Lappeenranta University of Technology
Industrial Engineering and Management

Master`s Thesis

VSM FOR PHASE OUT PROCESS

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ABSTRACT

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This thesis was done for the company which operates tightly competed market and where cost efficiency is necessity in all functions. Company`s phase out process was improved by using value stream mapping (VSM) in this thesis. Phase out process is used to remove old product from production when new substitutive product is ready for volume production. Inefficient phase out leads a long production overlap time of old and new product which is very expensive. Other target for this thesis was to gain experiences how to use VSM in improvement of administrative process.

The first step in this thesis was to familiarize with lean theory, waste identification, execution of VSM and phase out process. Based on this literature review VSM was done for phase out process and possible improvement possibilities were identified.

Influences of identified improvement possibilities were estimated from time and cost point of view. Results of this thesis showed that production overlap time can be shortened significantly and remarkable financial saving can be achieved. This thesis provided also valuable experiences how to use VSM in improvement of administrative process.

TIIVISTELMÄ

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Hakusanat: Lean, lean työkalut, arvo, arvovirta, arvovirtakuvaus, hukka, asiantuntijaprosessi

Tämä työ tehtiin yritykseen, joka toimii todella vahvasti kilpailluilla markkinoilla ja tästä syystä kustannustehokkuus on välttämättömyys kaikissa toiminnoissa. Työssä parannettiin yrityksen phase out prosessia, jota käytetään poistamaan vanha tuote tuotannosta uuden korvaavan tuotteen tieltä. Hidas vanhan tuotteen alasajo johtaa pitkään uuden ja vanhan tuotteen päällekkäiseen tuotantoon mikä aiheuttaa huomattavia kustannuksia yritykselle. Työn avulla tutkittiin myös asiantuntijaorganisaatioiden prosessien kehitystä arvovirtakuvauksen avulla.

Työssä tutustuttiin aluksi lean teoriaan, hukan tunnistamiseen, arvovirtakuvauksen tekemiseen sekä kehittämiskohteena olevaan prosessiin. Tämän pohjalta suoritettiin arvovirtakuvaus phase out prosessille ja tunnistettiin prosessin kehittämiskohteet.

Tehtyjen löydösten korjaamisen vaikutuksia arvioitiin sekä ajallisesti että rahallisesti. Tehtyjen löydösten korjaamisella voidaan lyhentää uuden ja vanhan tuotteen päällekkäistä tuotantoaikaa huomattavasti ja saavuttaa todella merkittäviä rahallisia säästöjä. Työ antoi myös arvokasta kokemusta arvovirtakuvauksen käyttämisestä asiantuntijaorganisaatioiden prosessien kehittämishankkeissa.

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Pekka Ristikaarto
Oulu, 30.9.2016.

TABLE OF CONTENT

APPENDIXES

APPENDIX 1/2 Photograph of current state map

APPENDIX 2/2 Current state map in electronic format

FIGURE LIST

ABBREVIATIONS

BAT	Business Approval Tool
CT	Customer Team
DCM	Delivery Capability Manager
EMS	Electronic Manufacturing Service
EoL	End of Life
E/O	Excess / Obsolescence
GPR	Global Procurement
GSM	Global System for Mobile
HW	Hardware
HWS	Hardware Service
IP	Internet Protocol
JIT	Just in Time
NET	Networks
NMT	Nordic Mobile Telephone
MN	Mobile Networks
NNVA	Necessary but Non-Value Adding
NPD	New Product Development
NSN	Nokia Siemens Networks
NVA	Non-Value Adding
PCPP	Plan & Collaboration Products
PiPo	Phase in - Phase out
PLM	Product Line Management
R&D	Research and Development
SC&PE	Supply Chain & Procurement Engineering
SCM	Supply Chain Management
SOP	Sales and Operations Planning
SW	Software
TPM	Total Productive Maintenance

TPS	Toyota Production System
TQM	Total Quality Management
VA	Value Adding
VSM	Value Stream Mapping

1 INTRODUCTION

1.1 Background

Competition in telecommunication business is very tight nowadays. Telecommunication companies are compelled to seek opportunities to reduce all cost to manage the challenging situation on market. Companies must develop and improve their operations as efficient as possible and try to get more results with less resources. Companies which are able to exploit their resources effectively can response to the challenging market situation and have also possibility to survive in the future.

Companies' supply chain and its processes are essential elements to be efficient in market. It is not enough that manufacturing processes are designed as efficient as possible, also non-manufacturing processes must be taken into account in development activities. Lean philosophy has been used for a long time for improving manufacturing processes but nowadays lean principles are applied more and more in office environment as well. Lean philosophy and tools are very effective way to get better process flow and performance also in office environment.

Nokia is not exception in telecommunication business. Challenging market situation has forced Nokia as well to seek opportunities to enhance a function of supply chain. Because of these challenges Nokia has started to apply a continuous improvement culture and lean principles also in office environment to get better process performance and productivity.

1.2 Research problem and scope

Non-manufacturing processes are usually called as administrative, engineering or office processes. Administrative process term is used in this thesis. Phase out process

is a typical administrative process in Nokia Mobile Networks used to remove an old product from production when a new substitutive product is ready for volume production and customer deliveries. New product development (NPD) must be very quick that company can compete and survive in market. Nokia focus has been heavily in the NPD activities to get new products to customer deliveries as soon as possible. Because of this phase out of older product has been in a minor role in phase in – phase out (PiPo) process and therefore phase out process has been slow which extends a production overlap time of old and new product. Production overlap time is critical because it causes a lot of cost and therefore it should be as short as possible. Nokia has set a tight target to shorten production overlap time significantly and this was a trigger for this thesis.

The main purpose of this thesis was to analyze phase out process by value stream mapping (VSM) to find out improvement possibilities to get production overlap time shorter. VSM is a lean tool used for process improvement to identify process performance related issues. The purpose was also to get experiences how the VSM should be used in improvement of administrative processes. Research question of this thesis are presented below:

1. How to use VSM to analyze and improve administrative processes?
2. How to execute VSM for phase out process to get production overlap time shorter?
3. What are the improvement possibilities found by VSM and how suitable tool it was for process improvement?

This thesis focused on phase out process activities even though phase in process affects the production overlap time as well. Phase in and phase out processes have many links between each other so phase in process cannot be totally ruled out from this study. Also implementation and follow up of corrective action for findings made by VSM were ruled out from scope of this thesis.

1.3 Structure of report

This report consist of three parts. The first part is theoretical review of literature which gives an introduction how to use lean principles and VSM in improvement activities of administrative processes. The purpose of the first part is to give an answer to the first research question. The second part of report introduces a study environment including company and phase out process presentations. It also introduces how the VSM was used for improvement of phase out process in this thesis. The purpose of this part is to give an answer to the second research question. The third part of report presents the results of this thesis. Also applicability of VSM for administrative process improvement activities was considered and recommendation for further VSMs were given. The purpose of the third part is to answer to the third research question.

2 LITERATURE REVIEW

This chapter presents a theoretical background of thesis which is needed to understand how to analyze and improve administrative process by VSM. The aim of this chapter is to give an answer to the research question 1: How to use VSM to analyze and improve administrative processes?

2.1 Lean philosophy

The first steps of lean philosophy were taken in Japan in the 1940s when Toyota Production System (TPS) recognized that only a small part of process time and effort produced value to customers. Toyota started to develop their production so that it was run as a continuous way and focus was on producing value to customers. In Western countries the focus was heavily in mass production principles developed by Henry Ford in the early 1900s. (Melton 2005, 662)

A book *The Machine that Changed the World* (Womack et al., 1990) first time compared Japanese production methods to traditional Western side mass production methods and brought out the superior performance of Japanese methods. The lean principles were the first time summarized in a book *Lean Thinking: Banish Waste and Create Wealth in your Organization* (Womack and Jones, 1996) which also launched a phrase lean production and therefore the book is an important step in the lean history. (Melton 2005, 662)

Lean philosophy is a systematic method to identify and eliminate waste from process. Waist is anything that is not necessary to produce product or service to customers. With lean principles organizations can achieve many benefits in their activities. Some of the typical benefits of the lean philosophy are listed below. (Melton 2005, 663; Pojasec 2003, 1)

- Less process waste
- Reduced lead-times
- Less rework
- Financial savings
- Increased process understanding
- Reduced inventory

Although the background of lean thinking is in Japanese automotive industry it has been applied world-wide in all business sectors. Keyte and Locher have presented in their book *"The Complete Lean Enterprise"* how to apply lean methods in office environment successfully. Many people are often surprised that lean principles and methods developed for manufacturing processes can be applied also to administrative processes. The challenge in office environment is usually to find out a creative way to use methods so that wanted benefits can be achieved. (Keyte & Locher 2004, 1)

An essential element of lean thinking is customer and value which is produced to customer. Both manufacturing and administrative processes are used to deliver value to customers which can be internal or external. Lean thinking consists of five main principles which are fundamental when organization is implementing the lean. These main principles are: (Hines & Taylor 2000, 4; Piercy & Morgan 1997, 683-684; Silva 2011, 40-41)

1. Define what does and what does not create value from customer point of view.
2. Identify whole value stream including all activities which are needed to produce product or service to customer to find out non-value adding waste.
3. Organize value creating activities around flow to remove all waiting.
4. Response only what is pulled by customer to eliminate stocks.
5. Pursuit of the perfection.

Lean philosophy includes many tools and techniques. Value defined by customers is the most important point in lean philosophy and hence tools and techniques are developed to identify and eliminate waste which does not add value. With the lean tools and techniques organizations can reduce cost and increase productivity. The lean tools are normally used as a package supporting each other. Commonly used lean tools are presented below excluding VSM which is presented more precisely in the chapters 2.4 and 2.5. (Amit B. Dutta & Sneha Banerjee 2014, 31; Pojasec 2003, 2-3; Abdulmalek & Rajgopal 2007, 224)

- *5S:* Effective tool for continuous improvements. 5S includes five activities for creating workplace suited for visual control and lean practices. The 5S technique is named after five activity which begin with the letter "S" in Japanese. These five activities are Sort (Seiri), Straighten (Seiton), Sweep and Clean (Seiso), Systemize (Seiketsu), and Standardize (Shitsuke).
- *Just-in-time Production (JIT):* Based on pull production where customer demand is transmitted backwards through the whole production process. The main idea of JIT is that the right part is in the right place at the right time and hence to eliminate sources of waste in manufacturing process.
- *Total Productive Maintenance (TPM):* Optimize effectiveness of manufacturing equipment by changing the focus from fixing broken equipment to prevent the breakage.
- *Kaizen:* Japanese term which basically means continues improvement. The main aim is to produce more value with less wastes to achieve more stable process and better working environment. Must be applied though all organization levels from managers to workers.
- *Kanban:* Japanese word Kanban is a signboard in English and it is a scheduling system for JIT production. It makes concept of pull production "visual" and means that work centers do not make anything before request from the next work center.

- *Six Sigma:* Data driven methodology which is used to enhance product quality by improving processes. Six sigma statistically analyze and measure how processes are performing.
- *The 5 why:* Helps to identify the root cause by asking five times why and peeling off layers of symptoms over the root cause. Although name is 5 why it does not mean that exactly five times why need to be asked, it could be more or less as well.
- *Poka Yoke:* Aim is to make mistake-proof system to remove all mistakes which could cause issues for processes.
- *Total quality management (TQM):* TQM is management approach to customer satisfaction and long-term success. All company`s organizations participate and commit process, product, service and culture improvements in TQM.

2.2 Value and value stream

Value identification and definition of value propositions for customers is an essential point when going lean. Value is basically features and functions of product or service which meet or exceed customers' expectations and therefore customer is willing to pay for it. Value can be seen as a customer satisfaction and therefore the key issue is to identify and understand what creates value to customers. Different customers can value different things and this may cause challenges for value identification. Identification and understanding of value defined by customers is critical because it basically determine how company can success in market. (Gericke et al. 2015, 14; Kennedy & Huntzinger 2005, 32; Silva 2011, 38)

Value stream includes all activities that company must do to create value to customers. It starts from customer needs and ends to satisfy these needs. Value stream consists of activities which are needed to transform customer needs to product or service which finally satisfy these needs. It includes value adding activities as well as non-value adding activities. These activities are related to flow of materials and information

through the whole supply chain. (Melton 2005, 665; Kennedy & Huntzinger 2005, 33; Silva 2011, 38)

Value stream is different in manufacturing and administrative processes. The value stream consist of materials, parts and information in manufacturing processes but usually only information and knowledge are flowing in the value stream of administrative processes. Value stream is usually cross functional as well as cross organizational. A simple value stream is described in the figure 1. (Melton 2005, 665; Kennedy & Huntzinger 2005, 33; Lohcer 2008, 18-19)

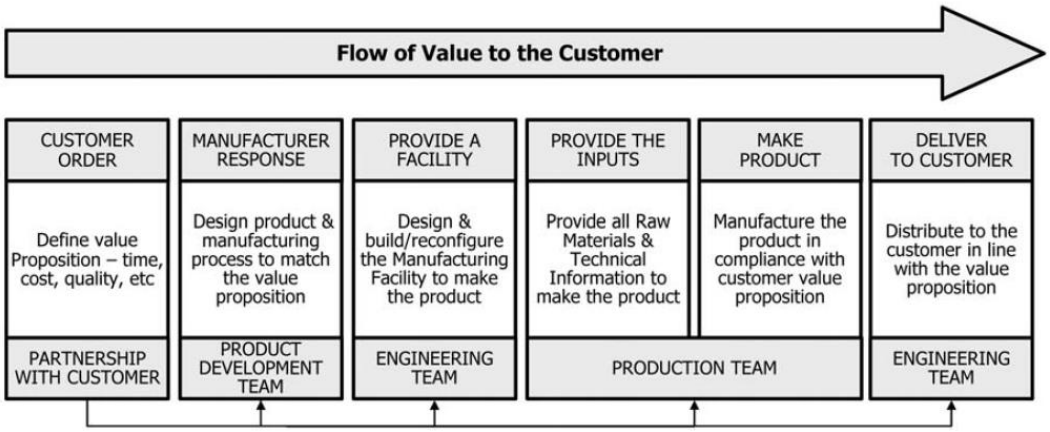


Figure 1. Typical value stream (Melton 2005, s.667)

2.3 Typical wastes

Waste can be defined as a non-value adding activity in value stream of processes, in other words activities which do not provide value to customer and therefore should be removed. Waste is basically all activities which only increase cost without providing value. Non-value adding activity is not always just a waste because it could also be necessary for some other activity which is value adding to customers. (Chiarini 2013, 15; Oppenheim 2004, 355-357)

The aim of lean philosophy is to create successful and profitable value streams by identifying and eliminating waste from every processes of organization. Waste can be found from manufacturing processes as well as administrative processes. In traditional manufacturing companies the most important waste can usually be found from production process but it is very important to understand that the root cause of waste can also be in administrative processes. (Chiarini 2013, 15; Oppenheim 2004, 355-357)

The seven type of wastes presented by Toyota are doubtless the most famous and widely used classification of wastes in lean thinking. The seven type of wastes are presented in the figure 2. These were originally developed in TPS by Ohno (1988) and also later reported by Womack and Jones (1997). The roots of the seven wastes are in manufacturing processes but nevertheless these can be applied for administrative processes as well. Addition to the Toyota`s seven type of waste underutilization of people as an eight waste also occurs in some sources. It is also presented in this chapter. (Oehmen & Rebentisch 2010, 7; Chiarini 2013, 19)

Many wastes have complex relationships between each other forming the very complex causal network. This means that one waste can easily be a trigger for other types of waste. For example overproduction of information normally increases waiting times because processing times increase and this will easily lead to accumulation of information as well. (Oehmen & Rebentisch 2010, 9-10)

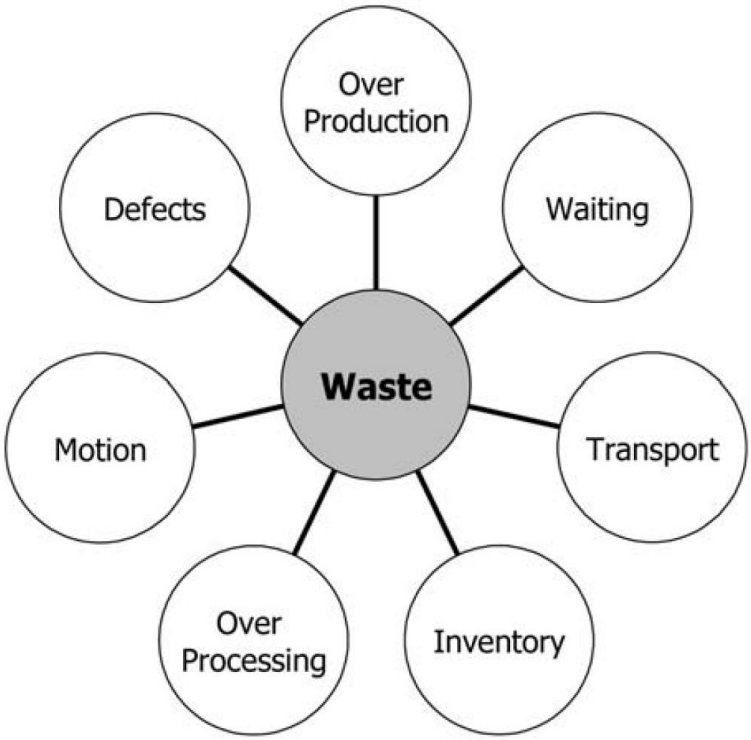


Figure 2. Seven type of waste (Melton 2005, 665)

2.3.1 Overproduction

Overproduction is usually a big problem in manufacturing as well as in administrative processes. In manufacturing processes it basically means that more products are produced than needed or producing products too fast or soon, in other word producing without clear customer order. Overproduction increases inventories and waiting times in processes. It also disturb a smooth flow of production process and weaken quality and productivity. (Chiarini 2013, 20-21; Hines & Rich 1997, 47-48)

Problem in administrative processes is overproduction of information instead of products or parts. Otherwise same principles are pretty much valid for administrative processes as well. Overproduction of information occurs usually subsequent steps. At the beginning either excessive or unnecessary information is delivered or information is delivered out of sync and hence it cannot be exploited. Also unnecessary details and

too high accuracy of information or over-dissemination are typical examples of overproduction in administrative processes. (Oehmen & Rebentisch 2010, 11; McManus 2005, 58)

Unnecessary information means process outputs which are not needed at all and must be separated from needed information. Unnecessary information is usually result of duplicate work or creating unnecessary deliverables. Out of sync information means that information cannot be exploited immediately when received. Out of sync information is usually result of delivering excess information or delivering information too early. (Oehmen & Rebentisch 2010, 11-12)

2.3.2 Waiting

Waiting is very common and many times also the most accepted waste in processes. Waiting concerns both workers and machines in manufacturing processes. It means a time when products are not moving or under processing and because of this products, workers and machines are just waiting. An idle time of products, workers or machines does not provide any value to customer. Usually waiting in one process step generates delays and waiting in the next step as well. Waiting causes poor process flow and longer lead times. (Chiarini 2013, 29; Hines & Taylor 2000, 9; Hines & Rich 1997, 48)

Waiting in administrative processes usually means that some person is idle because information needed to perform some activity is not available and hence value is not flowing in value stream. It is also possible that information is waiting for person in cases where it is provided too early. (Oehmen & Rebentisch 2010, 21; McManus 2005, 58)

There are normally two different kind of waiting in administrative processes which are scheduled and unscheduled waiting. Scheduled waiting means that waiting happens expectedly so people, information or resources are planned to stay idle for some time.

Unscheduled waiting means that waiting happens unexpectedly. Reasons behind the unscheduled waiting are normally neglect or inappropriate schedules and plans, different kind of unexpected changes, poor performance or other wastes. (Oehmen & Rebentisch 2010, 21-22; McManus 2005, 58)

2.3.3 Transportation

Transportation is excessive movement of people, information or products which waste time, causes cost and rises a risk of damage. It usually means movement of products from one location to other in manufacturing processes, normally from warehouse to manufacturing process. When product is in transit it cannot be processed and therefore transportation is not value adding activity. Transportation cannot usually be removed totally from manufacturing processes but it must always be minimized. (Chiarini 2013, 26; Hines & Rich 1997, 48)

From administrative process point of view transportation and excess motion can be seen almost as a same thing and it is not easy to differentiate these from each other. Extra movements in administrative processes are presented and covered in chapter 2.3.6 Motion.

2.3.4 Inventory

Inventory means stored raw materials, semi-finished products or finished products for some certain period of time in manufacturing processes. Usually excess inventory is linked to overproduction. Excess inventory does not add value at all and should always be totally removed or at least minimized. Stored materials and products need valuable floor space and also hide problems. It also tend to increase lead times, damaged goods and transportations. (Chiarini 2013, 21; Hines & Rich 1997, 48)

In office environment inventory normally consist of information. It occurs between process steps when one step is finished and information is waiting for the next step where processing continues. This is a clear indicator that process is not well synchronized and value stream is not fluent. Reasons behind the excess inventory is often overproduction of information because of poor understanding of actual needs. Also multiple sources of information tend to increase inventories. Excess information inventory increases a risk of obsolescence and hence increases needs for corrective actions. (Oehmen & Rebentisch 2010, 16; McManus 2005, 58)

2.3.5 Overprocessing

Overprocessing should not be mixed with overproduction. Overproduction means that production process produces goods more than needed. Overprocessing refers to excess activity in manufacturing processes which is not necessary needed or not request by customer and therefore it is not value adding. Common examples of overprocessing are rework, extra inspection and rechecks. Overprocessing is linked to other wastes as well, for example overproduction increases inventory which increases a risks of damaged goods and damaged goods need to be inspected and reworked. (Chiarini 2013, 27; Hines & Rich 1997, 48; Melton 2005, 666)

Overprocessing or inappropriate processing means excess steps in administrative processes, in other words information is processed more that really needed. It can be divided into four different categories which are overengineering, data conversion, reinvention and processing of defective information. These typically are too tight excess iterations, unnecessary data conversions, excess verifications and too many approvals. Sometimes it could be challenging to define what is overprocessing and what is not in administrative processes. (Oehmen & Rebentisch 2010, 12-13; McManus 2005, 58)

2.3.6 Motion

Motion means unnecessary movements of workers to get work finished in manufacturing processes which waste time and effort. Typically this relates to ergonomics of work place where worker must search, stretch, bend and pick up that needed process step can be done. These kind of waste must be totally removed because it spends workers effort and decrease productivity and many time also increase quality defects. Often the reason behind excess motion is disorder in workplace or poor layout design in production line. (Chiarini 2013, 23; Hines & Rich 1997, 48)

Motion can been seen as an unnecessary movement of people in office environment. Basically it is a motion of person to get needed information to perform needed tasks. Also handling of information by multiple people before it finally arrives to person who really need it is typical example of unnecessary movements. Unnecessary movement is normally caused by poor information systems, insufficient use of information systems, tools and equipment or separate location of persons which make cooperation complicated. When person is in transit to get needed information or information is handled by multiple persons without results it just waste time and effort and does not provide any value. (Oehmen & Rebentisch 2010, 22; McManus 2005, 58)

2.3.7 Defects

Defect are errors in manufacturing or administrative processes which require extra work and hence cause direct cost for organization. Typical extra works caused by defects are repairing, extra inspections and scrapping. In many organizations total cost of defects is very big part of total manufacturing cost. Defects can also lead to poor delivery performance because of missed or late deliveries. Reasons behind the defects are usually errors in reports and specifications, human errors or misunderstandings. (Oehmen & Rebentisch 2010, 18-19; McManus 2005, 48, Melton 2005, 666)

2.3.8 Underutilization of people

Underutilization of people is increasing in business world nowadays and therefore it is also listed in this chapter addition to Toyota`s seven waste. It means improper utilization of competence of people who are working in organization. Typical examples are selecting an overqualified person to perform very simple tasks or give training to people but then not exploit that new competence at all. Underutilization of people can affect detrimentally to organization and a lot off valuable suggestions, improvements ideas and knowledge can be lost. So managers should place talent people for the right position in processes and take input from them to maximize utilization of talents and make more with less. Underutilization of people decreases an engagement of people as well as decreases productivity of organization. (Benson & Kulkarni 2011, 5)

2.4 Value stream mapping tools

To understand different value streams in organizations and make business more profitable mapping of processes is needed. Value adding processes make organization`s products and services more valuable to customer and therefore it improves profitability of whole company. (Hines & Rich 1997, 46)

There are several different kind of tools available for process mapping to understand value and value streams. Hines and Rick have presented the tool box for process mapping in their article "*The seven value stream mapping tools*" in 1997. The tool box consist of seven different mapping tools which can be used one by one or as a combination. These seven tools have a correlation with the Toyota`s seven waste presented in chapter 2.3. Correlations and usefulness of the seven tools for different kind of waste identification are presented in the figure 3 which helps to choose the most appropriate tool for process mapping needs. (Hines & Rich 1997, 49-50)

Wastes/structure	Mapping tool: Process activity mapping	Supply chain response matrix	Production variety funnel	Quality filter mapping	Demand amplification mapping	Decision point analysis	Physical structure (a) volume (b) value
Overproduction	L	M		L	M	M	
Waiting	H	H	L		M	M	
Transport	H						L
Inappropriate processing	H		M	L		L	
Unnecessary inventory	M	H	M		H	M	L
Unnecessary motion	H	L					
Defects	L			H			
Overall structure	L	L	M	L	H	M	H

Notes: H = High correlation and usefulness
M = Medium correlation and usefulness
L = Low correlation and usefulness

Figure 3. Correlations between mapping tools and wastes (Hines & Rich 1997, 50)

2.4.1 Process activity mapping

Process activity mapping is the most common tool used for process mapping and it is known by many names. Its roots are in industrial engineering and it is widely used in different areas of supply chain. It is used to eliminate wastes and inconsistencies from processes to make possible to produce high quality products and services effectively to customers. (Hines & Rich 1997, 51; Pude et al. 2012, 7)

Process activity mapping consists of different steps. At first process flow is studied to identify materials and information which are flowing in process. After process study waste identification is done to find out is there any process rearrangement possibilities to achieve better process flow and performance. Also necessity of different process steps are studied to understand are all steps really needed or is there something which can be totally removed from process flow. The purpose of this approach is to identify and eliminate unnecessary activities, simplify and combine activities and seek

rearrangements which reduce waste and therefore enhance performance of process. (Hines & Rich 1997, 51)

2.4.2 Supply chain response matrix

Supply chain response matrix is widely used in different industries and it especially helps to avoid unnecessary inventories. It is also known by many different names like for example time-based process mapping. Time is the most important factor in supply chain response matrix and the focus of tool is in cumulative inventory time and lead time. The total response time is got as a sum of these times. When consist of total response time is understood in organizations they can target improvement activities for individual lead times and inventory amounts to get better process performance. (Hines & Rich 1997, 51-52)

2.4.3 Production variety funnel

Production variety funnel is a visual mapping technique which has similarities with IVAT analysis. The aim of technique is to map a number of product variants at the different production process points. It helps mapper to understand how well supply chain or company works and it also helps to plan where the most logical point for buffer is in production process. The purpose of production variety funnel technique is also to generate questions about the reasons for product variants and question is the whole variety really needed. With the production variety funnel organizations can optimize inventories and reduce product variants. (Hines & Rich 1997, 53; Pude et al. 2012, 8)

2.4.4 Quality filter mapping

Quality filter mapping tool is used to identify locations of quality defects in supply chain. Quality defects are categorized into the three different categories. The first category is product defects which are defects in products that already have been

delivered to customers and not caught in quality control of production. The second category is service defects. Service defect does not relate directly to products and typical example is too early or late delivery. The third category is internal scrap which refers to defects in products that are caught in production process and not delivered to customer. The quality filter mapping tool helps to identify and locate defects and problems and show where to target improvement activities. (Hines & Rich 1997, 54-55; Pude et al. 2012, 9)

2.4.5 Demand amplification mapping

Demand amplification mapping is simple analytic tool which provide information about the demand changes in supply chain during some certain time frame. This demand change is known as a Forrester effect and it was presented in a Harvard Business Review article already in 1958 by Jay W. Forrester. Demand amplification mapping tool helps to understand behavior of demand through the whole supply chain. This information can be used specially for managing fluctuation of demand and redesign value streams. It also helps to see is a dual-mode solution needed where stable demand is managed in one way and fluctuating demand in other way. (Forrester 1958, 37-38; Hines & Rich 1997, 55-56)

2.4.6 Decision point analysis

Decision point analysis tool is used to find out a point where actual demand pull is changed to forecast driven push. This is the point where products stop and are finished according to actual customer demand instead of forecast only. Location of this point can theoretically be anywhere inside the whole supply chain. There are two important reasons to use the tool and understand the location of point. It makes possible to build a supply chain which operate efficiently both upstream and downstream from the point and it also make possible to create scenarios how a change of point affect the value stream. (Hines & Rich 1997, 57)

2.4.7 Physical structure

Physical structure mapping is a tool used to understand what supply chain looks like from industry level point of view. This understanding is important to realize how the whole industry operates and what areas need to have development actions. Structure of the tool can be divided into the two different parts which are volume structure and cost structure. All suppliers and distributions are presented as tiers in a volume structure diagram. Assembler is located in the middle of diagram. Cost structure diagram shows an industry similar way but instead of number of firms involved in supply chain it describes the industry from cost adding point of view. It shows where the major cost adding areas occurs in supply chain. These information helps to target development activities into the right area of supply chain. (Hines & Rich 1997, 58)

2.5 Value stream mapping process

Value stream mapping was originally developed for improvement of manufacturing processes but it can be applied to administrative processes as well. Mapping process is very similar in administrative processes like it is in manufacturing processes. Figure 4 helps to realize the differences between manufacturing and engineering or administrative processes from lean five main principles point of view. (Keyte & Locher 2004, 1; Locher 2008, 18-19; McManus & Millard 2002, 2)

Administrative processes usually also support many value streams and operations in company which makes documentation of processes more difficult compared to quite a straightforward manufacturing processes. Therefore there are often many doubts how well lean principles work in office environment. Despite the doubts value stream mapping is very efficient tool to visualize process flow and point out problems in administrative processes as well. (Keyte & Locher 2004, 5; Locher 2008, 18-19; Tyagi et al. 2015, 208-209)

	Manufacturing	Engineering
Value	Visible at each step, defined goal	Harder to see, emergent goals
Value Stream	Parts and material	Information and knowledge
Flow	Iterations are waste	Planned iterations must be efficient
Pull	Driven by takt time	Driven by needs of enterprise
Perfection	Process repeatable without errors	Process enables enterprise improvement

Figure 4. Differences between manufacturing and engineering processes (McManus 2005, 18)

Value stream mapping process is quite a simple paper and pencil tool which helps to understand the flow of value stream. The main purpose of value stream mapping is to help management visualize and communicate how organization works at the moment and also help to plan how organization should work in the future to achieve better productivity. With value stream mapping different kind of activities can be found out from process flows. Activities which are done in processes can be divided into the three different category which are: (Hines & Rich 1997, 46-47; Lovelle 2001, 2; Rother & Shook 1999, 10)

1. Non-value adding (NVA)
2. Necessary but non-value adding (NNVA)
3. Value adding (VA)

Non-value adding activities are pure waste and do not add value to customer at all. All non-value adding activities should be eliminated from processes. Necessary but non-value adding activities are basically waste but are still necessary to perform value adding activities. These activities cannot be totally eliminated from processes but it is

still important to investigate is it possible to reduce this kind of activities by doing changes to process flow. (Hines & Rich 1997, 47)

Value adding activities are the core of process flow because they add and create value to customers. These activities cannot be removed from processes and optimal process should include only value adding activities. Normally it is not possible achieve this goal but organizations should still try to reach it. Also the fifth main principle of lean *"pursuit the perfection"* encourages to do so. (Hines & Rich 1997, 47)

The main steps of value stream mapping are preparation, current state mapping, future state mapping and planning & implementation. These steps with short explanations are presented in the figure 5. (Locher 2008, 1-2)

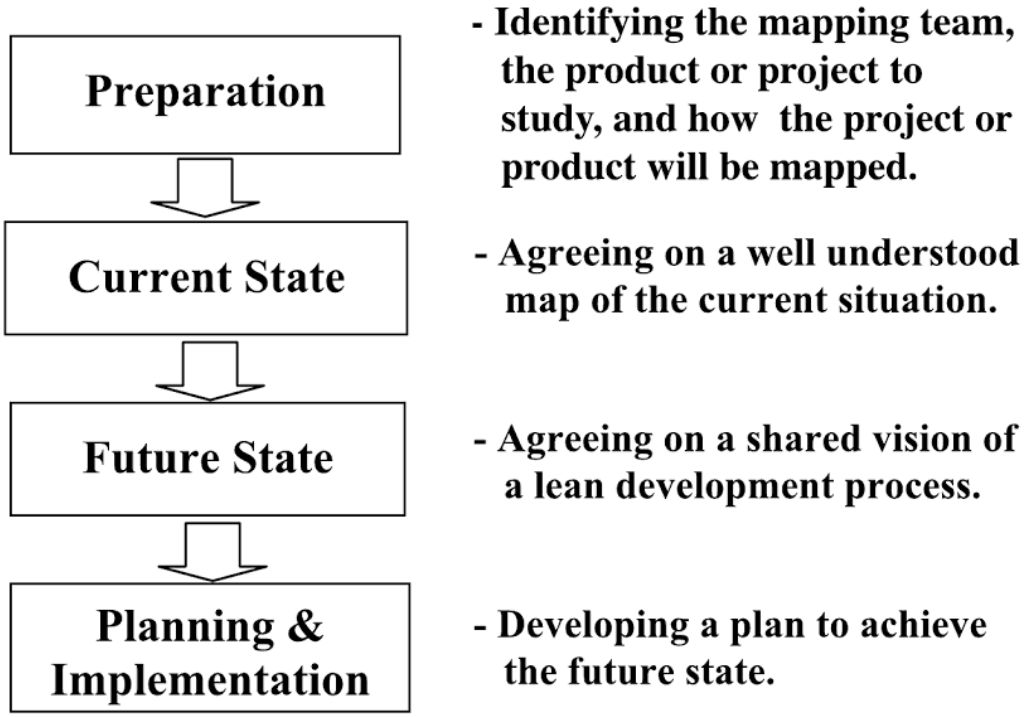


Figure 5. Main steps in value stream mapping process (Locher 2008, 2)

At the beginning of preparation step a process for mapping must be selected. It is essential to ensure that process to be mapped is really value adding. If not then mapping is just waste of time. There is different kind of tools available for process selection and for example product or service matrix help to discuss which process should be selected for improving. (Keyte & Locher 2004, 9)

When process for value stream mapping is selected all stakeholders who are involved in process must be identified. This is very important because without identifying key stakeholders the right team for mapping cannot be established and if the right person are not involved in mapping process it cannot be done properly. Normally about 10 person is suitable size for VSM team. Following person should be included in the team: (McManus 2005, 23; Manos 2006, 65)

- *Facilitator* who has knowledge and experiences about lean methods and tools used for mapping and improvement activities. Facilitator is a leader of mapping sessions.
- *System / Enterprise thinkers* who are "out of the box" thinkers. They are observing process mapping from whole system or company point of view.
- *Process owners* who are responsible for process and have authority to change it. They also have deep understanding of the whole process and its function.
- *Process participants* who has practical experiences about process. They are the best source for development ideas and they also have a knowledge about possible pitfalls in process improvements.
- *Customers and suppliers* who have a strong understanding of process input or output and thus can bring valuable knowledge for process improvement. They can be internal or external.
- *Other key stakeholders* are persons who are not directly dealing with process but can be able to provide some valuable knowledge or understanding for process improvement.

When all needed stakeholders have been identified and team established it is time to ensure that team has at least basic understanding of lean philosophy and tools. Participants should be familiar with mapping tool which is chosen for value stream mapping. If team does not have this knowledge it is important to organize training and train the whole team together before mapping sessions. Then all team members are able to understand used lean toolset and progress of mapping process. This ensures that all members are prepared for mapping process and mapping sessions will be as efficient as possible. (McManus 2005, 24)

Preparing phase must include also defining of value created by process and also defining how process create that value to customers. Without understanding of value and value creation improvement activities cannot be guided successfully and output of mapping process is not proper. (McManus 2005, 27)

It is recommended to have whole day VSM sessions instead of shorter ones. Normally two or three days is needed to perform comprehensive VSM. Before current state mapping a decision how exactly process is mapped need to be done. It is important to realize that very exact breakdown of process does not necessary provide much more information and benefits for mapping. Very exact mapping just make the current state mapping very difficult to manage. Based on the experience 10 and 30 tasks in mapping is the best solution. This amount of tasks is easy to manage and still provides sufficient insight of process flow. (McManus 2005, 40; Manos 2006, 65)

The current state map is done in value stream mapping session where all needed stakeholders are in the same room. The first step in current state mapping is to identify all tasks which are included in process and information which flows between these tasks. In other words flow of tasks and information are mapped which build up the whole process. These steps are written down on template one after other or next to each other depending the process flow. Also all stakeholders who are involved in process must be marked on the mapping. (Tyagi et al. 2015, 207-208)

Very practical and visual tools for making current state map are a large white paper put on the wall and a different color sticky notes which illustrates tasks and issues in process flow and pencil for marking. It is easy to change the order of sticky notes on the paper if any updates are needed later in sessions. (Tyagi et al. 2015, 207-208; McManus 2005, 40)

Team members must select suitable metrics for mapping process. The purpose of metrics is to measure an effectiveness of process. It is not necessary easy to find out suitable metrics for administrative process because there are no standard metrics available for office environment. Team must find out metrics which support a visualization of process. The most common metrics used in administrative processes are process time, lead time, value-added time and cost. (Keyte & Locher 2004, 23-25)

When the current state of value stream is ready it is time to do identification of different kind of waste from process flow. Waste identification must be done very carefully because this is maybe the most important step in value stream mapping to get better process performance. Current state map make waste visible and therefore also make waste removal possible. If waste is not possible to see it cannot be removed either. It is important that all team members have a clear understanding about the waste in process flow to get desired results. (Lovelle, 2001, 4; McManus 2005, 57)

Most of activities done in administrative processes are usually necessary but non-value adding (NNVA) which cannot be eliminated and are not clear waste. It is still important to investigate is there something what can be done to get amount of NNVA activities smaller and maximize value adding work in process. Non-value adding (NVA) activities are many times hidden inside value adding activities. It is also possible that NVA activities may have value but it is executed NVA way. (Keyte & Locher 2004, 16-17, McManus 2005, 61)

When current state map is ready and waste identification is done team can focus on the future state map. Future state map is basically redrawn version of current state map where waste elimination and all other improvement activities are taken into account. Future state map shows improved process flow and value stream based on the findings done in current state mapping phase. Following questions can be used as a guideline when developing future state map. (Manos 2006, 68-69; McManus 2005, 71; Keyte & Locher 2004, 68; Rother & Shook 1999, 70-71)

- What does customer really need?
- How often should process performance be checked?
- Which process steps really add value and which generate waste?
- How to make process flow with fewer interruptions?
- How should workload be balanced?
- What are process improvements which are needed to achieve future state map?

The last step in VSM process is planning and implementation phase which is also one of the most important phases in VSM. Creation of the current and future state maps helps to find out waste from process but if corrective actions are not planned and plan executed results of mapping are easily just waste. (Lovelle 2001, 7; Keyte & Locher 2004, 98-99)

Action plan show what actions are needed to reach future state map from current state and it gives answers to questions who, what, how and when for each activities which are needed to achieve the future state. Many times organizations have limited resources to perform improvement activities and therefore prioritization is often needed to use resources effectively. There are many kind of tools available for prioritization but one and simple way is to investigate which action is the most important from strategy point of view. (Manos 2006, 69; Lovelle 2001, 7; Keyte & Locher 2004, 98-99)

Normally different implementation teams are needed to execute the plans. It is also important that progress of action plan is followed frequently and updated if needed. It is not enough that team members are committed to process improvements done by mapping but also the top management and all relevant organizations must understand the importance of improvement activities and must commit to the target. (Keyte & Locher 2004, 104)

3 STUDY ENVIRONMENT

This chapter describes the environment where the thesis was done including company and process presentations. The aim of this chapter is to give answer together with chapter 4 to the research question 2: *How to execute VSM for phase out process to get production overlap time shorter?*

3.1 Nokia

Nokia`s roots are in the year 1865 when Finnish engineer Fredrik Idestam opened a simple paper mill. A short time later Idestam opened a second paper mill on the River Nokianvirta and he decided to give a name Nokia AB to his company. The first steps in telecommunication business Nokia took already in 1880. After those years Nokia has operated in several sectors like paper products, cable, rubber boots, tires, mobile devices and telecommunication infrastructure equipment. (Nokia intranet 2016)

In 1982 Nokia was the first in Europe who provided a fully digital local telephone exchange and also the first car phone for NMT analog standard in the whole world. In the 1991 the first GSM call in the world was called with the Nokia mobile phone in GSM network which was built by Nokia for Finnish teleoperator called Radiolinja. At the beginning of 1990 Nokia made the big strategic decision to focus only on telecommunication and mobile phone business. All other business sectors were sold out. In 1998 Nokia was the world leading mobile phone producer and they held this position over 10 years. (Nokia intranet 2016)

Nokia combined its telecommunication equipment business with Siemens in 2007 and this joint venture got name Nokia Siemens Networks (NSN). In 2013 Nokia bought Siemens` share from NSN and later this revealed a successful strategy movement. In 2011 Nokia combined its mobile phone business with Microsoft to get better position in tightly competed smartphone markets. Only three years later Nokia decided to sell

whole unprofitable mobile phone business to Microsoft. Nokia also decided to sell its HERE digital mapping and location business in 2015 to a car company consortium.
At the same year Nokia board made once again a big strategic decision to purchase Alcatel-Lucent. (Nokia intranet 2016)

The acquisition of Alcatel-Lucent made Nokia as a leader in next generation technologies and services which connect things and people. Nowadays Nokia has five different business groups: Mobile Networks, Fixed Networks, Application & Analytics, IP/Optical Networks and Nokia Technologies. Nokia has customers in over 100 countries around the world. In 2015 Nokia has 55178 employees globally. Net sales was €12,5bn and operating profit €1,7bn. These figures were given before Alcatel-Lucent deal. (Nokia intranet 2016)

This thesis was done for Supply Chain & Procurement Engineering (SC & PE) unit which is one of the main functions in Nokia Mobile Networks (MN) business unit. Nokia MN business unit provides end-to-end mobile networks solutions globally. SC & PE unit is responsible to maximize the total life-cycle value of MN product portfolio in supply chain combining life-cycle management, engineering and business group procurement. SC & PE is responsible also for phase in – phase out (PiPo) process in MN. (Nokia intranet 2016)

3.2 Phase out process

3.2.1 Overview of phase out process

Phase in – phase out process is used in Nokia MN to remove old product from production and to replace it by the new one. The purpose of phase out in the PiPo process is to remove product gradually and successfully from productions and product portfolio. Phase out process is done for older product when new substitutive product has been developed in R&D and is ready for volume production and customer

deliveries. Phase out process ensures that all mandatory and important tasks are performed during the removal of old product. Nokia Networks has an upper level phase out process called NET phase out process which consists of several sub processes. All phase out processes are presented in the figure 6. (Nokia NET phase out process material 2016)

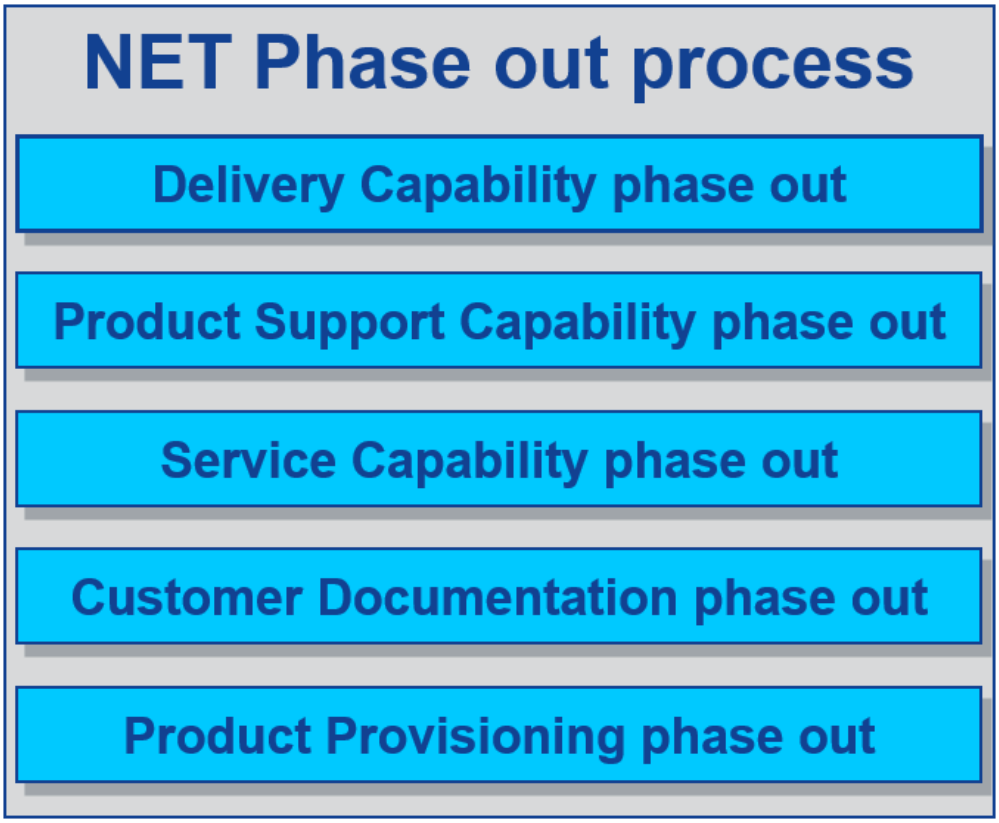


Figure 6. Nokia NET phase out process and its sub-processes (Nokia NET phase out process material 2016)

Every sub-process has its own specific purpose in phase out of product to perform needed activities in a controlled way. Delivery capability phase out process ensures that all needed activities which relate to delivery processes and materials will be performed. Product support capability phase out process operates with ramp down support activities of phase out product. Service capability phase out relates to product services like installation and commissioning. Customer documentation phase out

operates with marketing and sales documentations related activities. Products provisioning phase out process ensures that product related data is up to date in data systems. (Nokia NET phase out process material 2016)

There are many stakeholders who are involved in the phase out process and its sub-processes. The main participant are presented below:

- PLM, Product Line Management is responsible for products.
- DCM, Delivery Capability Manager is responsible for ensuring delivery capability of products.
- CT, Customer Teams are responsible for customer related activities and they are working in customer interface.
- SCM / PCPP, Supply Chain Management / Plan & Collaboration Products is responsible for demand planning.
- HWS, hardware service is responsible for spare parts and hardware service modules.
- GPR, global procurement is responsible for sourcing related activities.

3.2.2 Process steps and decision points

Phase out process has five main stages which include several smaller tasks in different sub-processes presented earlier. There is also five milestones C6 – C10 between these five stages where decision can the phase out process go further is done. The main stages and milestones are presented in the figure 7. (Nokia NET phase out process material 2016)

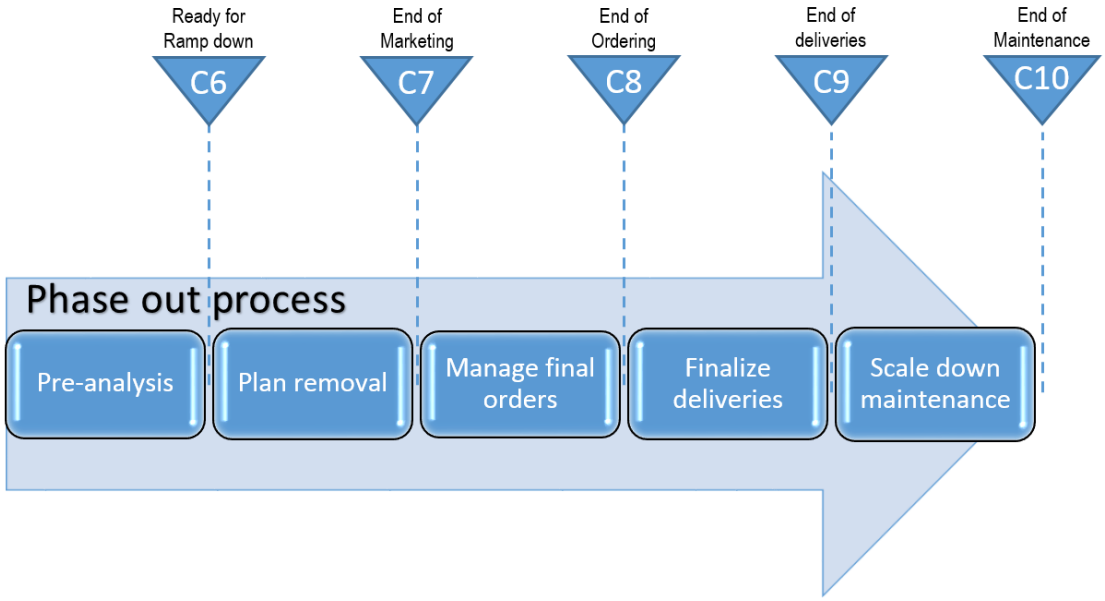


Figure 7. Main stages and milestones of phase out process (Modified from Nokia NET phase out process material 2016)

The main tasks of pre-analysis stage are to provide phase out proposal for C6 milestone and start preliminary phase out planning. Phase out proposal includes a short summary of phase out product, reason for phase out, customer analysis and target date for C7 milestone. Phase out planning includes overview of stocks, demand and order situation, effort, cost and risk estimations and also production and delivery ramp down planning. When all needed criteria of pre-analysis stage are fulfilled phase out process can achieve C6 milestone. (Nokia NET phase out process material 2016)

When C6 milestone is achieved product is approved for phase out. After C6 point removal planning stage is started. Removal planning includes more exact planning of phase out with resource allocation and it is a starting point for actual phase out execution. The stage includes planning of the last forecast and order dates, planning of external communication and defining the target dates for C8 end of ordering, C9 end of deliveries and C10 end of maintenance. Also marketing and sales organizations are involved in the phase out process. When all needed criteria of removal planning stage

are fulfilled phase out process can achieve C7 milestone. (Nokia NET phase out process material 2016)

C7 milestone ends the marketing of phase out product and thus marketing and sales material is not anymore available for customers. The last orders are managed after the C7 milestone. Phase out plan is followed and executed and also updated if needed at this stage. Target dates for C8, C9 and C10 milestones are defined again if needed. When all needed criteria of final orders managing stage are fulfilled phase out process can achieve C8 milestone. (Nokia NET phase out process material 2016)

C8 milestone is the end of ordering which means that after this point new orders are not taken anymore but the last orders which are already inside are handled. Possible scarp cost of excess materials and stock assets are estimated. Phase out process follows the plan made in the early stages and when all criteria are fulfilled phase out process can achieve C9 milestone. (Nokia NET phase out process material 2016)

C9 milestone is ending point for deliveries and phase out process proceed towards end of maintenance C10 milestone which is the end of product support. All customer documentation and sales items are removed at this stage. When the last orders are done product supports will continue according to the phase out plan until phase out process achieve C10 milestone which officially ends the lifecycle of product. (Nokia NET phase out process material 2016)

3.2.3 Production overlap time

Production overlap time is the time when new substitutive product is already in volume production but old is not ramped down yet. Overlap time should be as short as possible because it causes a lot of unnecessary cost. There are three different main reasons for the cost of overlap time. The first is double production because two different production lines are needed parallel for the new and old products and it is very expensive. The

second reason is losses of sales revenue because profit of new product is normally clearly better than profit of older product. The third reason is different kind of maintenance cost of old product.

One essential factor which affect the production overlap time is phase in process. Phase in process is used to transfer the new product from R&D program to volume production. Communication in the PiPo processes must be fluent and seamless to achieve the successful and fast transfer between old and new product and thus keep production overlap short.

R&D program follows P0-P9 milestones when developing new products. V0-V9 milestones are also used when the product which is under the development is variant from other product. The purpose of both milestones is same despite the different naming. The milestones are presented with a short explanation in the figure 8.

Milestone	Purpose
P0 / V0	Start of R&D program
P1 / V1	Initial plans approved
P2 / V2	Investments approved
P3 / V3	R&D program plan confirmed
P4-5 / V4-5	End of bring-up
P6 / V6	End of HW testing / Ready for trials
P7 / V7	Ready for pilots
P8 / V8	Ready for volume
P9 / V9	End of R&D program

Figure 8. Milestones of R&D program (Modified from Nokia HW development process material)

When the new product achieve P8/V8 milestone it is ready for volume production and it is ramped up. This is a trigger point for overlap time and it continues until phase out product achieve C9 milestone and it is removed from volume production. So the overlap time is the time between P8 milestone of new product and C9 milestone of old product. Production overlap time is presented in the figure 9.

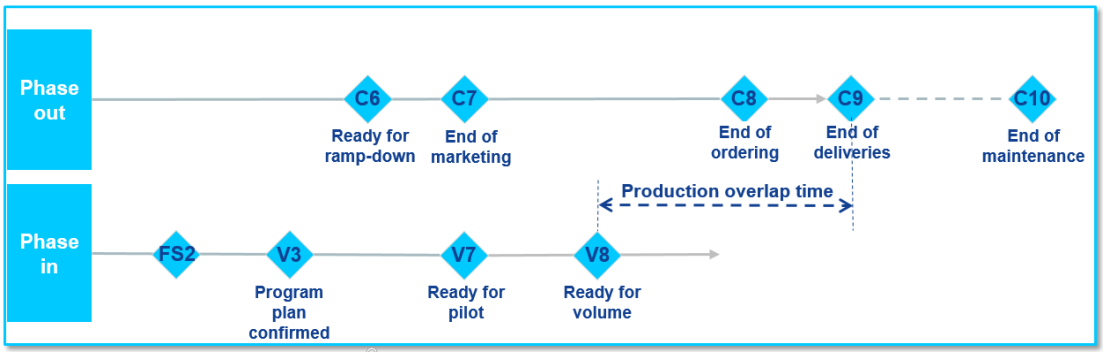


Figure 9. Production overlap time

4 EXECUTION OF VSM FOR PHASE OUT PROCESS

This chapter introduces the progress of VSM for phase out process. The aim of this chapter is to give answer together with chapter 3 to the research question 2: *How to execute VSM for phase out process to get production overlap time shorter?*

Execution of VSM for phase out process was done in different steps which are presented in the figure 10. The projects was started in March 2016 when Nokia has a clear need to enhance the phase out process. The exact scope of project was defined during March and April. At the same time background information gathering was also started. VSM workshop planning was done during May and at the end of May two different VSM workshops were held. Analyzing the results of VSM workshops was done in June and agreement of further action during June and August.

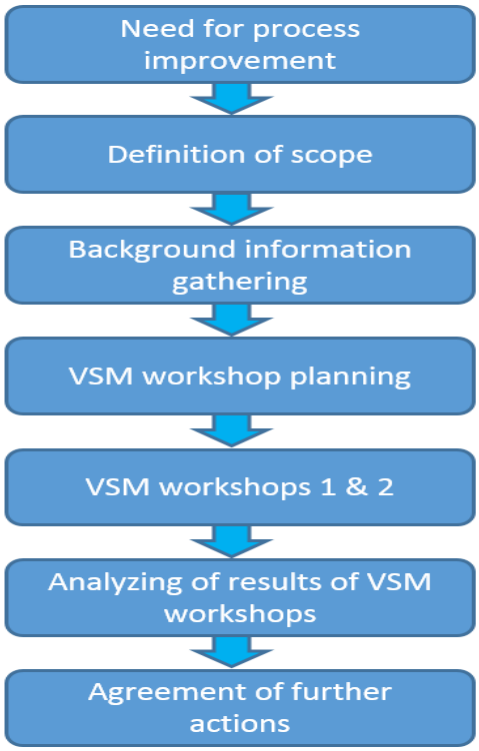


Figure 10. Execution steps of VSM for phase out process

4.1 Need for process improvements

In the recent years Nokia has noticed that phase out of old products is slow in PiPo process. Focus has been more in phase in process to ensure fast ram up of new product and to get the new product for customer deliveries. Short NPD time is an important asset when fighting about the market shares and quick phase in is an essential part of it. Despite the importance of phase in process the phase out is also important part of the PiPo process especially from cost point of view. Slow phase out process affects directly to the production overlap time of old and new product which causes remarkable cost.

Nokia is developing more and more new products and pace of NPD is faster than earlier. This means that number of phase out products is rising as well because most of the new products replace some older product. Use of external production plants (EMS) is also rising which creates pressures for the fast phase out because product-specific cost usually rises in EMS production when volume is going down. Sometimes production capacity can also be an issue and fast phase out releases a production capacity for the new products. Also extremely tight competition in telecommunication markets has forced companies looking for ways to produce more with less. Because of these reasons there was a clear need to improve the phase out process and get production overlap time shorter.

Nokia MN`s top management has set a tight target to shorten production overlap time from current 10 months to 1 months by the end of 2020. Phase out process has not been analyzed and improved earlier so the first step was to analyze phase out process to find out development possibilities which were needed to achieve the set target. It was clear already at the beginning that only with this thesis it is not possible to achieve 1 month production overlap time in PiPo process. The main target of this thesis was to be the first step toward that ambitious target set by top management.

4.2 Definition of scope

Even though the need for phase out process improvement was clear already at the very beginning of thesis still it was a little challenging to define exact scope. Phase out process is very complex entity which consists of several sub-processes and there is a number of stakeholders who give a contribution to the phase out process. There are also many links between phase out and phase in process from production overlap time point of view so whole PiPo process needed to take into account in definition of scope for thesis.

Many meetings were held during the definition step with different stakeholders to get understanding how to execute VSM for phase out process and where are the most important development points in process from production overlap time shortening point of view. Preliminary plan was to concentrate on process stages C7-C9 which affect most the overlap time but later it was noted that C6 must also be included in the scope of study. Planning of C7-C9 process stages are done mainly in C6 stage so therefore it affect directly the duration of C7-C9 stages and also production overlap time.

It was also decided in definition of scope step that VSM is the lean tool which will be used for improving the phase out process. Nokia MN has used lean tools for administrative process development in the recent years and Nokia MN SC&PE has an annual target for VSM studies done for administrative process. SC&PE has already used VSM for process improvement and it was seen as an effective tool for improve process performance.

Process activity mapping was chosen from different VSM tools for this thesis as a mapping tool. Like described in picture 3 it is the most suitable tool when identifying different kind of wastes. It was also agreed that swim line style mapping is used because

this same method is used earlier in improvement activities of administrative process in Nokia. Traditional VSM symbols are not used in swim line style mapping.

Finally it was decided that only main tasks which affect most the production overlap time between C6-C9 stages of phase out process are taken in account. There are a lot of tasks during C6-C9 process steps in phase out process and its sub-process but all of those are not so important from production overlap point of view. This decision was done because the total amount of tasks which can be properly managed in one VSM is only 10-30 as wrote in theory part on the page 27.

4.3 Background information gathering

Background information gathering was stared already during the definition of scope step and it continued until VSM workshops. The purpose of background information gathering was to understand the research problem and tool which were aimed to use for solving the problem. The first step was to get familiar with PiPo process and its function to understand the process which was purpose to improve by VSM. The second step was literature review of lean principles and methodology to get understanding how to use lean tools in process improvement. Specially applying lean methods and tools in office environment and administrative processes were studied. Different kind of instructions for making VSM were also gone through to ensure fluent and seamless workshops.

Background information gathering related to PiPo process was done by discussing with relevant people in company and by studying company`s process descriptions and documents. Literature review of lean principles and VSM theory was done by studying books and web articles. Also previous thesis` which related to VSM and process development were utilized.

4.4 VSM workshop planning

Planning of VSM workshops were started when all needed background information was gathered and analyzed. Many meetings were held where the execution of VSM workshops was planned. Two different workshops were decided to have and 3 hours' time slot were reserved for one workshop. It was decided to have two separate 3 hours session because it is easier to participants to find suitable time slot from their calendar if session is not too long. Also focus will be better if session is not too long. It is recommended to have longer sessions in literature but in this case it was seen easier to arrange two shorter meetings. An agenda for both workshop sessions were also done and agreed during the planning phase.

One of the main task in the planning step was to decide the participants for VSM workshops to establish a correct team for process improvement. It is very important to identify all relevant stakeholders because otherwise workshops cannot be done properly and therefore results are not necessarily valid as wrote in theory part on page 26. The selection of participant was done based on the role and knowledge. 11 person were selected for VSM workshops. Addition to this thesis worker and lean six sigma specialist operated as facilitators so total amount of persons were 13. Invited participant were from DCM, PLM, SCM/PCPP, HWS and GPR organizations. Also one process owner was invited.

It is highly recommended that all workshop participants are in the same meeting room during the workshop so conference call meetings are not recommended. This is important because VSM is done into the big white paper which is on the wall and this "base of mapping" must be visible for all participants. It was a little problematic to get all relevant persons into the workshops because phase out process is a global process and traveling was not possible in this case. Even though this caused some challenges eventually persons from all essential stakeholder groups were able to participate in the

workshops without conference call. When participation list was ready invitations were send out to all participants. Invitations were sent about two weeks before workshops.

All practicalities were planned during the VSM planning phase as well. These practicalities were to find suitable room for workshops, to get big white paper and different color sticky notes for mapping and pencils for marking.

4.5 VSM workshops

Two different VSM workshop sessions were held at weekly intervals and duration of one workshop was 3 hours. Totally 12 persons were participated in the first session and 10 persons in other one. Meeting rooms were prepared before workshop session. White big paper was put on the wall and sticky notes and pencils in different colors were available as well. A clear reason for VSM workshops were explained in the invitation so purpose of sessions was clear for all participant already at the beginning of sessions.

At the beginning of the first workshop an agenda was gone through with the participants. The first session was started with a short introduction of participants, aim of the workshop and VSM activities which were purpose to do during the workshops. Also a short introduction of VSM was given to ensure that all participants have a basic understanding about the VSM and how the mapping process is done.

After the introduction and preparing activities the mapping process was started. At the beginning of mapping process all essential stakeholders who involve the process were marked into the left side and C6 – C9 milestones as well as P7-P8 milestones on the top of white paper which was base for the mapping. Then the main tasks of phase out process from production overlap time point of view between C6 – C9 milestones were put by yellow sticky notes step by step on the map and all issues related to this tasks were marked by red sticky notes. This procedure was continued until all relevant steps from production overlap time point of view were mapped and improvement

possibilities related these step were identified. The mapping process was finished in the second workshop when VSM team agreed that all essential tasks with possible issues were on the map.

It was agreed that future state map is not done in workshops because it would be exactly same like the current state map because it was not possible to change the order of tasks or remove any tasks. Therefore it was decided to use VSM for identifying all issues from the current process flow to improve the performance of process and shorten the production overlap time.

There were still some time left when the current state map with findings was ready in the second workshop so findings were also prioritized to get understanding which of the findings participants saw to be the most important ones to solve. Two different tools were used for prioritizations and evaluations of findings. The first prioritization tool based on benefits which can be achieved by correcting the findings and complexity which tells how difficult the correction is to do. Tool consists of coordinate system where benefit is on vertical axis and complexity on the horizontal axis. The tool can be used to identify how big benefit can be achieved and how complex i.e. difficult the finding is to correct. The other tool used for prioritization was basic voting where every participant gave three votes for three findings which they saw the most important from shorting the production overlap time point of view. The findings where then sorted based on the amount of given votes.

4.6 Analyzing of results of VSM workshops

A short summary of the results of workshops were done and reviewed with participants in the result analyzing step. Findings were analyzed to find out is it possible to do some kind of grouping which would help to agree further actions. Purpose was to categorize findings so that owner for corrective actions is easy to find and agree how to correct

the findings. All findings were finally categorized into the three different category and every category has a different owner.

It was also analyzed how the corrective actions of finding would affect the production overlap time. Old actual PiPo case was used as a support to visualize how much would have been saved in time if corrective actions for findings done in VSM workshops would have been taken into account in phase out. This was very illustrative presentation which helped stakeholders to understand how important is to implement corrections for findings and how big benefit can be achieved with corrective actions. Also possible financial benefits were estimated based on three actual PiPo case.

4.7 Agreement of further actions

Further actions were agreed when findings were categorized and the right owners for corrective action were defined. All categories were reviewed with relevant persons and it was agreed what findings from every category will be corrected. Corrective actions were decided to implement almost for all findings. Only one category was problematic because it was noted in the review that the owner who was defined for this category cannot do all corrective actions and therefore implementation of corrective action were still open when this report was written. Anyway actions are ongoing in company to find out owner also for corrective actions of this one category.

Agreement of further action was the last step in thesis. Implementation and follow up of corrective actions for findings were ruled out already in the scope defining phase therefore these are not mentioned in this thesis. When further actions were agreed the final report of VSM for phase out process was done for company. The final report summarized this project and its results. Review of this final report was ending point for VSM for phase out process.

5 RESULTS OF VSM FOR PHASE OUT PROCESS

This chapter presents the results of this thesis. All findings, prioritization and evaluation of findings as well as agreed further actions were presented in this chapter. Also suitability of VSM for administrative process development is evaluated and recommendations for further VSM workshops were given. The aim of this chapter is to give an answer to the research question 3: *What are the improvement possibilities found by VSM and how suitable tool it was for process improvement?*

5.1 Outcome of VSM workshops

This chapter presents the results of two different VSM workshops. Current state map, all findings and prioritization of findings are presented in this chapter. It was agreed in VSM workshops that future state map is not done even though it is normally an important part of value stream mapping. Even though the future state map was not done possible benefits which could be achieved by doing corrective actions for findings were estimated based on the old actual PiPo cases.

5.1.1 Current state map

Current state map was done on the big white paper which was made of flip chart papers. Roles of stakeholders, tasks and issues in process flow were marked by sticky notes. Pencil was used for marking. The photo of current state map is presented in appendix 1 and electrical version in appendix 2.

Mapping process was done according to swim line style where parallel lines divide the mapping into the different lanes and every lane has a responsible person. Tasks which were under responsibility person were marked on the line so that all tasks in the mapping were in order how they are performed in process. The swim line style mapping is not what is recommended in literature but this style is used in Nokia for

administrative processes and therefore it was applied to this mapping as well. This style is according to Kaizen Institute instruction and it is very suitable for complex administrative process development.

The mapping process was done from upstream to downstream even though upstream mapping is recommended in many literatures. The mapping was planned to do between C6 – C9 stages but the first mapped task was actually before C6 milestone. Also a couple of findings were identified already before C6 milestone. This task and two findings were so important from production overlap time point of view that it was decided to take these into account. All other mapped tasks and findings were between C6 and C9 milestones. There were not any particular spots where the issues occur most in process flow. All findings were around the all mapped tasks as can be seen from appendix 1 and 2.

Participants in the workshops were more or less unanimous about the roles and tasks which should be on current state map. Also identified findings did not cause any disagreements during the workshops. Totally 6 responsible roles were marked on the map which were DCM, PLM, CT, SCM/PCPP, HWS and GPR. These roles are the key stakeholders in phase out process.

21 tasks were identified in the current state mapping. One task before C6, eight tasks between C6 - C7, seven tasks between C7 – C8 and five tasks between C8 –C9. These are the most important ones and all of these affect somehow the production overlap time. Actually there are more tasks between C6 – C9 milestones in phase out process but as agreed in planning phase focus will be in the shortening of overlap time and therefore only tasks which are relevant from overlap time point of view were described. This helped to get clear and manageable current state map. As instructed in literature the amount of mapped tasks should be 10 – 30 to have clear view of process flow so amount of tasks was very well in this target.

The first task in current state map was C6 proposal made by PLM which is the trigger for actual phase out process. When C6 was achieved PLM make internal announcement about starting the phase out. After announcement DCM starts PiPo planning activities like material balancing and SCM/PCPP starts demand planning. At the same time CT starts phase out planning and informs key customers about it. When the key customers are informed PLM starts to plan C7 – C9 milestones and create communication plan. Before C7 milestone DCM makes material excess and obsolescence calculations and GPR go through supplier contracts for liability. If excess and obsolescence are seen, provisioning need to be done.

When C7 milestone is achieved PLM publishes phase out letter. The purpose of letter is to inform all customers, EMS productions and suppliers about the phase out. After C7 milestone DCM makes E/O calculations and HWS EoL planning for spare parts of phase out product. CT makes preparation of the last forecast and order dates and SCM/PCPP take care of internal and external communication via SOP plan. HWS defines the last order dates for spare parts and HWS EoL orders. After C8 milestone DCM makes adjustments for excess and obsolescence material, make provisioning BAT, close production lines, close product structures and create scrap BAT. Before C9 GPR do material liability closing which was the last task in the current state map.

5.1.2 Findings and development possibilities

Totally 19 findings which weaken the performance of phase out process and extends the production overlap time were identified from the current state map during the workshops. Later findings were combined so that total amount of finding was 17. Combining was done because a couple of findings where so close to each other and basically meant same thing. All 17 finding with short explanations are presented below:

1. *C6 should be earlier, planning should be started backwards from P8*

C6 milestone of phase out process is too late in a current process flow. C6 is a trigger for actual phase out activities and late C6 means that these activities are stared too late in PiPo process. The late C6 is one of the biggest things which add production overlap time. It was proposed in the workshops that C6 planning should be started from P8 milestone of phase in product so that P8 and C8 milestone are synchronized in PiPo process. This would shorten production overlap time in PiPo process significantly.

2. *C6-C9 information does not reach Solution Manager in CT when PLM has done internal phase out announcement*

Information about C6 – C9 milestones given in internal phase out announcement does not reach solution managers in different CTs. Current phase out process does not ensure is information received. This communication problem makes phase out planning difficult and causes often delays for phase out process because CT is a key player from customer interface point of view.

3. *PLM has problems to get feedback from CT when phase out planning has been started and key customers informed*

PLM has difficulties to get feedback from CT about the phase out activities like key customer information. This finding relates also to the communication between PLM and CT like previous finding no 2. This communication problem affect the phase out planning and causes often delays for phase out process as well like previous finding.

4. *EMS contract check is totally missing at the moment*

EMS contract check is totally missing from phase out process at the moment. EMS contracts should be gone through during the phase out because it helps to ramp down

factories and helps to manage inventories in EMS plants. These activities are important that execution of phase out would be cost effective and quick.

5. *Supplier contract check should be earlier*

Supplier contract check is done just before C7 milestone of phase out process at the moment. This check should be done earlier to harmonize estimated needs of raw materials in production of phase out product and raw material stocks. This is important especially from cost efficiency point of view.

6. *PLM should make communication plan already before C6*

PLM makes communication plan between C6 and C7 milestones in the current phase out process. This is too late and this is one issue which causes unnecessary delays for phase out process. It was proposed that communication plan should be done already before C6.

7. *Phase out letter should be sent earlier to customers*

Phase out letter is an official notice for external stakeholders like customers, suppliers and EMS plants about the phase out. PLM releases the phase out letter right after C7 milestone in current phase out process. Externals stakeholders especially customers would have more time to react the phase out activities if notification is sent out earlier and therefore this would speed up whole phase out process.

8. *HWS EoL planning should be earlier*

HWS EoL planning is after C7 milestone in the current phase out process. EoL planning for spare parts and HWS modules should be earlier because the late planning

causes delays in ramp down of production lines. If HWS EoL planning is done earlier it would help to take HWS needs into account in phase out production planning.

9. *The last order date for HWS modules and spare parts should be earlier*

The last order date for HWS modules and spare parts is just before C8 milestone in the current phase out process. Late order date causes problems for production planning of phase out product and therefore causes delays for phase out process.

10. *Customer analysis should be done more precisely. Is there resources enough for exact customer analysis?*

It was question in the workshops that is the customer analysis done precisely and is there recourses enough for exact customer analysis. Purpose of customer analysis is to estimate and analyze customer requirements and needs. This is very important from phase out planning point of view. Exact customer analysis is an essential part of careful phase out planning which makes quick and cost-effective phase out possible.

11. *Internal Po announcement should be shared as a pre-notice to external stakeholders, to open discussion about Po.*

Internal announcement of phase out is released inside the company already after C6. This information does not go outside of company except for some of the key customers. The announcement should be shared to outside of company to prepare external stakeholders for the coming phase out. This finding relates to the same thing like finding no 7.

12. Phase out letter info does not reach suppliers/EMS

There are issues to reach suppliers and EMS plants with phase out letter in the current phase out process. Phase out letter is shared suppliers and EMS production as well but in the current process it is not clear does the letter reach suppliers and EMS plants and are the needed activities started. This causes issues for phase out planning.

13. Feedback missing from suppliers/EMS after phase out letter published

There are difficulties to get any feedback from suppliers and EMS plants when phase out letter is published. The current phase out process does not require to answer phase out letter which is problematic from phase out planning point of view. This finding has similarities with the finding no 12.

14. Last orders and forecasts come too late from customers, last forecasts are not binding

Forecasts and orders come too late from customers, in other words after the informed latest dates. Problem is also that forecasts are not binding so real order can be much smaller or bigger than given forecast. This is very problematic for phase out planning and cause a lot of exceptions with C8 and C9 milestones because orders are taken after C8 which end of ordering and deliveries are done after C9 which is end of deliveries. Because of this production of phase out product must be continued further than planned and this affect directly the production overlap time.

15. Too many exceptions with C8 and C9 (orders after C8 and deliveries after C9)

This finding relates to the finding no 14. At the moment there are too many exceptions with C8 and C9 dates in phase out process. Because of this production of phase out product must be continued further than planned and this affect directly the production

overlap time. It must be critically studied does it make sense to take these orders and is there a clear business case to deliver delayed orders.

16. Po planning should be included in feature screening phase.

Phase out planning should be started earlier than nowadays to ensure efficient PiPo process and short overlap time. Planning activities are stared too late which directly affect the duration of production overlap time. Phase out planning should be started already in feature screening phase of the new phase in product. Feature screening phase is done before the start of R&D program where features of the new possible product are analyzed. Also older product which the new product is going to replace is known in feature screening phase and therefore phase out planning for older product can be started. Good and fluent communication between phase in and phase out processes is an essential in this case.

17. Customer contracts and communication could be improved, quick phase out should be taken into account

Current customer contracts do not support quick and efficient phase out process. There are often mention in contracts that the both new and old products are available for example for 12 months. Basically this means that customer contracts demand to run the both old and new products in production so in other words customer contracts demand to have overlapped production for a long time. It is very important to take quick and cost-efficient phase out process into account when new customer contracts are done.

5.1.3 Categorization of findings according to lean seven type of waste

Some findings were quite an easy to put into the different waste category according to lean seven type of waste but there were also some findings which were not so easy to categorize.

Findings 1, 5, 6, 7, 8, 9, 16 and 17 belong to waiting waste group. As wrote in theory part on page 15 waiting in administrative processes can be divided into the two groups which are unscheduled waiting and scheduled waiting. In this case all mentioned findings belong to the scheduled waiting group because current phase out process does not require to start activities any earlier. So if phase out process is followed these activities are stared too late and therefore waiting is scheduled and planned in process flow. The finding 17 which relates to customer contracts belongs to this group as well because current contracts can force to wait some time period before the old product can be ramped down.

Findings 2, 3, 12 and 13 relate to insufficient communication. There is not this kind of waste group in seven type of wastes developed by Toyota but these findings can be put into the transportation waste group. According to literature transportation is unnecessary or inefficient movement of people, information or product. In this case findings related to the inefficient movement of information which is the root cause for insufficient communication and this causes unnecessary waiting in process. Oehmen (2010) also put communication related issues into the transportation group when wastes are reviewed from Toyota`s seven waste point of view.

Findings 14 and 15 are very close to each other and both relate to the communication with customers so from that point of view these can be put into transportation category like previous ones. Findings 14 and 15 causes defects in phase out process and therefore production plans need to be updated when information is finally got from customers. From this point of view these findings can be put into the defect category as well.

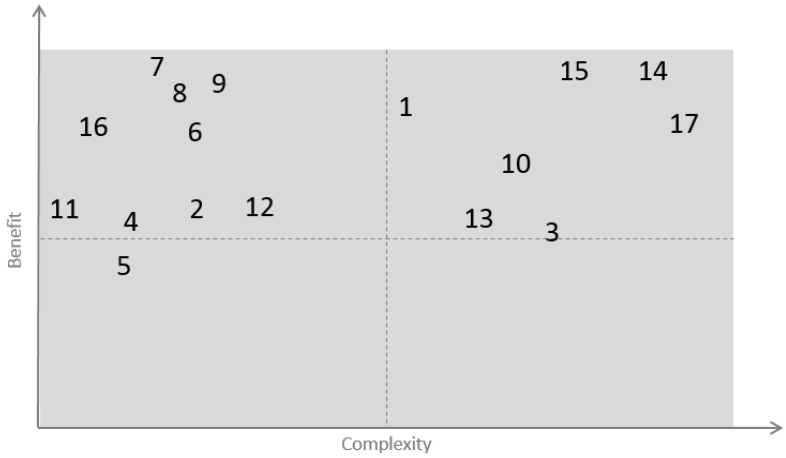
Oehmen (2010) has listed different types of waste from lean product development point of view and generating defect information is mention in that list. This would be suitable waste group also for these findings.

Findings 4, 10 and 11 are defects in process so these can be put into the defect group. Finding 4 relates to task which is totally missing from process flow so it is clear mistake in phase out process. Finding 10 is a defect in process which could provide defective information which makes phase out planning difficult. Finding 11 can also be seen as a defect because it would be beneficial if the task which relates to this finding is done different way.

5.1.4 Prioritization of findings

Prioritization of the finding were done in the second workshop when the current state map was ready and findings identified. The purpose of prioritization was to rank the findings and find out the most important ones based on the participant`s opinion. Two different methods were used for prioritization. The first method was to rank the findings based on complexity and benefits. The results of prioritization of the first method is shown in the figure 11.

The figure 11 shows that participants saw findings 6,7,8,9 and 16 very beneficial but not very complex to implement. At the other end findings 14, 15 and 17 were seen very beneficial but also complex to implement. It was also ingesting to see that there are no findings which participants would have been seen as a very unbeneficial so all findings were seen as an important from process development point of view.



1. C6 should be earlier. Planning should be started backwards from P8.
2. C6-C9 information does not reach Solution Manager in CT when PLM has done internal phase out announcement
3. PLM has problems to get feedback from CT when phase out planning has been started and key customers informed
4. EMS contract check is totally missing at the moment
5. Supplier contract check should be earlier
6. PLM should make communication plan already before C6
7. Phase out letter should be sent earlier to customers
8. HWS EoL planning should be earlier
9. The last ordering date of HWS modules and spare parts should be earlier
10. Customer analysis should be done more precisely. Is there resources enough for exact customer analysis?
11. Internal Po announcement should be shared as pre-notice to external stakeholders, to open discussion about Po.
12. Phase out letter info does not reach suppliers/EMS
13. Feedback missing from suppliers/EMS after phase out letter published
14. Last orders and forecasts come too late from customers, last forecasts are not binding
15. Too many exceptions with C8 and C9 (orders after C8 and deliveries after C9)
16. Po planning should be included in feature screening phase
17. Customer contracts and communication could be improved, quick phase out should be taken into account

Figure 11. Prioritization of findings based on benefits and complexity

Other prioritization method used in the second workshop was basic voting where every participant had three votes. Participants gave votes for findings which they saw to be the most important ones from phase out process development point of view. Participant could give only one vote for one finding so votes for three different findings were given per participant.

Totally 7 findings got votes. The top three findings based on the voting were 1, 16 and 17. Finding no 1 got 5 votes, finding 16 got 4 votes and finding 17 got 3 votes. The results of voting is presented in the figure 12.

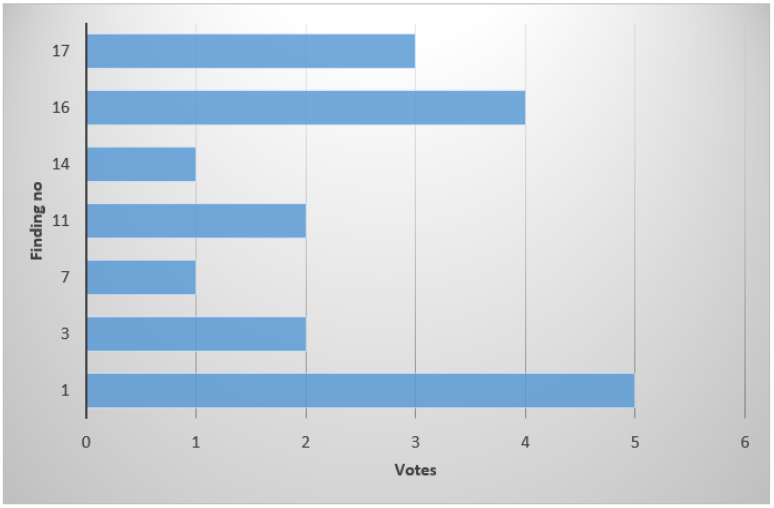


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Figure 12. Prioritization of findings based on voting

5.1.5 Agreed further actions for findings

Findings were divided into the three different category after workshops. The purpose of categorization was to make easier to find an owner for corrective actions and thus agree further actions. Findings were categorized as described below:

Category 1, NET phase out process related findings.

- C6 should be earlier, planning should be started backwards from P8.
- PLM should make communication plan already before C6.
- Phase out letter should be sent earlier to customers.

- Internal Po announcement should be shared as a pre-notice to external stakeholders, to open discussion about Po.
- Po planning should be included in feature screening phase.

Category 2, delivery capability phase out process related findings.

- EMS contract check is totally missing at the moment.
- Supplier contract check should be earlier.
- HWS EoL planning should be earlier.
- The last ordering date of HWS modules and spare parts should be earlier.
- Phase out letter info does not reach suppliers/EMS.
- Feedback missing from suppliers/EMS after phase out letter published.
- Last orders and forecasts come too late from customers, last forecasts are not binding.

Category 3, CT activities and communication related findings.

- C6-C9 information does not reach Solution Manager in CT when PLM has done internal phase out announcement.
- PLM has problems to get feedback from CT when phase out planning has been started and key customers informed.
- Customer analysis should be done more precisely. Is there resources enough for exact customer analysis?
- Customer contracts and communication could be improved, quick phase out should be taken into account.
- Too many exceptions with C8 and C9 (orders after C8 and deliveries after C9).

NET phase out process related findings relate the main phase out process and corrective action must be done for upper level phase out process. Delivery capability phase out process related findings relate to the delivery capability sub-process and corrective actions must be done in sub-process level. CT activities and communication related

findings do not relate directly to the phase out process or its sub-processes. CT follows their own procedure in phase out and many of the findings relate more and less to poor communication between phase out process and CT organization.

Corrective actions for all findings which belong into the category 1 were decided to implement with NET phase out process owner. Only finding which related to sharing an internal phase out announcement as a pre-notice to external stakeholders needed further investigation before implementation. The next release of NET phase out process is released early next year and corrections for findings will be implement in the new process release.

Finding which relates to the late and unsure forecasts and orders from customers was ruled out from corrective actions in category 2 because it was noticed that it is not possible to affect this issue only by updating the delivery capability process. All other findings were decided to correct with delivery capability process owner. The next release of delivery capability process is released early next year as well and correction for findings will be implement in the new process release.

Corrective actions for findings which are in category 3 were still open when this thesis was written. The reason was that owner for corrective actions was not clear because CT is following own procedure in phase out process and therefore CT representative is needed for corrective actions. Actions were ongoing in company when this thesis was written to define right owner for corrections of this category findings as well.

5.2 Evaluation of outcome of VSM workshops

This VSM was the first improvement activity which was done for whole phase out process. All participant in the workshops agreed that phase out process does not work very effectively at the moment and this cause unnecessary cost. Therefore there was a clear need for improvement activities and participant were very committed to do VSM

for phase out process. Based on the discussion at the end of the second workshop participants agreed that VSM as a tool was very suitable to identify issues from process flow.

VSM sessions were very successful and current state map revealed that there are a lot of improvement possibilities in phase out process. Even though this VSM was done on the upper level of C6 and C9 stages of phase out process still 17 findings or issues were identified from current state map which weaken the performance of phase out process. It was decided in the VSM workshops that future state map is not done and focus is in the identification of findings from current state map. Still VSM was good and practical tool for identification of improvement possibilities from phase out process. It is recommend to continue phase out process development because there still a plenty of improvement possibilities in phase out process and its sub-processes.

Some of the finding were very beneficial from shortening the production overlap time point of view but affection of some findings were medium or even low. It is still important to understand that the estimated time and financial benefits presented in this chapter based on the estimation that all findings were corrected. Even though the direct impact of single finding could be low for production overlap time it is still important correct all findings because they are liked each other. So single not so important finding could affect the implementation of some other finding which could affect much the shortening of production overlap time.

It would have been very beneficial to invite participant from CT as well into the VSM workshops but unfortunately this need was not recognized in planning phase when participant for VSM was decided. It was noted during the workshops that there are many important findings where CT is the key player. Because CT representative was not in the workshops it made agreement of corrective action which relate CT activities more difficult. This was a clear evidence of importance of selecting the right persons for workshops.

5.2.1 Possible benefits in time

As wrote the future state map was not done in VSM workshops because it was not possible to change the order of task or remove any tasks from phase out process flow and therefore focus was in waste identification. It was decided that the possible benefits which can achieved with corrective actions of findings are estimated based on the real PiPo case. This estimation is a kind of substitute for the future state map and makes possible benefits visible.

Estimated benefits in time are described in the figure 13. Actual PiPo process describes the plan for real PiPo case which is ongoing at the moment. Figure shows dates for C6 - C9 milestones of phase out product and duration of every stage between the milestones. Dates for V3, V7 and V8 milestones and durations of these stages for phase in product are given as well. As described in the figure time between V8 and C9 milestones is 10 months which is the actual production overlap time in this case.

Improved PiPo process describes the situation where the all findings done in VSM workshops have been corrected. Phase out activities are now started much earlier and production overlap time is now shortened from 10 to 3 months. Phase out planning is started backward from V8 milestone of phase in product and this milestone is synchronized with C8 milestone of phase out product. The dates of phase in product milestones are same like they are in actual PiPo process, only dates of phase out process are changed. Also duration of different stages in phase out process are described to take same time in improved and actual cases but these stages will most probably be shorten after corrective actions. This does not necessary affect much the production overlap time and therefore effect of correction are not estimated in the duration of stages.

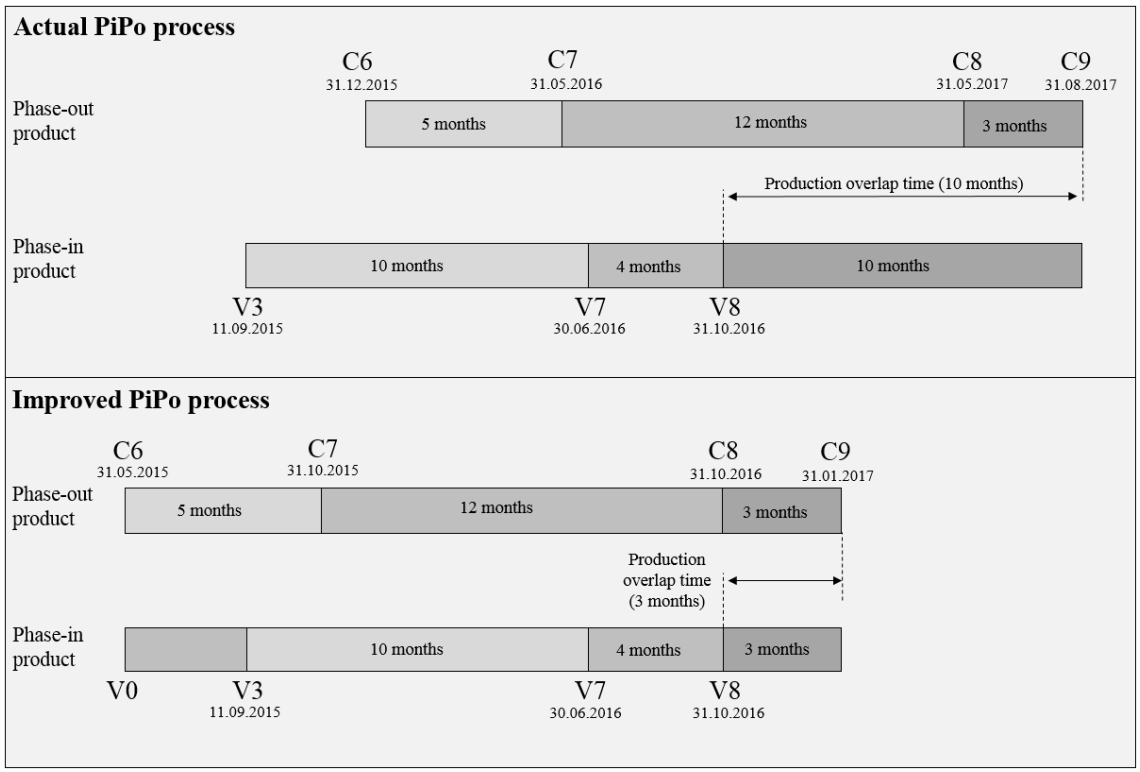

Figure 13. Estimated benefits in time

Based on the estimations and analyzes production overlap time can be shortened from 10 months which is average overlap time at the moment to 3 months in a long term. It is very difficult to define exactly how would improvements in one category affect the overlap time but some rough estimations are presented below:

- Effect of NET phase out process related findings is **high**
- Effect of Delivery capability phase out process related findings is **medium**
- Effect of CT activities and communication related findings is **low / medium**

As wrote planning activities like C6 milestone must be much earlier and C8 and V8/P8 milestone must be harmonized. These changes in phase out process are possible only if all findings are corrected because all findings are linked to each other. Therefore all

findings need to be fixed to achieve estimated benefits although direct effect of single finding could be low.

There are still some important points which need to be taken into account that the long term target is possible to achieve. These points based on the discussions after the workshops with different stakeholders who have a lot of experiences about the execution of PiPo process and thus very deep understanding how the process works.

- It is very important to pay attention to the customer relationships of the key customers who are most involved in the PiPo process.
- Phase out must be a solid part of the customer communication already in early phase.
- Quick phase out must be taken into account when making the new customer contracts.
- Phase out must be part of the phase in planning at the beginning of product program (already in feasibility screening phase).
- High SW deployment rate is an essential part for fast ramp-up of phase-in product.
- Estimated benefits in time are valid only for radio module products.
- Gap between C7-C8 milestones is one year and it comes from customer contracts at the moment. This one year gap is default at the moment but this must be challenged to get it shorter.
- Accuracy of P8/V8 milestone of phase in product is an essential to achieve estimated benefits because phase out planning is started backwards from P8/V8 milestone immediately when the schedule for phase in product is available.
- Maturity of phase in product must be high enough that customers are willing to buy it when P8 / V8 milestone is achieved.

- Seamless cooperation between phase in and phase out processes is extremely important (risk assessment & mitigation planning). Nowadays communication is not efficient enough.
- CT activities and communication related findings affect much C8/C9 customer specific exceptions.
- Corrective actions for findings help to ramp down production lines which also shorten production overlap time, especially in cases where several production locations are used.

5.2.2 Possible financial benefits

Financial benefits of corrective action of findings were also estimated to show how much can be saved if production overlap time is got shorter. Three old actual PiPo cases were used in estimation. The production overlap time was 15 months in the first case, 18 months in the second case and 30 months in the third case. Examples show what could have been saved if proposed improvement activities would have been taken into account in phase out process and production overlap time would be only 3 months. In the other words cost shown in the figure 14 would have been saved if overlap time would have been only 3 months.

Financial benefits and exact calculation in euros are company confidential information and therefore not presented in this report. Anyway can be said that estimated financial benefits in the three PiPo example cases are several million euros together. Only difference in marginal profits of phase in and phase out products were taken into account in the calculations. There are still other cost like production and maintenance of old product related cost which increase the amount of total cost. It was too difficult to take these cost into account in the estimations so therefore these were ruled out. Difference in marginal profit gave still a good view how expensive the long production overlap time is for the company and therefore how important is to get it shorter.

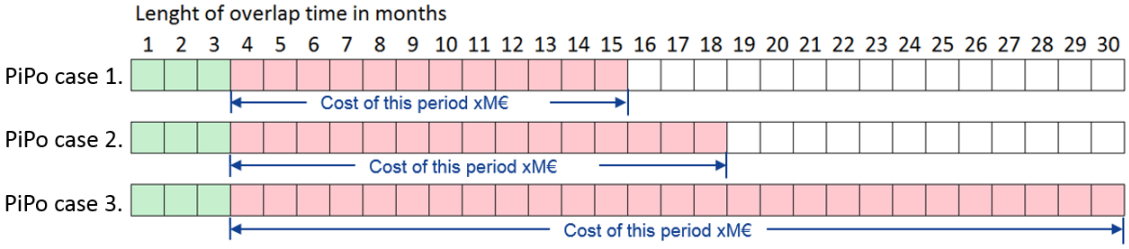

Figure 14. Estimated financial benefits

5.3 Evaluation of suitability of VSM for phase out process improvement

VSM is developed for manufacturing processes but nowadays it is widely used in office environment as well. Even though VSM is not necessarily suitable as such for administrative processes it is still very practical and useful tool for process development. This was noted also during this theses. The current state map of VSM was very visual view of process and it helps participants to perceive how the process operate at that moment. It is very easy to discuss about the process flow and figure out what creates value and what does not when process flow is opened in current state map. It basically open the eyes to see possible problems and therefore helps to open discussion about the problems in process. VSM for phase out process workshops showed also that it is easy to identify issues from process flow when current state map is done. When task was put on the map participants could pretty easily find out all issues which related to the task.

In this project VSM was used only for identification of findings which weaken the process flow and affect the production overlap time. In this case future state map was not done because it would have been exactly same like current state map because changes were not possible to do. Even though only the current state map was done in workshops it was still very efficient tool to identify issues from phase out process and fulfilled the targets which were set for VSM for phase out process workshops.

It was also noted in VSM workshops that selection of suitable metrics is difficult in administrative processes. Some kind of metrics is still important to define because otherwise it is not possible to measure what is the effectiveness of process. And if you don't know what is effectiveness of process at the moment you can`t know how well the improvement activities really work and is the process more efficient after improvements.

Time and cost are the most common metrics in administrative processes and these were used in phase out process development as well. The time and cost of individual tasks were not estimated in current state map. Only times between C6 – C9 milestones were marked on the map. In this case focus was in production overlap time which was the real target for VSM. Production overlap time was analyzed from old actual PiPo case point of view and then it was estimated how the corrections of findings would affect the production overlap time. Also cost were estimated addition to time. This was a kind of substitute for future state map and helped to communicate how the phase out process should be done in the future.

When correction for finding are implemented it is easy to compare how much shorter is the production overlap time of new and old products. There are plenty of old PiPo material available which can be used as a reference when compared the difference in production overlap time between old and new PiPo cases. And if it seems that result is not as estimated it is important to analyze what was gone wrong that same mistake can be avoided in the future.

Like mention VSM was applied pretty much in phase out process development but still it was effective and suitable tool which gave very good results. As mentioned in the chapter 2.1 Keyte and Locher have wrote that the challenge in office environment is usually to find out creative way to use lean methods so that the benefits can be achieved. The results of this VSM project support this theory because by applying VSM the set

target was achieved and a lot of good experiences were gained which can be used in further VSMs in office environment.

VSM can without doubts be recommended for different kind of administrative process improvement activities because it is multi-use tool which can be used case-specific for different kind of purposes like done in this thesis. There is not only the one right way to do VSM and it can always be adapted according to the requirements of process development case. Recommendations for further VSM workshops are given in the next chapter to help to use VSM for administrative process improvements and also help to arrange VSM workshops.

5.4 Recommendations for further VSMs

Some recommendation for further VSMs are given in this chapter. These recommendation based on the experiences got during this thesis. Also literature references and other VSM cases which were done for company earlier are exploited in the recommendations.

Before starting the planning activities process which is going to be improved must be selected. Process must be suitable for VSM because it does not make sense to use VSM just for the reason that it is efficient tool. In other words process must be analyzed and it must be suitable for VSM to get clear benefit from VSM activities. On the other hand VSM is multi-use tool and can quite an easily be adapted in different purposes as wrote in the previous chapter so based on this VSM can be used for most of the process improvement activities.

It is also possible that there is need to improve several processes at the same time but resources are available only for one VSM. Then improvement needs must be prioritized somehow. It can be done for example by calculating financial benefits of improved activities and the processes are put on the order according to financial benefits and the

most beneficial is selected for VSM at first. It is also possible to arrange voting to prioritize the needs. Team who has a wide and deep knowledge about the needs and influences about improvement activities can vote which of the processes is selected first for development activities.

When process is selected and suitability of VSM for process improvement is analyzed and ensured it is time to start planning of VSM. Planning phase of VSM is very important and must be done carefully that the execution of VSM is successful and thus get good results. One extremely important task in planning phase is to select the right person for VSM sessions. Without the right persons VSM cannot be executed properly and results of VSM are not useful. It is even possible that wrong persons can make wrong conclusions and decisions in mapping process and this can even weaken the performance of process which is under the improvement. Persons must come from different areas of process to ensure wide understanding about the function of process.

One or two specialists from one process area would be recommended. There were 12 in the first and 10 persons in VSM for phase out process workshops and they were from different stakeholders groups. Amount of participants were very suitable and can be recommended for further VSMs as well if the size of VSM is 10-30 tasks as recommended in literature. It was noticed in VSM workshops that CT should also have been invited into the workshops. The importance of CT was not recognized in planning phase and therefore CT representative was missing from VSM workshops. This demonstrates that very careful planning is needed to get all important participant into the workshops.

Professional facilitator is the key to the success when doing VSM. Facilitator ensures that everything goes fine and all important things which relate to VSM activities are taken into account in VSM workshops. One professional facilitator was used addition to thesis worker in VSM for phase out process workshops. VSM workshops gone through smoothly and without any issues thanks to facilitator who already had

experiences about execution of VSM and was very familiar with lean methods and tools.

Workshops can be executed as a whole day sessions or shorter session. To shorter sessions were the optimal solution in this VSM case. Two 3 hours session were arranged at weekly intervals and it was enough in this case. It was much easier to find a suitable time slot from calendar for 10 or 12 person when length of sessions was 3 hours. 3 hours would be a minimum duration for one session because VSM is still time consuming and if session are split for shorter sessions focus will suffer. If participant are traveling to the workshops then whole day meetings are the better choice.

To find a suitable room for VSM workshop is one task which is good to do already in planning phase as well. Many time companies do not have many meeting rooms which are suitable for 10 – 20 person workshops and therefore reservation is important to do early enough. It is also good to view the room before actual workshop and ensure that there really is space enough for workshops. It is not enough that there are chairs for everyone there must also be enough room to make current state map on the wall. Some challenges were in the second workshop of VSM for phase out process because room was not checked beforehand. There were chairs for all participant but room was a little bit too narrow and mapping was a bit difficult.

Exactness level of mapping need to be decided before VSM workshops and making the current state map. In other words how deep and detailed breakdown will be done from process in current state mapping. It is important to analyze what is the sufficient level to achieve the set goal but also at the same time keep mapping process manageable. In this thesis 21 tasks were mapped in the current state map and this was very suitable amount. Mapping was easy to manage and it also provided needed results. 10 – 30 tasks is recommended in literature and this can be used as a guideline when planning the exactness level of process mapping.

The VSM workshop itself must be face to face meeting so all participants must be in the same room. Conference call is not recommended because it would make the execution of VSM workshops very difficult because current state map is done on the wall of meeting room. There were one very essential person in this thesis who was not able to join face to face VSM workshop but anyway it was still decided that conference call workshop is not arranged because of difficulties in VSM execution. Result were reviewed with the person right after both workshops and therefore person was able to give the feedback for VSM. This procedure worked finally fine and can be recommended for other VSM workshops if same problem exists.

Current and future state maps are easiest to do with different color sticky notes and pencil into the big white paper put on the wall which is a kind of base for mapping. Sticky notes are very handy way to build up the mapping because they can be easily moved if needed so making correction for mapping is very easy. A base for mapping can be built for example with flip chart papers which are put side by side on the wall. In this VSM totally eight flip chart papers were put on the wall by tape. Picture from the current state map of VSM for phase out process is presented in the appendix 2. This current state map was easy to remove when workshop was over and put back to the wall in the next workshop session.

Suitable metrics need to be also defined for mapping. Lead time vs actual process time is often used and it is suitable for most cases. It is also important to calculate what the financial benefits are which are possible to achieve with process improvements. VSM participants leaded by facilitator can define what the best case-specific metrics is. Like in this case production overlap time was the main metrics and also financial influences were calculated and estimated even though these were not visible in current state map. Waste identification is the main target of VSM. All task need to be evaluated and categorized to VA, NVA and NNVA groups. Ideal future state map would include only value adding tasks but this is not normally possible. Any tasks were not removed or places changed in this thesis because it was not possible to do. Focus was to identify

all issues from every tasks which were mapped. So VSM can be used for process improvement also so that when current state map is ready the issues which relate to mapped tasks are identified and later corrected.

Based on the results of this thesis future state map is not necessity even though it is always recommended to do if possible. It was aligned with facilitator that in this case it does not provide any addition value to do future state map as wrote earlier and therefore it was not done at all. Affections of improvement activities were estimated other ways and still VSM provided good results.

When waste identification is done findings should be prioritized for corrective actions. This helps especially in cases where only limited resources are available for implementation of corrective actions. Two good and simple tools for prioritization are benefit vs. complexity diagram or voting. Both were used in this thesis and these can be recommended for further VSMs as well. The last but not least thing is follow up of agreed further actions. There must be clear responsibility persons for all issues and action points. Also one person must be nominated to arrange and lead follow up meetings. If corrective action are not implemented any benefits cannot be achieved and whole VSM is just waste of time. Therefore agreement of corrective actions for findings and follow up of actions are very important.

5.5 Further development possibilities

This thesis was the first improvement activity which was pointed to phase out process so for sure there are still many areas where further development activities can be done. Phase out process was analyzed only on the upper level between C6 – C9 milestones so if phase out process or its sub-processes are analyzed more exactly more benefits can be achieved. And of course there might be more improvement possibilities if the whole PiPo process is investigated instead of phase out process. Based on the result of this thesis production overlap time of old and new product can be reduced from current

10 months to 3 months. One further development possibility would be to investigate how to get the production overlap time from 3 months to 1 month which Nokia top management was set as a long term target.

6 CONCLUSION

This thesis was done for Nokia Mobile Networks. The purpose of this thesis was to analyze and improve phase out process by value stream mapping (VSM) to get production overlap time of old and new product shorter. Other purpose of this thesis was to gain experiences how to use VSM for improvement of administrative processes. This chapter summarizes the answers to the three research questions and evaluates the results.

The chapter 2 in this thesis is a theoretical review of literature which aim is to give an answer to the first research question: *"How to use VSM to analyze and improve administrative processes?"* Use of VSM in administrative processes differs from manufacturing operations. Value stream in manufacturing processes is usually straightforward where parts and materials are flowing. Administrative processes are often more complicated and information is flowing in value stream instead of parts and materials. Using the VSM in administrative processes the main steps are still quite a same like with manufacturing processes. These steps are preparation phase, current state mapping, future state mapping and planning & implementation phase. Anyway even though the main steps are same the VSM must be often adapted somehow in administrative processes to get needed results.

The main tasks in preparation phase are to define the process which is purpose to improve, decide the exactness level of mapping and define the team for VSM which includes all key stakeholders. The main tasks in current state mapping are define suitable metrics for mapping, identify all relevant tasks in process flow and identify waste from process flow. When the current state map is ready then future state map is done. The future state map is redrawn version of the current state map where waste elimination and all other improvement activities are taken into account. The future state map shows the improved process flow and value stream. The last step in VSM is planning and implementation phase which purpose is to reach future state map and

therefore it is very important. The current and future state maps helps to identify waste and to find out improvement possibilities be but if corrective actions are not planned and implemented the results of mapping are just waste.

The chapters 3 and 4 in this thesis introduce a study environment and how the VSM was executed for phase out process. These chapters give an answer to the second research question: *"How to execute VSM for phase out process to get production overlap time shorter?"* Execution of VSM for phase out process differed a little from the model which is presented in literature. There were some challenges in the preparation phase to define which part of phase out process will be mapped. Phase out process is very wide entity and it includes several sub-processes and many stakeholders are involved on it. Finally it was decided that focus will be in C6 – C9 stages because these stages affect production overlap time most. C6 milestone means that product is ready for ramp down, C7 is end of marketing, C8 end of ordering and C9 end of deliveries.

It was decided that only tasks which affect the most the production overlap time will be taken into account in the current state map because otherwise there will be too many task which makes the managing of VSM difficult. VSM workshops were held in two different 3 hours sessions where 12 person were in the first session and 10 person were in the second one. Current state map was done into the big white paper which was put on the wall. Roles of stakeholders, tasks and issues were marked with different color of sticky notes and pencil was used for marking. Totally 21 tasks were identified to be important from production overlap time point of view.

Lead or process times were not used in current state map and only estimation of time between C6 – C9 milestones were marked on the map. It was agreed already before the workshops that production overlap time is the main metrics in VSM. The target of this VSM was to find out improvement possibilities to shorten the production overlap time by improving phase out activities and therefore production overlap time was used as a

metrics. One actual PiPo case was used as a reference and with this case it was estimated how corrections of findings done in workshops would affect the overlap time. Estimation was done based on discussion with experienced key stakeholders who have very deep knowledge about the PiPo process.

Future state map was not done in this VSM case. Changing the order of tasks or remove any tasks were not possible to do so future state map would have not been provided any value. Estimation of possible benefits in time was used as a substitute for future state map which shows how phase out process should be executed in the future to get production overlap time shorter. Also possible financial benefits were estimated based on the three actual PiPo case. Even though the VSM was applied quite a much in this thesis it still gave good results and set target was achieved.

The chapter 5 presents the results of this thesis and gives an answer to the third research question: *"What are the improvement possibilities found by VSM and how suitable tool it was for process improvement?"* VSM for phase out process revealed that there are a lot of improvement possibilities in phase out process. There was 21 tasks on the current state map and 17 findings were identified which weaken the performance of process flow and affect production overlap time. Some findings affect directly just a little to overlap time but it is still important to realize that almost all findings are linked each other someway so single not so important finding could affect much the implementation of some other finding and this combination can affect much the production overlap time. Therefore all finding need to be fixed to achieved estimated benefits

The findings done in the VSM for phase out process can be summarized as follows. Phase out activities are stared too late at the moment and this extends the production overlap time so early and careful planning is extremely important to get production overlap time shorter. Also communication between different stakeholders is not good enough and this cause unnecessary delays or even mistakes in planning and execution

of phase out. The third thing is customer contracts which do not support quick phase out activities because there are often mentioned that both old and new product must be available for example one year. All 17 finding related more or less to these three issues.

Affection of corrective actions of findings are analyzed from time and financial point of view. Based on the estimation production overlap time can be shortened from current 10 months to 3 months by implementing correction for findings. Estimation of financial benefits were done based on the three actual PiPo cases. Only with these three cases estimated saving were already several million euros so by implementing the corrective actions it is possible to achieve really significant savings when improved phase out process is used in all PiPo cases.

VSM was applied pretty much in this thesis from recommendations and instructions given in a literature. Still VSM was effective and suitable tool for improving phase out process and it gave very good results. VSM can be recommended for different kind of administrative process improvements because it is multi-use tool which can be applied and changed case specific like done in this thesis. It is recommended to have experienced facilitator when applying VSM who know the limits of VSM tool and can help to adapt VSM according to needs.

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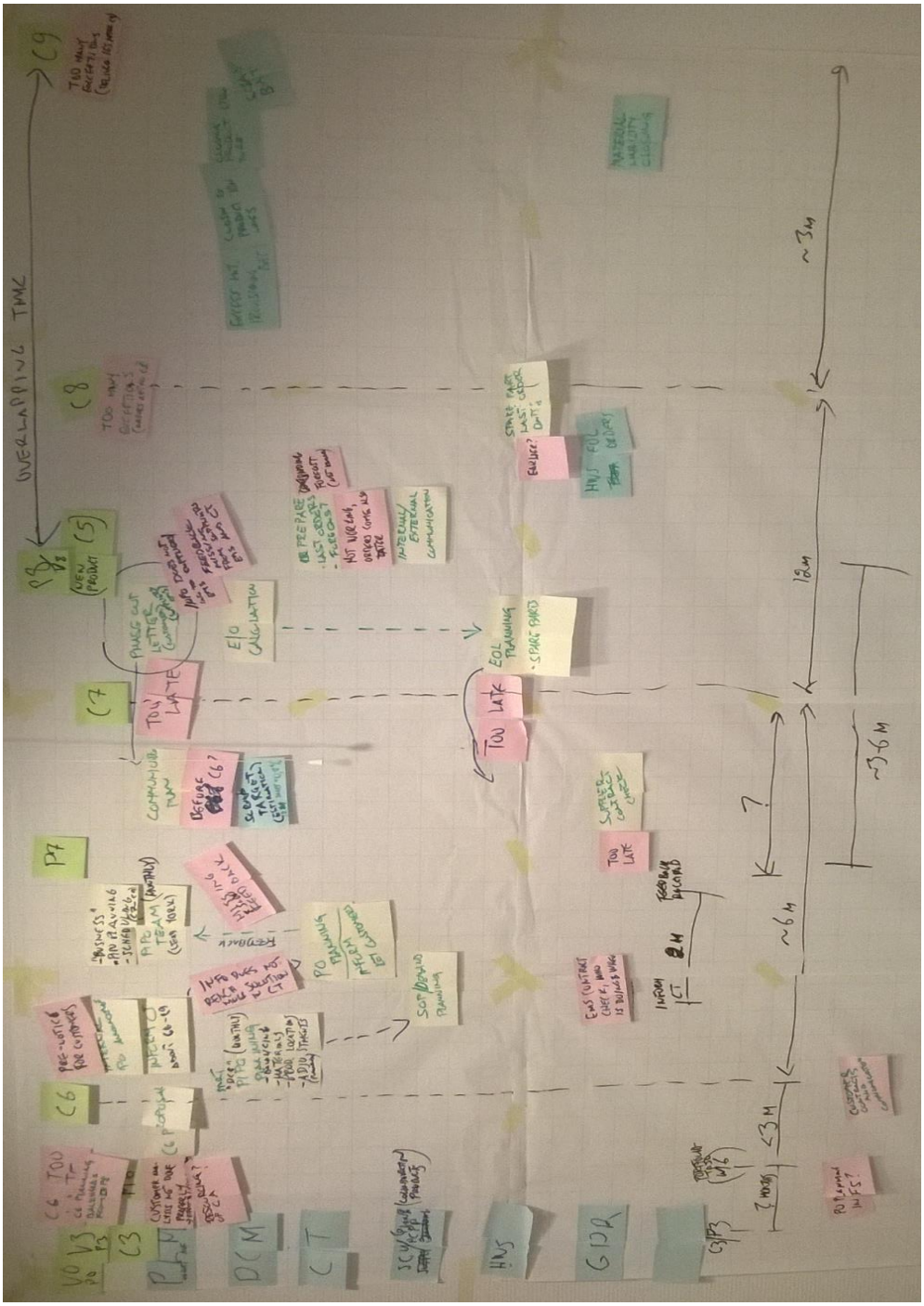
APPENDIXES

APPENDIX 1/2 Photograph of current state map



APPENDIX 2/2 Current state map in electronic format