulation. The operators must participate to designing the kanban system. Basically, rules must come from management but operators must be involved in designing the details. (Baudin, 2004)

4.4 Conceptual Framework

The findings from the best practice and, business and academic literature that are relevant for this study are summarized into conceptual framework that is described in Figure 16 below. The conceptual framework consists of three main elements: process improvement, customer pull in lean and kanban as a tool in realizing customer pull. The elements are linked to each other and together they form a basis for improving the material purchasing process.

Figure 16. The conceptual framework of this study.



As seen in Figure 16, the conceptual framework starts from process improvement. In that section methods for problem solving, continuous improvement and process management are described. The theory of problem solving and continuous improvement is based on best practices form Toyota Production System and lean literature.

The second section is about customer pull in lean. In that section different kind of pull systems are described and their strengths and weaknesses are shortly analysed. Pull and push systems are compared against each other. Based on these findings it is possible to choose the relevant pull system for the company's needs.

The third section is about kanban and how kanban can be used as a tool to realize customer pull. In that section the kanban system and its characteristics are described more detailed. Kanban policies and rules are described to understand the requirements to create a working kanban system in practice.

These three elements create the basis for developing and improving the case company's material purchasing process. To use this basis efficiently the process improvement and problem solving tools need to be used actively and different kind of pull systems need to be compared to get the best possible pull system for the case company's needs. This conceptual framework is applied in the next section where the improved material purchasing process is built.

5 Building an Improved Material Purchasing Process

In this section the initial proposal for the improved material purchasing process is done. The target of the proposal is to improve the weaknesses identified in Section 3. The proposal is done based on best practices found from literature and described in Section 4.

5.1 Overview of the Proposal Building Stage

The proposal building is done in three stages. The first two stages were handled in meetings with stakeholders. The two meetings are described in Data Collection 2 in pages 9-11.

In the first meeting the idea of the proposal was created and in the second meeting the proposal was presented to management and approved. In the third stage the proposal is described and the advantages are analysed.

In the first meeting there was persons from the case company's purchasing department and from an external subcontractor, which is managing the operations in the case company's external warehouse. The persons from the subcontractor were needed because the case company purchases materials to the external warehouses. The purpose of the meeting was to decide what would be the suitable solution to the weaknesses in the current process, which were defined in Data 1.

It was previously decided in the case company that the testing is done with this specific subcontractor because of their capabilities to handle new processes required by the company. It was also decided that the testing is done with some of the material specified in the Appendix 4. It was decided to use only one supplier in the testing phase. Based on these decisions six parts were taken to the testing.

In the first meeting there was discussion about the pull systems, which would be the best to be operated in the warehouse. The meeting notes can be found from Appendix 2. First it was proposed by the case company persons that a kanban-based process would

be preferred. The subcontractor's persons responded that a kanban system could be done but their opinion was that it would be too vulnerable for individual human mistakes. A reorder point system was chosen instead.

In the second meeting, the idea of the reorder point system and automated purchase orders were presented to the case company's management representatives. The meeting notes can be found in Appendix 2.

5.2 Building the Initial Proposal for the Improved Material Purchasing Process

The proposal developed in the workshops was that the case company would create the system to the case company's SAP system and the subcontractor would handle only the physical material movements. The case company's Development Engineer proposed a reorder point system to the company's SAP system. The reorder point system was discussed in section 4. To make it more efficient, an automated ordering tool from SAP could be taken to use. After short discussion about the technical possibilities of this system it was decided to propose an automated reorder point system to the company's management.

It was decided that the case company defines the parts that are tested and informs them to the subcontractor. It was also decided that the case company to enable better material movement process would standardize the lot sizes of the parts. The case company will also define the reorder point level. All this information would be also in the subcontractors ERP system.

Two risks were identified. The testing parts are used in several plants they all might have different lot sizes that they order from the external warehouse. It was acknowledged that the lot sizes must be aligned with the purchased lot size from the supplier. The second risk was about the automated purchase orders. That tool wasn't in use in the case company anymore and it was not sure how it works in practice. It was decided that instructions how to use the tool will

be investigated and the automated purchase ordering must be tested carefully. Last it was decided to start the testing as soon as possible, preferably in the beginning of May.

In the second meeting, the discussion of the first meeting was shortly presented and the proposal was grounded with the facts that the automated system would increase the purchasing departments productivity and that with the reorder point system the purchase orders would be better in line with the real demand from the customer. Also by using push-pull system, where material is pushed to supplier's buffer stock and pulled to the company's own stock, the company's inventory level can be decreased and inventory turnover will increase.

The piloting plan was presented, including the pilot supplier and timing. It was mentioned which production lines the pilot parts belong to and a comment came that the more detailed plan needs to be communicated to the production line managers before the pilot starts. The plan to implement a reorder point system was approved and as a final feedback one of the Production Line Managers called this a good idea that most likely will bring the company good results in productivity and in material turnover.

5.3 Summary of the Total Proposed Improved Material Purchasing Process

In Figure 17 below, the initial proposal for the improved material purchasing process is described. On the left there is the current process and on the right the new proposal. As it can be seen from the Figure 16., the target is to increase buffer stock at the supplier side and reduce the stock at the case company's stock.

In the current process materials are pushed first from supplier's factory to supplier's buffer stock and then pushed from supplier's buffer stock to company's warehouse, and finally pulled to company's factory. In the new process the materials are pushed to supplier's buffer stock and then pulled first to company's warehouse and finally to company's factory. So it will be a push-pull system.

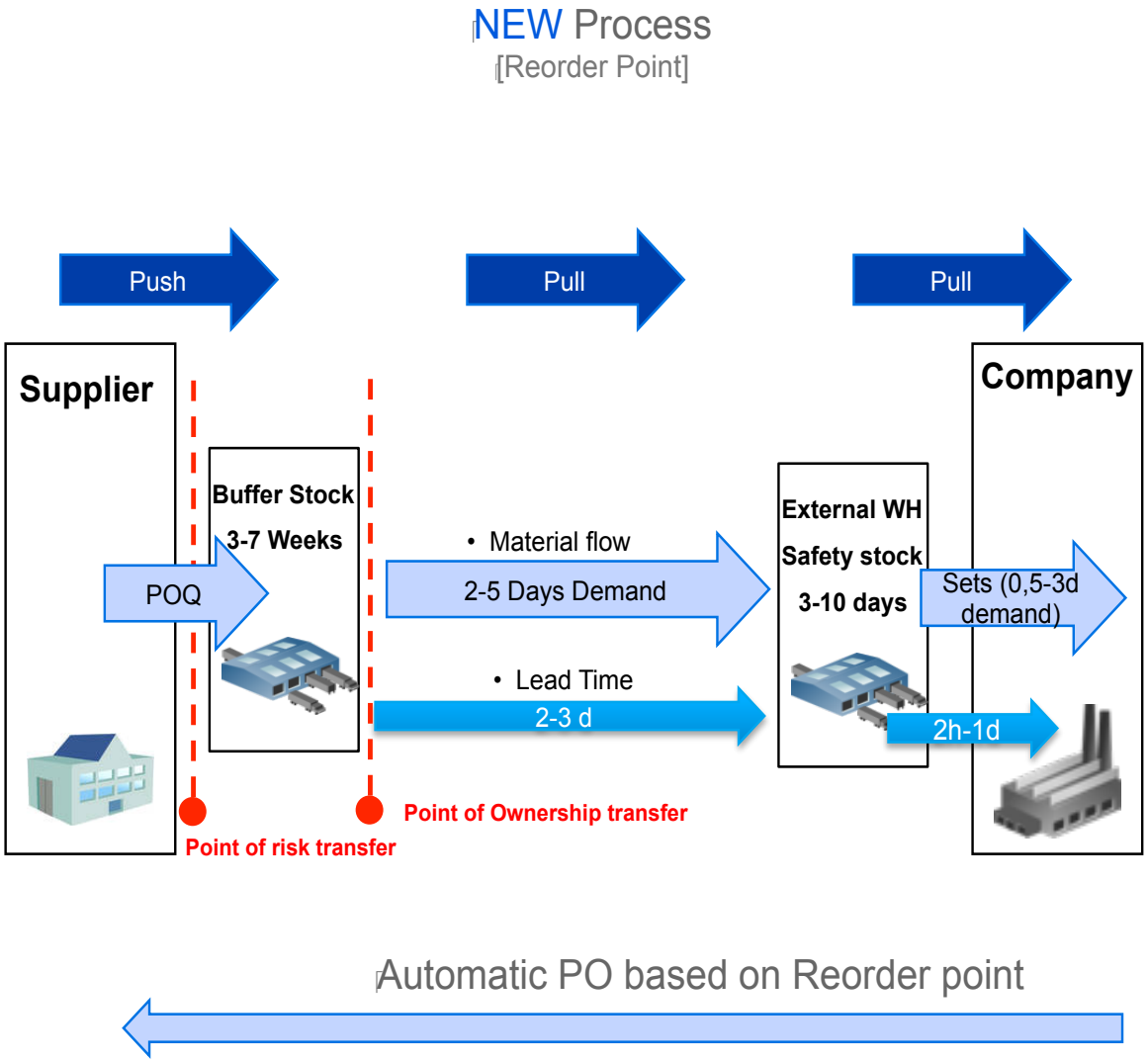


Figure 17. Proposed improved material purchasing process.

In the new process materials are ordered with shorter lead-time from the suppliers and in smaller lots. In the current process the lot sizes are covering often 1-2 week demand. In the new proposal the coverage of an ordered lot would be maximum of one week.

Another important thing is that in the current process purchasers based on SAP MRP do the purchase orders manually and in the new process the purchase orders are done automatically by the system based on specifically defined reorder points. In these ways

the productivity of the material purchasing will increase and the material turnover will be significantly higher.

This section described the proposal building process and the next section is about testing the proposal. Testing is needed to validate the initial proposal and to improve it to make the final proposal.

6 Testing the Improved Material Purchasing Process

In this section the proposed improved material purchasing process is tested. The test is done based on calculations, as the concrete testing will take several weeks. Based in the findings of the test more recommendations are introduced and last, the final proposal is introduced.

6.1 Overview of the Testing Stage

In the first stage the materials to the piloting are identified and their current figures, safety stock level, inventory turnover and lot sizes, are analysed. In the second stage new reorder point levels and order lot sizes are defined and it is analysed how the changes effect to the inventory levels and to material turnover.

In the next stage the finding from the calculations are reviewed. The results form the calculations are discussed together with two stakeholders and based on them, improvement proposals are given and next steps for the testing and implementing the process are defined.

6.2 Findings of the Testing

As it was introduced in Section 5, six parts from one pilot supplier were chosen to the test. The pilot supplier is a Finnish supplier that has done long business with the case company. In the Table 8 below the pilot parts and their current figures are detailed.

Table 8. Pilot parts and their current figures.

Part	Delivery time (days)	Lot size (pcs)	Inventory turnover	Safety stock (pcs)
Part 1.	8	2000	5,75	2362
Part 2.	10	400	4,25	130
Part 3.	9	300	4,75	422
Part 4.	8	780	7,90	646
Part 5.	10	600	2,59	200
Part 6.	10	1000	5,55	1097

The company's target is to have inventory turnover over 10 for short delivery time parts so these pilot parts are good for the testing purposes. The pilot supplier was contacted by email. The new supplier buffer levels, order lot sizes and delivery times were agreed. In the Table 9. below, the new figures for the testing are described.

Table 9. Pilot parts and their new figures for the testing.

Part	Delivery time (days)	Lot size (pcs)	Inventory turnover	Reorder point (pcs)
Part 1.	2	500	32,13	400
Part 2.	2	300	31,99	300
Part 3.	2	80	19,33	50
Part 4.	2	250	22,20	250
Part 5.	2	200	22,49	100
Part 6.	2	150	33,80	150

As it can be seen in Table 9, the figures are significantly lower than in the current process. This is possible because the supplier can push more ready parts to their buffer stock and ship them to the company with only a couple of days delivery time. The changes are more detailed described in the Table 10 below.

Table 10. The relative changes in the new process versus the old process.

Part	Delivery time decreased (%)	Lot size decreased (%)	Inventory turnover increased (%)	Safety stock level decreased (%)
Part 1.	75,0	75,0	558,8	83,1
Part 2.	80,0	25,0	752,7	-230,8
Part 3.	77,8	73,3	407,0	88,2
Part 4.	75,0	67,9	281,0	61,3
Part 5.	80,0	66,7	868,3	50,0
Part 6.	80,0	85,0	608,9	86,3

As it can be recognised in the results in the Table 10, the new process is creating many benefits compared to the current process. The delivery times are significantly shorter and lot sizes are also much smaller. Both of these are enabling the case company to decrease their own safety stock levels and also the maximum stock levels. The new inventory turnovers are remarkably higher in the new process compared to the old one.

There is one part that has a much smaller safety stock level in the current process. It was noticed that that particular part is having a smaller safety stock level that is recommended in the company's risk policy. So it will be adjusted to the same line with the others.

6.3 Recommendations for the Improved Material Purchasing Process Based on the Test Results

The test results were reviewed together with the company's implementation manager and a development engineer. In this chapter their comments related to the calculated results and the process are described. The meeting notes are in Appendix 4.

The first comment from the both participants and the researcher was that especially the inventory turn figures are surprisingly good. It was brought up that some inventory turns might be too high, as some of the parts would have inventory turn over 30. It was still decided to make the pilot with the proposed figures. If there will be a material

shortage in the pilot phase, the reorder points can be quickly and easily adjusted.

It was decided that the next step is to start the concrete testing. Also more items need to be reviewed and analysed if they fit the reorder point system or should the MRP system be still used. Also other categories than mechanics need to be reviewed if this process could be applied for them. The implementation manager's comment was, that on a longer term a process needs to be created to make decisions for each item, which purchasing method to be used.

The implementation manager commented also that an implementation plan needs to be done during next weeks and an estimate of how many items per month is planned to be implemented and what is the estimated decrease in the inventory level per month. To the proposed process there was no recommendations in the meeting. It was found to be sufficient on both the implementation manager's and the development engineer's opinion.

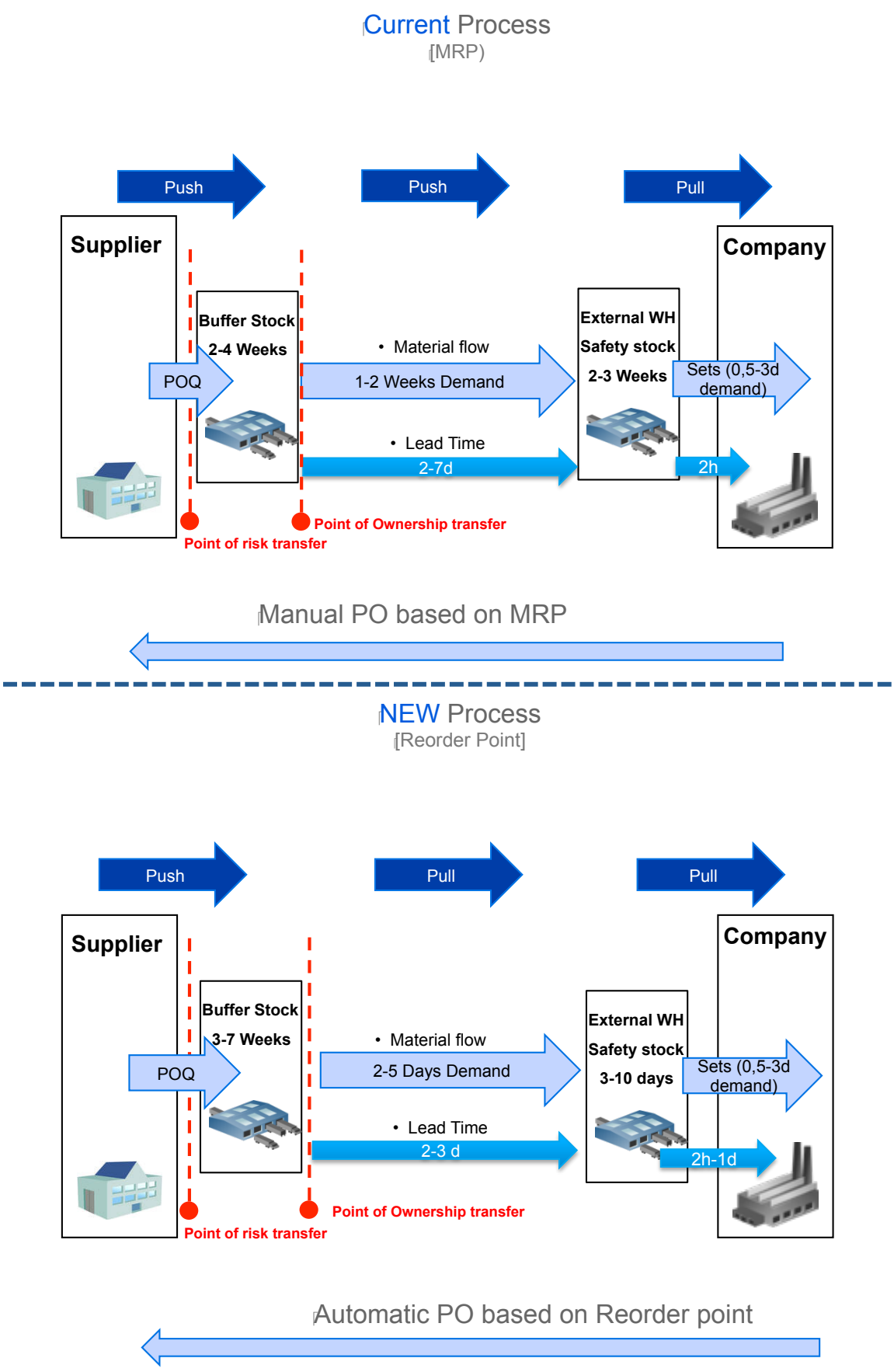


Figure 18. Current process versus the proposed new process.

In Figure 18 above the current process versus the new proposed process is described. The concrete testing possibly brings up development needs for the process.

6.4 Summary of the Improved Material Purchasing Process Versus the Current Process

This section described the testing process in this study and the internal validation that was done in the case company. In the first stage the pilot items for the testing were identified and new figures for lot sizes, reorder points and delivery times were defined. In the next stage calculations were done of the effects of the changes in the figures and they were compared to the current situation. The benefits of the new process compared to the old process are summarized in the Table 11 below.

Table 11. Benefits of the new process and their business effects.

Benefit	Effect
75-80 % shorter lead time	Purchase orders can be done according to the real customer demand just-in-time. Impact of forecast errors is disabled.
> 3 times higher inventory turn	Excess inventory is significantly lower; company money is released to other investments.
Automatic purchase orders	Productivity in purchasing increases. Buyers have more time to do more productive tasks.

The results that the calculations gave are promising. All delivery times and lot sizes are decreasing significantly, safety stock levels are decreasing with one part as an exception. The main focus in the testing was in the inventory turn and that is increasing remarkably based on the calculations. The outcome of the new inventory turns is much higher than the company target.

Table 12. Piloting plan for the new process.

Activity	Participants	Start (calendar week)	Finished (calendar week)
Buffer building at the supplier	Pilot supplier, researcher	21	23
Testing reorder point system in SAP test environment	Development engineer, researcher	21	23
Informing stakeholders of the changes and the schedule	Researcher	21	22
Testing reorder point system in SAP production environment	Researcher, buyer	24	27
Gathering feedback of the testing from stakeholders	Researcher, buyer, development engineer, stakeholders	27	28
Analysing inventory turn and inventory value results	Development engineer, researcher	28	29

A piloting plan was recommended by the implementation manager. The plan is in Table 12 above. The piloting will start by three activities at the same time, buffer building at the supplier, testing the reorder point system in SAP test environment and by informing about the piloting. When the first activities are done the real piloting in the SAP production environment can be done.

Four weeks will be reserved for the concrete piloting. After the piloting there will be feedback gathering and analyzing of the results. After the analysis the process can be improved and larger implementation can be started. The whole piloting will take nine

weeks. The key participants in the piloting are the researcher, development engineer and buyer.

7 Discussion and Conclusions

In this section the summary of the whole thesis is introduced. The summary includes the results of the study and recommendations for next steps.

7.1 Summary

This study describes a process to increase productivity, reduce inventory levels and to increase material turnover in a case company. The case company did not have a sufficiently working pull system in their purchasing, although previously there had been and some employees had brought up that such a system should be taken to use again. It was important to have several stakeholders involved to make the good proposal and the stakeholders supported the study well.

This study was conducted in several stages, starting from the current state analysis. It was done by reviewing the company's internal documentation and by having two workshops with stakeholders and colleagues from purchasing and internal logistics. The result of the current state analysis was a list of strengths and weaknesses of the current state. In the next stage best practice from the literature was studied. The literature was chosen based on the weaknesses identified in the current state analysis and the focus was on process improvement and lean. The result of the stage was a conceptual framework.

Based on the findings from the current state and literature a proposal was built. The proposal was planned in a meeting together with employees from purchasing and a subcontractor, and it was shown to the company's management. The final process was done in a meeting together with the instructor from the company and a person from purchasing.

The result of the study is a process that needs still concrete testing. Based on initial calculations the results are found very positive but there are technical details that need to be checked before the full

implementation. The process is based on reorder point system and automatic purchase orders to suppliers. This enables the company to increase their inventory turnover and reduce the inventory levels, and also to increase productivity in purchasing by automation.

7.2 Immediate Next Steps

The calculations that were done for the new process versus the current process are indicating that the company can gain the benefits that were wanted from the new process. There are still more to study and analyse to realise the benefits. The first step would be the concrete testing of the proposed process.

The automatic purchase orders need to be tested carefully to make sure that all the systems work. Also the inventory turns need to be calculated after some time in the piloting to verify the calculated results. The second step would be to make more analysis of parts that would fit this process and analysing other material categories. The third step would be to make a concrete implementation plan for all the recognised items and last, start to implement the process more widely.

Last, some managerial advices is presented. The pull method presented in this study can help the company to be more efficient and productive but it would be important to study other pull options and purchasing processes. Advanced pull methods such as VMI and consignment stock could be considered. The company has a lot of different kind of parts, which are purchased with different kind of volumes, lead times and prices. Based on these differences the parts need different kind of purchasing processes. Guidelines to make the decisions could be helpful for the purchasing.

7.3 Evaluation

In this phase it is evaluated what was the outcome of the thesis compared to the objective and expected outcome, which were described in section 2.4.

7.3.1 Outcome versus objective

As mentioned in the Section 1 in page 8, the objective of this study is to propose an improved material purchasing process that is based on a pull method. In that perspective the objective has been achieved. Originally a process based on kanban method was considered but in the proposal building stage it was decided that process based on reorder point system fits the company's needs better.

In the new process the materials are ordered based on the real demand, which decreases the effect of errors in forecasting that were identified as a weakness in the Section 3. Based on the calculations done in Section 6, there can be significant benefits of implementing the proposed process in lower inventory levels, higher material turnover and shorter lead times from suppliers. Another benefit comes from the automatic orders, which can increase the productivity of the purchasing unit.

The process needs to be tested carefully before full implementation, as there are risks in system failures. Originally it was planned that this study would include also the concrete testing but it was recognised that the testing takes several weeks, which went over the time limits and only piloting plan was done. There is also a risk with the lower stock levels, which means that the suppliers need to be reliable with their delivery accuracy and product quality. A purchasing process that is operating with low stock levels will bring up that kind of problems immediately so the company may need to put more resources in the problem solving.

7.3.2 Reliability and validity of the study

In Section 2.4 it was discussed that stakeholders proof the validity of the study. The reliability is recognised by testing the proposal and by gathering input from several stakeholders and several sources from the literature. The validity was first achieved by having two

workshops with relevant stakeholders and by reviewing the company's internal documentation in the Section 3.

In the second phase the validity was achieved by finding best practices from literature by focusing on process improvement and lean. Different sources related to lean were widely introduced but the process management phase was not taken to a large focus.

The reliability of this study was achieved by having structured workshops and meetings with stakeholders. In the workshops and meetings all ideas, problems and possibilities were noted. The best practices found from the literature are supporting the final proposal well. The weakness of the study is that the proposal could not be tested properly but the calculations done in the Section 6 are reliable and can be considered as a sufficient validation.

7.4 Closing words

Purchasing is a key function in industrial companies order-delivery process. By improving purchasing processes to more efficient level, companies can operate with lower inventories and be more agile towards their customers. In a nutshell, companies can be better than their competitors in highly competitive global markets.

How to improve the purchasing processes depends on the business environment where the company is operating. The processes can be improved by automation and by different kind of purchasing methods, such as kanbans and reorder point system described in this study.

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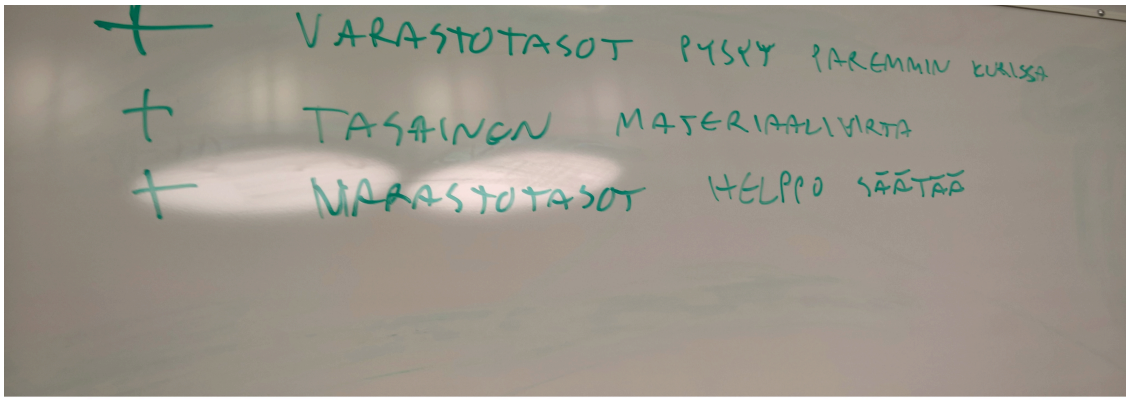
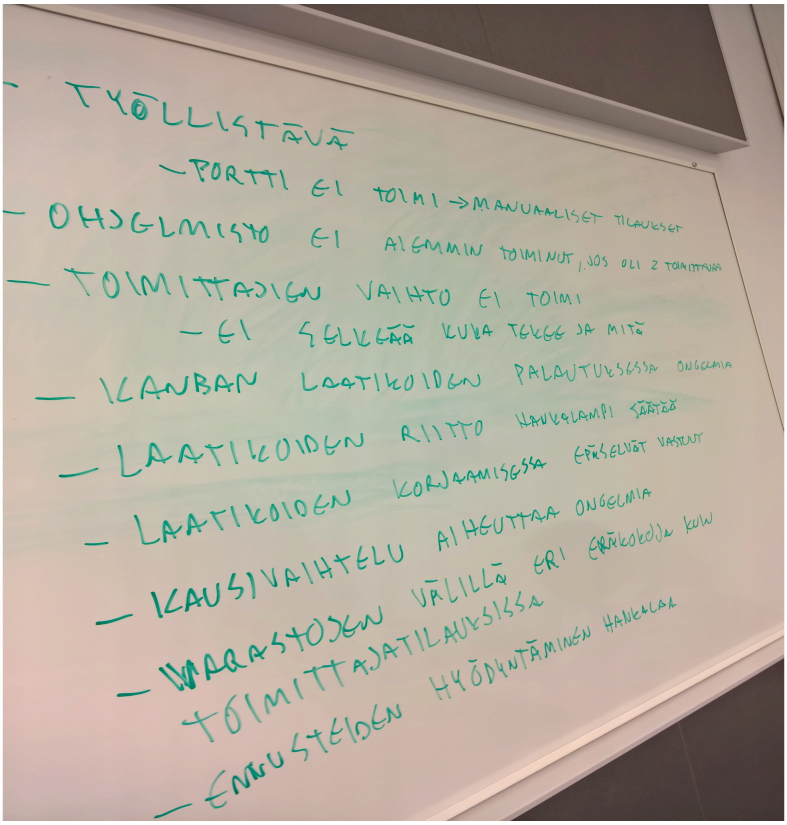
Appendix 1

Strengths and weaknesses identified in Workshops

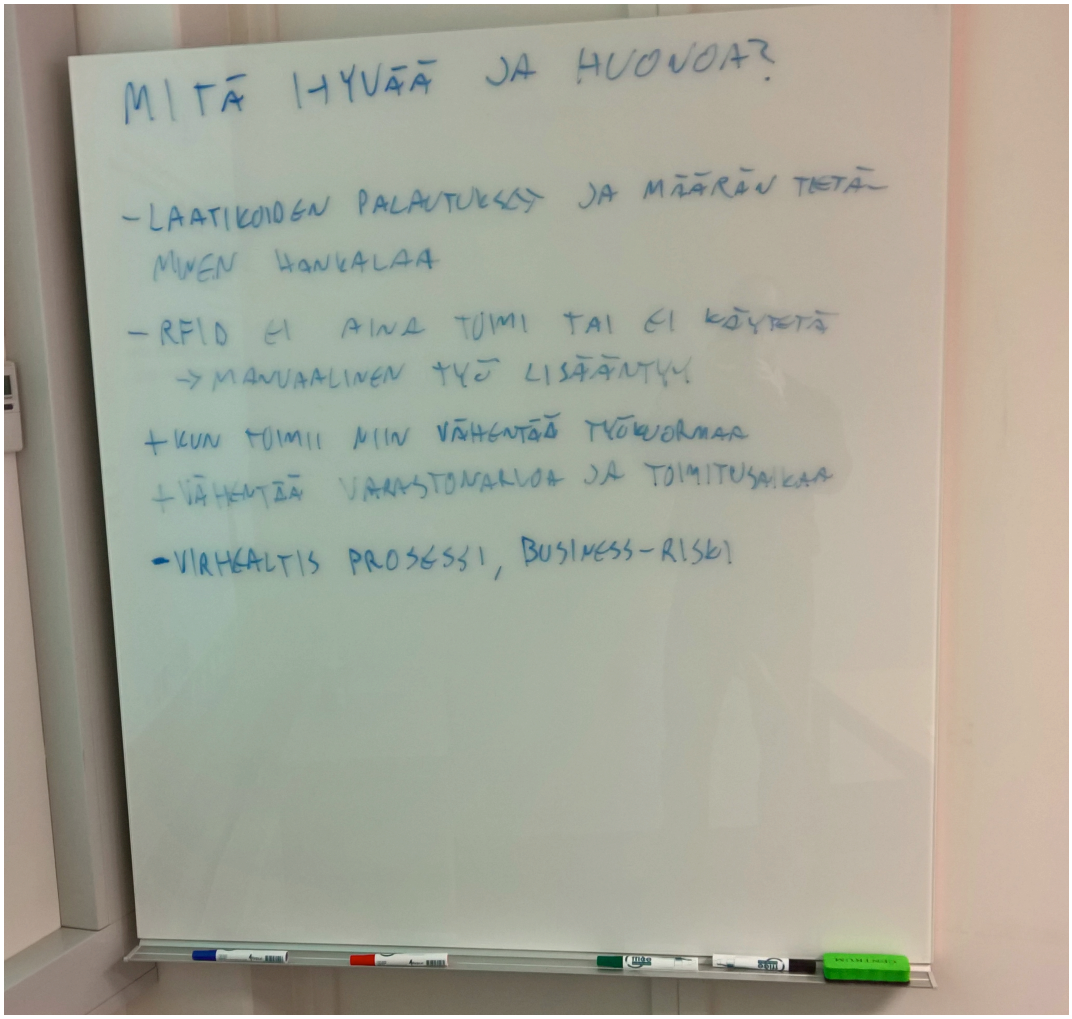
Strengths identified in Workshop 1.



Weaknesses identified in Workshop 1



Strengths and weaknesses identified in Workshop 2.



Appendix 2

Meeting notes from the meeting 1 for Data collection 2.

Date and Duration: 14.4.2016, 1 hour
Participants:
The case company: Researcher, Buyer, Development Engineer
Subcontractor: Operations Manager, Development Manager

Topic of the meeting: Kanban/Pull methods to external warehouse

Notes:

- How could Kanban be implemented to external warehouse? Case company proposal is to add barcodes to active storage places and create PO's to suppliers when a pallet goes empty automatically by using the barcode
    - Subcontractors comment was that in that kind of process there is too big risk for a human error, someone easily forgets to use the barcode and no PO will be sent
    - Subcontractors proposal was to use case company's SAP and to put same minimum levels and lot sizes to the subcontractors system
    - Idea came from the Development Engineer to use Reorder point system and activate automatic PO's from the system for those parts
- A risk was identified with internal material movements, which at the moment are not aligned with the purchased lot sizes. This needs to be taken to consideration before the piloting.
- It was decided that the case company defines the parts, lot sizes and the reorder points.
- It was decided that the piloting will be started with one local supplier from the mechanics category. Six parts that fit the criteria were identified for the piloting.
- It needs to be checked how the automatic POs can be taken to use in SAP.
- Target is to start the piloting in the beginning of May.

Meeting notes from the meeting 2 for Data collection 2.

Date and duration: 20.4.2016, 30 minutes
Participants: Implementation Manager, SCM Manager, Purchasing Manager, Production Line Manager 1, Production Line Manager 2, Production Line Manager 3, Inventory Manager, Team Leader Planning and Inventory Management

Topic of the meeting: Follow up of the progress of the project

Notes:

- The researcher presented what had been done during last weeks. The meeting with the subcontractors and the proposal what came up there.
- To the meeting participants it was proposed that a Reorder point system would be implemented and automatic PO's would be used.
- The piloting plan was introduced with the pilot supplier and which production lines the pilot parts are affecting.
- The proposal got an initial approval for the participants and researcher got a permission to proceed with the piloting.
    - It was noted that before the piloting starts the more detailed plan, including the timing and minimum levels need to be informed to the relevant production line managers.
- Overall feedback was that the idea is good and should bring the case company wanted results.

Appendix 3

Parts used to calculate the current inventory turnover

Part	3 month usage	1-3 month forecast	4-6 month forecast	Current delivery time	Current ITO
1	9 556	3 092	0	10	0,81
2	3 516	1 578	1 110	14	1,32
3	2 176	1 172	1 238	10	1,39
4	308	622	449	10	2,41
5	1 122	528	454	10	2,59
6	367	731	511	10	2,63
7	510	781	803	8	2,63
8	354	1 462	429	8	2,78
9	1 486	3 173	2 362	8	3,02
10	718	880	887	10	3,29
11	21 029	24 239	24 112	10	3,61
12	912	1 345	784	10	3,62
13	522	1 096	955	10	3,83
14	305	846	829	10	4,13
15	702	891	497	10	4,23
16	9 267	8 442	7 005	9	4,24
17	2 616	3 599	4 484	10	4,25
18	712	897	502	9	4,35
19	2 238	2 317	1 402	10	4,63
20	9 281	8 879	7 171	9	4,64
21	1 769	1 253	1 222	9	4,69
22	490	820	763	9	4,75
23	3 268	4 997	4 067	4	4,9
24	144	616	397	8	5,2
25	1 696	2 286	2 095	10	5,55
26	322	623	567	10	5,56
27	5 138	5 449	3 909	8	5,75
28	357	1 132	900	10	5,81
29	4 902	4 385	3 318	10	6,12
30	2 251	1 003	766	9	6,18
31	317	503	403	10	6,25
32	2 969	2 396	1 195	8	7,34
33	295	540	412	10	7,5
34	3 102	2 049	1 326	9	7,59
35	1 390	2 228	1 849	9	7,76
36	3 050	2 666	1 676	9	7,78
37	2 471	1 598	693	8	7,9
38	3 526	5 687	5 930	10	8,15
39	1 304	2 084	1 350	10	8,36
40	3 948	4 463	3 797	10	8,73
41	1 758	2 910	2 971	10	8,87
42	1 283	2 173	2 488	10	9,05
43	2 597	1 662	1 186	9	9,36
44	1 520	2 580	1 940	10	9,76
45	1 346	1 503	1 264	10	11,73

Appendix 4

Meeting notes of the meeting for Data collection 3.

Date and duration: 13.5.2016, 45 minutes
Participants: Implementation Manager and Development Engineer

Topic of the meeting: Reorder point calculation review

- Technically we should use reorder point parameters in SAP, not the normal safety parameters
- Next action is making the concrete testing
- Implementation plan needs to be done during next weeks
    - Amount of parts per month
    - The change in inventory value per month
- Different ordering methods should be analysed, which parts are suitable for reorder point, which are suitable for MRP, which are suitable for something else
    - Based on volume
    - Based on price
    - Based on delivery time
    - Based on criticality
    - Based on fluctuation
    - Etc.
- Other categories than mechanics need to be reviewed also, there will be parts suitable for this process
- A process should be created, how to decide which ordering method to use