



CROSS-FUNCTIONAL SUPPLY CHAIN MANAGEMENT

Recognizing the need and implementation

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ABSTRACT

The aim of the thesis is to find bottlenecks and root causes of the poor reliability of the deliveries in the internal supply chain in a case company called Lahden Autokori Oy (LAK). The company manufactures bus bodies for Scania CV AB, and the product is called OmniExpress. The departments have difficulties to follow the time schedule and they are lacking methods and metrics (KPIs) which could indicate the problems earlier in the process, and prevent the end result from being poor. The company filed for voluntary bankruptcy in September 2013, but it'll have a second chance after Scania CV AB has bought it (1st of May 2014). The research gives a current state picture for the new owners.

The aim of the research is to explore cross-functional management, as the organization is struggling to have the information and the materials in time without disturbing the flow in the production line. The theoretical part of the study is built around Lean and how to succeed in Lean transformation. The cross-functionality is explored through Lean leadership; how to see the abnormalities, measure the process, raise the accountability of the operators and how to use visualization in order to understand what is normal and what is not –Eventually, how to eliminate the bottlenecks which prevent the flow.

The research method chosen is an action research including a quantitative method approach and observations. The idea of the method is taken from Scania Slupsk, Poland, but modified according to Mann's (2010) view of leader standard work. The method is built around cross-functionality, regular meetings and a visual board, which demands accountability of the operators. Through the method, data was collected and the results were shown as numeric facts.

As a result the bottlenecks and root causes were found, however the main conclusion of the research is that there is a lack of cross-functional management in the organization. There is a lack of cross-functional methods and tools to support the information to flow in the process and the company is missing cross-functional KPIs, which indicate the problems earlier in the process as earlier only the end results were measured and known.

As an improvement suggestion the company should implement leader standard work (Mann 2010) for each organization level and use visual planning to help daily steering. Time related KPIs, the response times for each department, should

be re-evaluated and visualized to be able to control the process and raise the accountability of the operators. The company should start Lean transformation.

Keywords: cross-functionality, Lean, Six Sigma, supply chain management, visual

CONTENT

1	INTRODUCTION	1
1.1	Background	2
1.2	Thesis aim, objectives, research questions and scope	3
1.3	Theoretical framework	4
1.4	Research strategy and methods	5
1.5	Thesis structure	7
2	LEAN & SIX SIGMA –TOWARDS CROSS-FUNCTIONALITY	8
2.1	Introduction to Lean	8
2.1.1	Conventional vs. Lean supply chain management	10
2.1.2	Resource and flow efficiency	11
2.1.3	Efficiency paradox	12
2.1.4	Three main laws of Lean	14
2.2	Defining abnormalities	16
2.2.1	Principles of Lean: Jidoka & JIT	18
2.2.2	One piece flow	19
2.2.3	5S	22
2.3	Lean Six Sigma	23
2.3.1	Measuring performance	23
2.3.2	SPC-theory –variation	24
2.3.3	Identifying bottlenecks	28
2.4	Towards Lean management	29
2.4.1	Four elements of Lean management	31
2.4.2	Lean transformation	33
3	RESEARCH APPROACH AND METHODS	37
3.1	Lahden Autokori Oy –introduction	38
3.2	Research method and visual tool, TITO	41
4	RESEARCH FINDINGS	45
4.1	Theoretical lead time and variation	46
4.2	Amount of deviations and warnings	47
4.3	Bottlenecks	49
4.4	Response times	52
5	DISCUSSIONS AND CONCLUSIONS	53

5.1	Discussions: theory meets practise	53
5.2	Improvement suggestions	56
5.2.1	The plan	57
5.2.2	Lean management	57
5.2.3	Focus on time	60
5.2.4	Continuous improvement	60
5.3	Conclusions	61
	REFERENCES	64

LIST OF FIGURES

Figure 1. The scope of the thesis in supply chain	4
Figure 2. The research questions in theoretical framework	5
Figure 3. The scope of the research in DMAIC-method	6
Figure 4. The structure of the thesis	7
Figure 5: House of Toyota Production system (Holland 2010)	9
Figure 6: The 7 wastes (Earley 2014).	12
Figure 7: Efficiency matrix (Modig & Åhlström 2013, 98)	13
Figure 8: Little's law	15
Figure 9: Toyota Production System house (Lean Enterprise Institute, 2014).	17
Figure 10: Toyota Production System (Modig & Åhlström 2013, 138).	18
Figure 11: Example picture of VSM (BreezeTree Software 2014)	21
Figure 12: 5S (TPF Europe bv 2014)	22
Figure 13: Example of KPI-chart in production	24
Figure 14: Six Sigma, normal distribution (The Innovation Consultancy Partnership , 2014).	25
Figure 15: Control chart and normal distribution (Straker 2014).	26
Figure 16: Example of a control card (Runkel 2012).	26
Figure 17: SPC-chart before and after improvement (McNeese 2012).	27
Figure 18: Pareto-chart, paint defects	28
Figure 19: Example of a histogram (Straker 2014).	29
Figure 20: Lean management system (Mann 2010, 43).	32

Figure 21: Kübler-Ross curve (Lee 2014).	34
Figure 22: History of the products made by Lahden Autokori Oy	39
Figure 23: Sales and export countries	40
Figure 24: Market shares, buses/coaches in Europe over 16 ton (Autobei 2012)	41
Figure 25: TITO, a visual tool, white board	42
Figure 26: Structure of the white board, section 1.	42
Figure 27: The card	43
Figure 28: Structure of the white board, section 2	44
Figure 29: Theoretical process time, histogram	46
Figure 30: Theoretical process time, boxplot	47
Figure 31: Amount of warnings	48
Figure 32: Amount of warnings	48
Figure 33: Standard, Special and proto: Amount of deviations and warnings	49
Figure 34: Bottlenecks in timeline	50
Figure 35: Bottlenecks in departments	51
Figure 36: Bottlenecks in solution time	51
Figure 37: Structure of the organization	58
Figure 38: Example of a activity white board (Scania 2013)	59

LIST OF TABLES

Table 1: Difference in habits and practices between mass and Lean cultures (Mann 2010, 18).	11
Table 2: Benefits of value Steam Mapping (Väisänen 2013b).....	20
Table 3: Visible attributes of different cultures in Mass and Lean production (Mann 2010, 15 - 16).	30
Table 4: Basic information: Lahden Autokori Oy	38
Table 5: History in brief	38

1 INTRODUCTION

Companies are continuously facing challenges in changing global markets. This means that the manufacturing processes must be optimised; there is a constant need for higher product development speed, manufacturing flexibility, eliminating waste and to improve controlling processes. (Azharulm & Kazi 2013.) Many companies have chosen Lean, which originates from Toyota Production System (TPS), in order to improve or even to rescue their company, but many have failed. For example, only less than ten percent of the companies in UK have accomplished a successful Lean implementation (Bhasin 2012.) Many have turned into external consultants and struggled to sustain the results after the consultants have completed their projects. Instead of using external help, Toyota has a different approach towards Lean. TPS is an integrated system where each team member, leader and every worker in each level own, operate and continuously improve their processes. (Liker & Convis 2012, 144).

The communication between the departments and individuals is vital in order to react if deviations are found. Tayloristic way of managing the company leads departments to take care only of their own business (Väisänen 2013a). In this thesis Taylorism is considered as conventional mass production management. Without having a holistic picture of the whole supply chain, people tend easily to repeat the same mistakes and the deviations are not found until in the end of the production line and the end result is usually poor reliability of the deliveries. This thesis focuses on a case company where conventional mass production management style will be shifted towards Lean-philosophy keeping Toyota as an example emphasizing the matter of cross-functionality and visualisation.

Under this introduction chapter the background of the thesis is discussed in the subchapter 1.1 giving an overview why the author chose the subject of the thesis. In chapter 1.2 the aim of the thesis is presented and the research questions are identified. The scope of the thesis and the stakeholders of the research are also presented in subchapter 1.2. Subchapter 1.3 gives an overview of the theory and the research strategy and the methods are discussed in subchapter 1.4. The structure of the thesis is visualised in subchapter 1.5.

1.1 Background

The case company of the thesis, Lahden Autokori Oy, has faced numerous challenges during the last years. The problems at the case company have been severe; the deliveries have been continuously late and the cash-flow has been poor. The company is struggling to have information and materials in time without disturbing the flow in the production line. Also, different departments have difficulties to follow the time schedule and they are lacking methods and metrics, which could indicate the problems earlier in the process, and prevent the end result from being poor. Eventually, the problems are cumulated in the end of the production line when it is too late to react in order to deliver the orders in time.

The lack of communication between departments seems very obvious. People are used to “minding their own business” and therefore the holistic picture of the management of the supply chain process is lost. There are no adequate methods or tools to support cross-functional management as the leadership is strongly based on the tayloristic way of management. The earlier attempts to stop running after the deviations has failed one after another. The Key performance indicator (KPI), reliability of the deliveries has been poor, which led the Managing Director to ask the operative group to take the challenge to find the bottlenecks from the supply chain. In an environment where the culture is not cross-functional and where leadership is based on individuals, not in a system, people tend to repeat the same mistakes. It was obvious that the task to identify the bottlenecks was not only a simple problem solving project but something more. The challenge to find the bottlenecks and root causes needed a tool where fact-based data can be measured, but also it had to work as a method which brings the departments closer to each other. The subject of the thesis was born.

In September 2013 the case company filed for voluntary bankruptcy and the story of a family owned business died after manufacturing the bodies for buses and coaches since 1945. The production though did not die, but continues since Scania agreed to buy the company in December 2013. The ownership changes from May 2014. The case study in the thesis was performed just before the bankruptcy and

the results and improvement suggestion have been presented to the new owners. The implementation of some of the improvements has already started.

1.2 Thesis aim, objectives, research questions and scope

The aim of the thesis is to learn about cross-functional supply chain management in order to find improvement suggestions through the case study for improving the reliability of the deliveries and internal communication.

The main problem of the case company was the poor reliability of the deliveries. As there is no system how to measure or identify the problems earlier in the process, the objective of the thesis is also to create a tool which works not only as a reactive tool to support real-time management but also gathers data for the analysis, where the bottlenecks can be indicated and root causes analysed for future improvements and proactive actions.

Main research questions:

- How to manage the supply chain cross-functionally?
- How to improve the poor reliability of the deliveries?

Sub-research questions:

- How to measure the supply chain in order to find the deviations earlier in the process?
- What are the bottlenecks in the supply chain process and when do they occur?
- What are the root causes of the deviations in the supply chain process?

The concept of a supply chain can be categorised in three different levels – Internal, Supply and Customer level (Boon-itt, 2009). The scope of the thesis is to focus on finding the bottlenecks from the internal supply chain as the research reveals the problems which arise from inside of the organization.

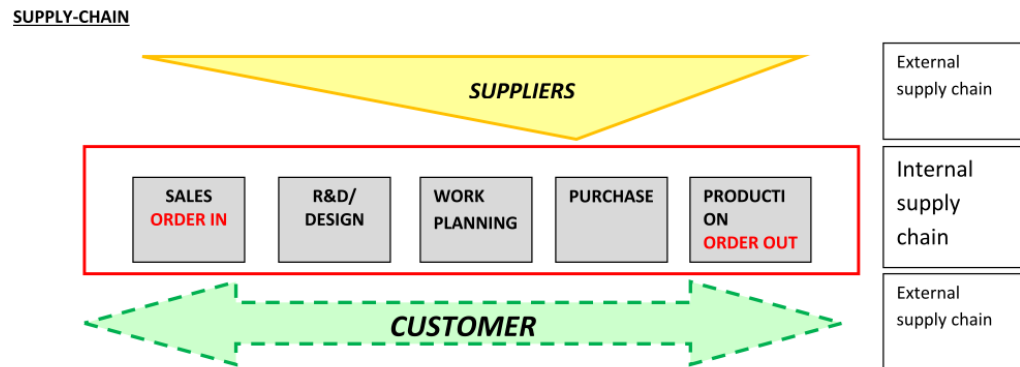


Figure 1. The scope of the thesis in supply chain

The scope of the thesis is presented in figure 1. The thesis focuses on the company's internal supply chain and the stakeholders are the departments presented in the figure 1.

1.3 Theoretical framework

The theory bases strongly on Lean-ideology and Six Sigma methods. The theory of cross-functional supply chain management is explored through Lean philosophy in order to understand how to manage internal supply chain and how to improve communication and make the orders flow smoothly in the supply chain process. The theory is structured first to introduce the fundamentals of Lean. To be able to see the deviations in the process the chapter 2.2 leads the reader to visual tools and methods for understanding better how organizations can see which is normal and which is not. In chapter 2.3 the statistical Six Sigma methods are presented to help identify what needs to be improved and the meaning of KPIs will be presented. In the end in chapter 2.4 changing the conventional mass production towards Lean management is being discussed.

The author refers to many different sources, but two of the books are considered as a skeleton of the theory. These books are: Modig & Åhlström (2013) "This is Lean" and David Mann (2010) "Creating a Lean culture". There is a lot of literature available about TPS and Lean, but not too much about how to recognise the need for Lean transformation and how to start the implementation in conventional supply chain management culture.

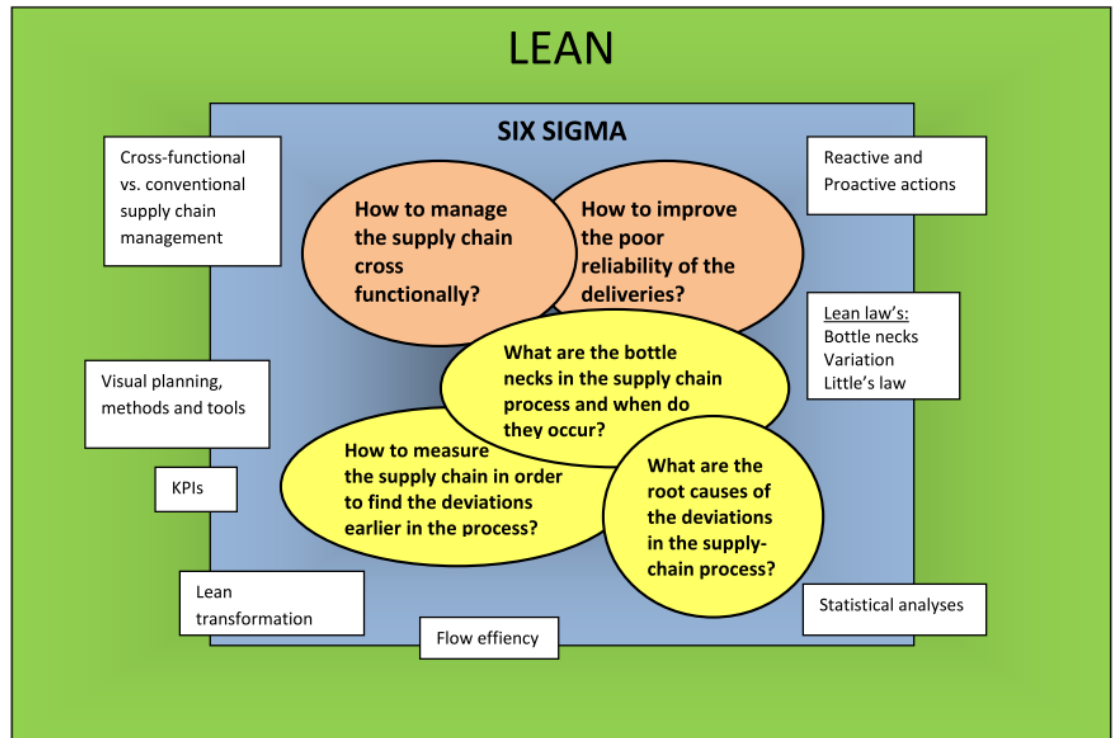


Figure 2. The research questions in theoretical framework

The research questions in theoretical framework are presented in figure 2. The theory of the thesis is discussed more detailed in chapter 2. In figure 2 the concept of Lean is the frame of the thesis theory, where Six Sigma tools are used in order to analyse the case study and perform the research to give the answers to the research questions. White text boxes are the key concepts used in the thesis.

1.4 Research strategy and methods

The research strategy is based on Six Sigma method called DMAIC. In the strategy the DMAIC-steps are followed and different methods and tools are used to be able to answer to the research questions. (Breyfogle 2003.)

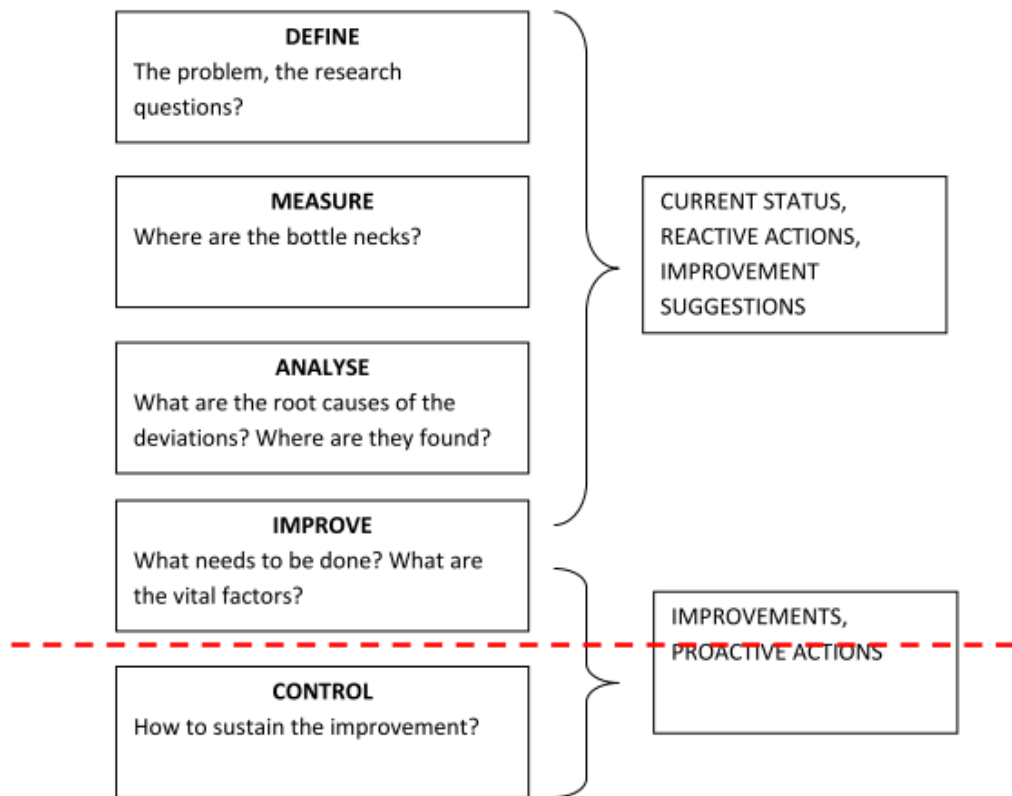


Figure 3. The scope of the research in DMAIC-method

The scope of the research is presented in figure 3. The thesis focuses mainly on the four steps of DMAIC-process of which step four is presented as improvement suggestions. The control step is discussed also, but is not performed in the actual research. The theoretical framework is also connected to DMAIC too as the chapter 2.2 examines how to see (= *define*) the abnormalities. The chapter 2.3 discusses about the tools how to *measure* the process and finally through the statistics, one can finally *analyse* the root causes of the problems and eventually move to stage where to improve.

The research method in case study chosen is an action research, including a quantitative method approach including observations and also interviews. The method chosen was originally found accidentally during the visit at Scania Slupsk. The original method “get the orders to flow” works as a real-time management tool for the Scania bus factory in Poland. The method was modified and the tool at Lahden Autokori Oy is called TITO (*Tilauksesta toimitukseen*) which in English means from order to supply.

1.5 Thesis structure

The thesis is structured in five different chapters. In chapter 1 the background of the thesis is introduced including the aim, theoretical framework and the research strategy and methods. In chapter 2 the theory is discussed more detailed. Chapter 3 concentrates on the research method called TITO and the findings are summarised in chapter 4. The conclusions of the case study and the thesis are presented in chapter 5 followed by the improvement suggestions.

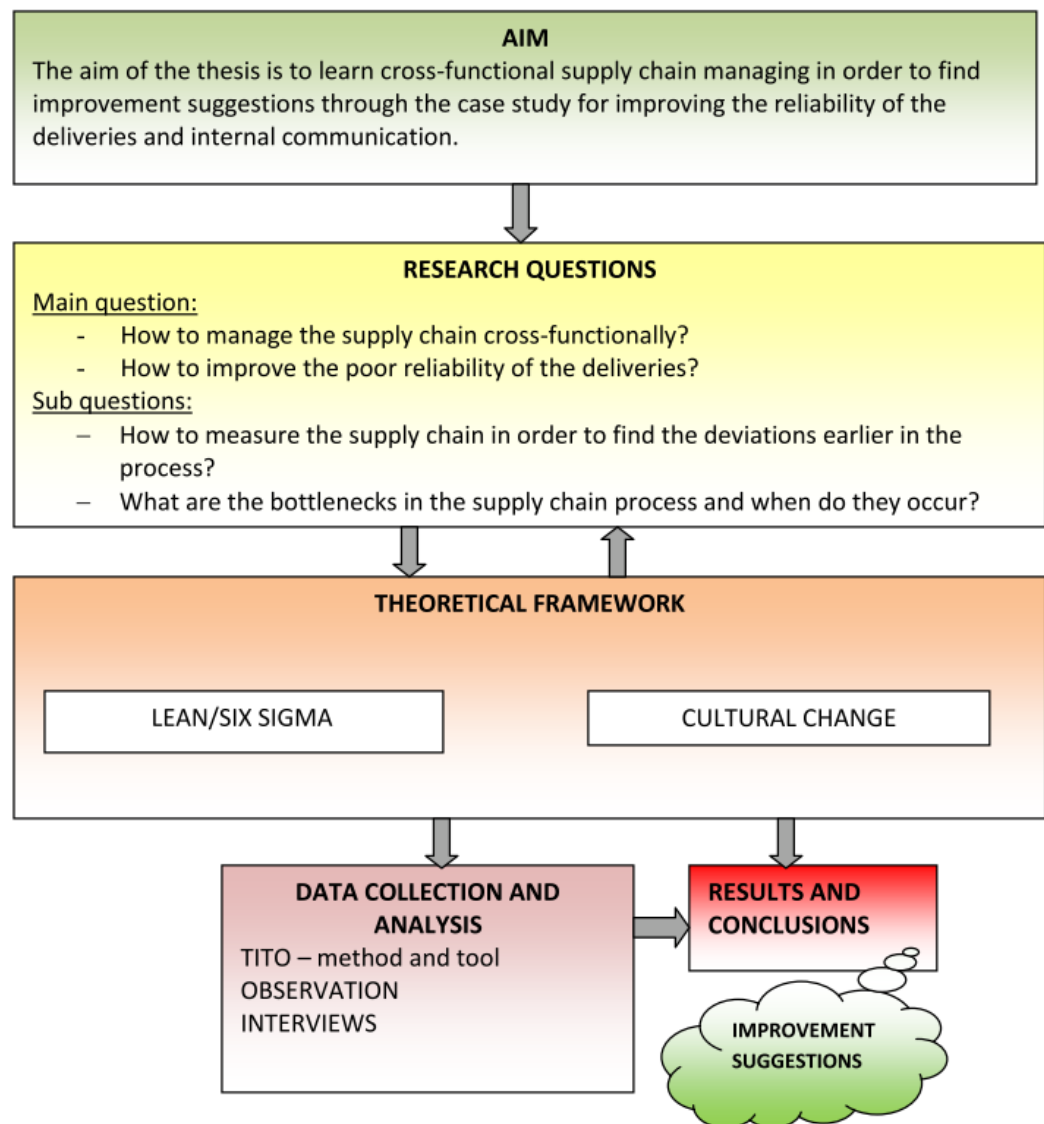


Figure 4. The structure of the thesis

The structure of the thesis is presented in figure 4.

2 LEAN & SIX SIGMA –TOWARDS CROSS-FUNCTIONALITY

Being cross-functional has different dimensions and definitions. One of the definitions used for cross-functional management is “*working together for the benefit of the company*” (Chuda 2013, 157). In this thesis cross-functionality is explored through Lean-philosophy.

This chapter 2 presents the fundamentals of Lean, which originates from Toyota production System (TPS). The first chapter 2.1 presents Lean-philosophy in higher level of an abstract and focuses on introducing Lean comparing it to conventional mass production system and presenting the paradox between efficiency and resource flow. The main three laws of Lean are also presented. To be able to eliminate the bottlenecks, the abnormalities in the process must first be detected (DeLong 2011.) Chapter 2.2 discusses the two main principles of Lean and guides how to *see* the abnormalities (i.e. deviations) in the supply chain with the help of the visual tools and standardisation. As the performance of the reliability of the deliveries in the case company was poor, the performance measuring and the meaning of Key Performance Indicators are presented in the chapter 2.3. In general chapter 2.3 explores how to measure and use statistical analyses to identify the bottlenecks from the process. The chapter 2.4 introduces the elements of Lean management and examines the factors for successful Lean transformation.

2.1 Introduction to Lean

Modig & Åhlström (2013) have written a book called “This is Lean”. The book is referred in the thesis several times as it gives the reader an easy approach towards understanding Lean. Lean is a word invented by the western researches and is originally based on the Toyota production system (TPS). Lean as a term is invented in the end of 1980’s, but TPS has been developed over a century ago. According to Modig & Åhlström (2013) Lean as a concept is an operations strategy, a strategy to achieve an objective, where high flow efficiency is prioritised over resource efficiency. “*TPS is a system where everything is connected*” (Modig & Åhlström 2013, 139.) Lean is also described as a series of

activities to minimize waste and non-value adding activities and it improves the value added process (Azharul & Kazi 2013, 171). The term “Lean process” in the literature has many definitions. Shah and Ward (2007) has defined Lean process as “an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability”. According to Azharul & Kazi (2013, 171.) they have summarised other researchers (Rother and Shook, 1999; Abdulmaleka and Rajgopal, 2007) definitions for Lean as Lean production meaning identification of all types of waste in the value stream of supply chain and implementation of necessary tools to eliminate them for minimizing lead time. The meaning of waste in Lean will be explained later in chapter 2.1.2. Liker & Convis (2012) describes Lean as a lifestyle, not like a project or a diet. Lean needs to be lived and it’s like restructuring company’s DNA, which happens in the company’s core, with its people. All the workers in each level of the organization are empowered to improve continuously. (Liker & Convis 2012, 8.)

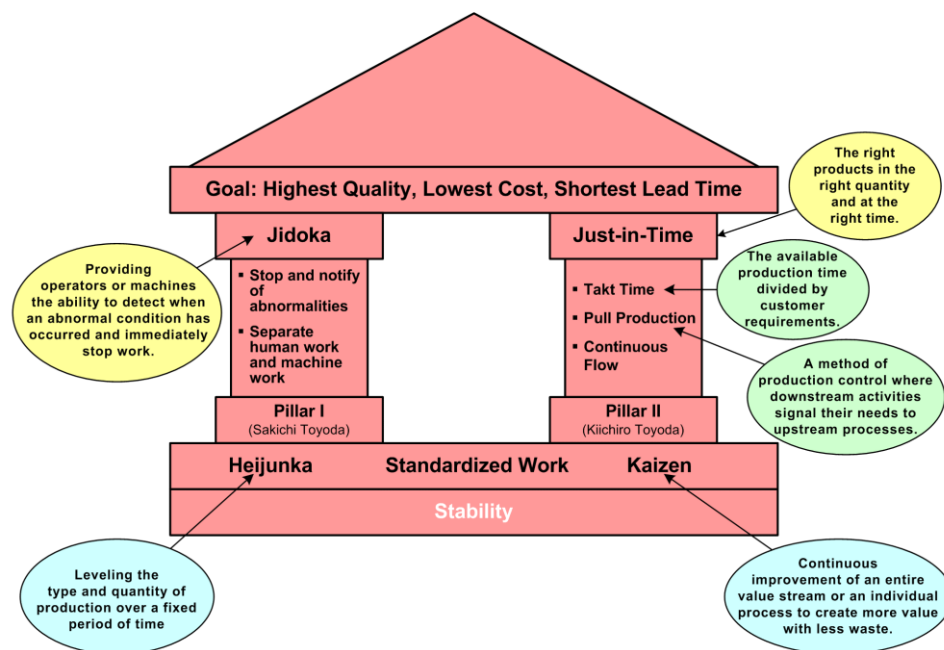


Figure 5: House of Toyota Production system (Holland 2010)

In figure 5 the house of Toyota Production System (TPS) is introduced. Toyota uses the house as a way the company works, it’s a summary. The house has been benchmarked and modified in many other companies around the world. For example Scania has also the Scania house and that’s called the Scania Production

System (SPS). The basement refers to normal condition, where people aim towards perfection. If deviations are found they are expected to respond to the problems by finding the root causes and eliminating them, leading *Kaizen* (continuous improvement) to be an inbuilt system in TPS. (Liker & Convis, 2012, 92 - 93.) The two main principles of TPS according to Modig and Åhlström (2013) are JIT and jidoka, which help one to *see* where the deviations are (Liker & Convis 2012, 92). These principles are discussed further in chapter 2.2.1.

This chapter leads the reader to understand the meaning of Lean by comparing the concept with conventional mass production in chapter 2.1.1. Chapter 2.1.2 compares flow efficiency to resource efficiency and leads the reader to understand the difficulty to find the balance between those two and also to understand the meaning of waste in manufacturing processes. The efficiency paradox discovered by Modig & Åhlström (2013, 98) is presented in chapter 2.1.3. and in chapter 2.1.4 the main laws of Lean are summarized.

2.1.1 Conventional vs. Lean supply chain management

In conventional leadership the individuals, usually the top managers, are seen as heroes taking the responsibility of the problems (Liker & Convis 2010, 30). In Lean management the focus is always in the process, not only in the results. Toyota way in leadership means that the leadership is built in the system where Toyota assumes the whole organization to find and deal with the root causes of any quality related issues without an individual manager needing to be a hero/heroine.

In conventional supply chain management the managers focus on following the key performance indicators (KPIs) through reports of certain period of data (weekly, monthly etc.) There is a risk of reports being sub-optimized and being written on that particular department's point of view, when there is a risk of bias reports to be produced. The focus is to meet the schedule whatever it takes, which leads the managers to invent their own ways to succeed. (Mann 2010, 10 – 11.) *“Action is what counts, and if it is based on the gut feel and experience it must be right..”* (Mann 2010, 17).

Table 1: Difference in habits and practices between mass and Lean cultures (Mann 2010, 18).

MASS PRODUCTION: Personally focused work practises	LEAN PRODUCTION: Process focused work practises
Independent	Interdependent
Self-paced work and breaks	Process-paced work, time as discipline
"Leave me alone"	"I work as part of a team"
"I have my own methods"	Methods and procedures are standardized"
Results are the focus, do what ever it takes	Process focus is the path to consistent results
"Improvements is someone else's job, not mine"	Improvement is the job for everyone
"Maintenance takes care of the equipment when it breaks; it's not my responsibility"	Taking care of equipment to minimize the unplanned downtime is routine

Mann (2010, 18) has presented differences between conventional mass production and Lean production in table 1. It's obvious that in Lean production the power is shared and people work as a part of a team. The way of working in Lean is more proactive as maintenance is emphasised and the focus is in the process, which is naturally defined and continuously improved. The way of working is more in control than in conventional supply chain management culture.

2.1.2 Resource and flow efficiency

In Lean high flow efficiency is prioritised over high resource efficiency (Modig & Åhlström 2013, 127). Resource efficiency means that resources are utilised as much as possible and the basic principle is to divide tasks into smaller tasks, which are performed by the different individuals and different organizational functions (departments) (Modig & Åhlström 2013, 9). The Finnish public healthcare system is a good example of resource efficiency as the doctors should work with the patients every minute of the day as efficiently as possible. Flow efficiency focuses instead of resources on the unit in the process and focuses on the needs the unit has (Modig & Åhlström 2013, 13).

In Toyota's production system the process is always observed from the customers' point of view by asking 'what does the customer want from this process'? With this question both the internal and the end customer are being

considered. (Liker 2004, 27). It does not matter if it's the next station in production line or the final customer in the end. The value is being added when the unit is processed in customer's point of view. All operations do not add value; therefore Toyota has invented seven different forms of waste (Liker 2004, 27). Seven forms of waste are: overproduction, inventories, waiting, motion, transportation, over producing, and failures (Liker 2004, 28 - 29).

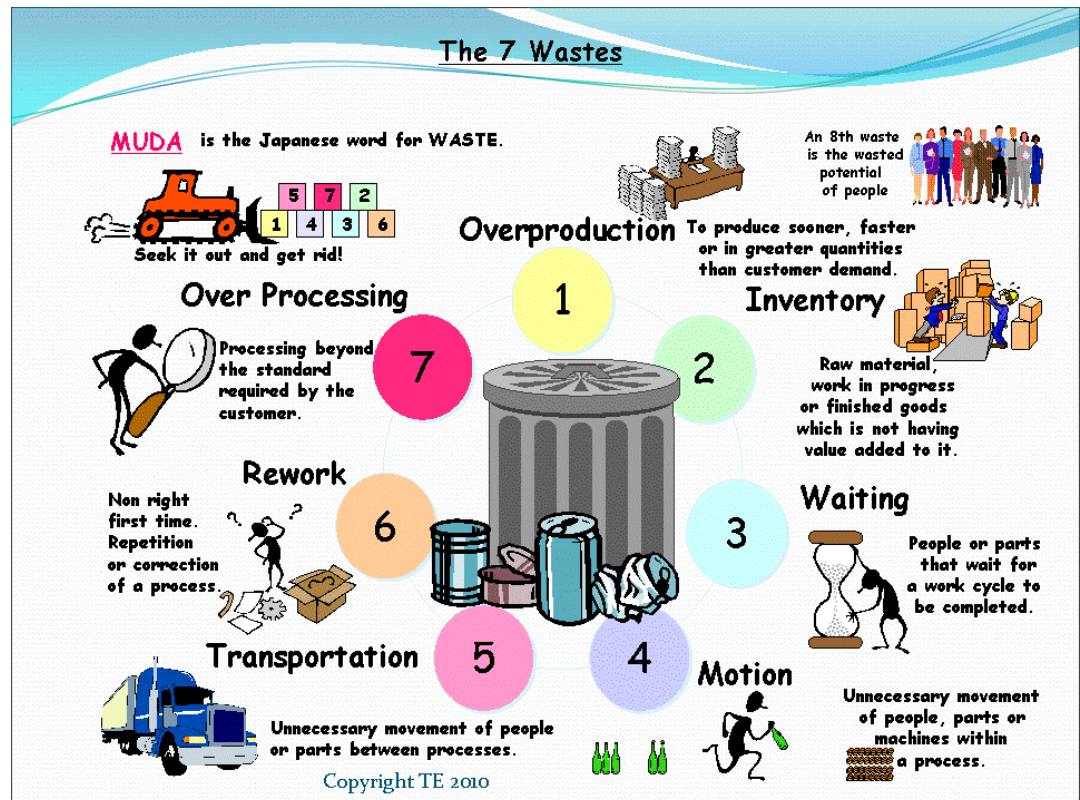


Figure 6: The 7 wastes (Earley 2014).

In figure 6 seven wastes are explained more detailed. Also an eighth form of waste is introduced: wasted potential of people.

The flow efficiency concentrates on value-adding time in order to satisfy the customer's need as quickly as possible by reducing the waste (time) in between the value-adding operations.

2.1.3 Efficiency paradox

According to Modig & Åhlström (2013) organizations can be divided into four different stages in efficiency matrix, where resource and flow efficiency are

presented as variables. These four stages are: efficient islands, efficient ocean, wasteland and the perfect state.

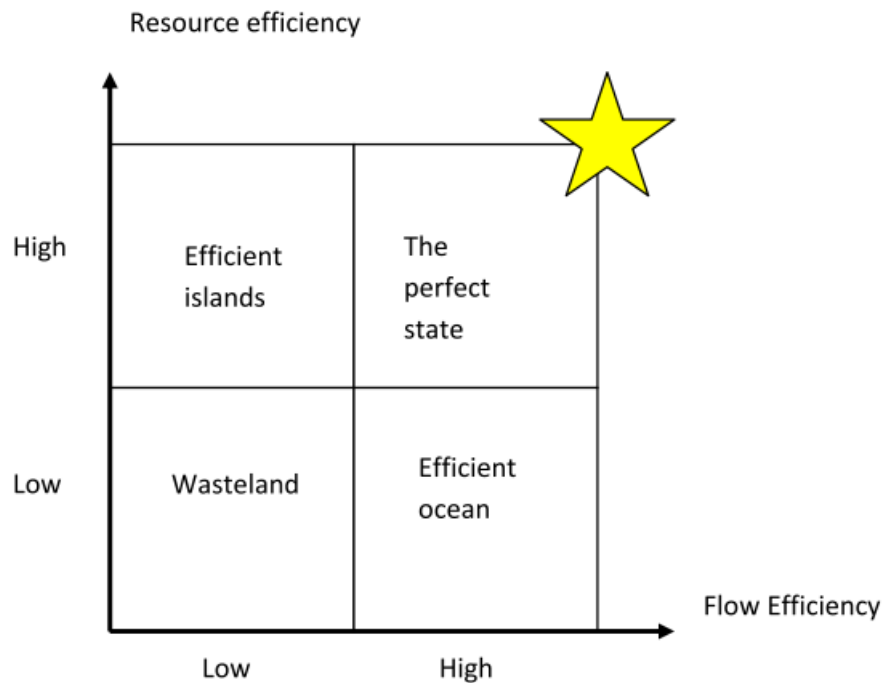


Figure 7: Efficiency matrix (Modig & Åhlström 2013, 98)

In figure 7 the target (star) is to have both high resource and high flow efficiency. The dilemma lies in finding the balance and how to maximise them both. The matrix is divided in four sections and explained below.

In efficient islands the organization consists of sub-optimised departments which operate in isolation (Modig & Åhlström 2013, 99). The cross-functionality between the departments is poor and departments focus working towards maximising their own resources. The flow efficiency is poor and normally the customer or a unit in the process has to wait before entering to the next value-adding stage. According to Bhasin (2012, 441) in most of the organizations the sub-cultures can be found, and if the aims and the needs of the departments are not the same, there is a risk of ending up on efficient island in the organization.

The flow efficiency is high in *efficient ocean* stage, but resource efficiency is low. There is a lot of capacity waiting to satisfy the customer needs. As an example the

high class luxury services belong to this category. (Modig & Åhlström 2013, 99.)

The category of *wasteland* is the worst. Both, the resource efficiency and the flow efficiency are poor (Modig & Åhlström 2013, 99). The value-adding work is minimal and the organization is surrounded by *muda*, waste. Muda refers to any activity which does not add value to the customer (Maazaki 1997, 75). As an example, new organizations can face these problems or other hand organizations where there are severe problems with management.

The perfect state is very hard to reach. There both, resource and flow efficiency are high. The key issue to prevent reaching the level of perfect state is variation. (Modig & Åhlström 2013, 100.) Variation will be discussed more in chapter 2.3.2. Lean is a way of trying to reach the perfect state, but in order to reach the perfection, the current state needs to be improved. Continuous improvement in Japanese is *kaizen*. The word means that improvements take place everywhere, not only at blue collar level but also at managerial level. In Japan the concept is so familiar, that people are not even aware of possessing it in their social, working and business life. (Masaaki 1997, 1.)

2.1.4 Three main laws of Lean

In Lean the flow efficiency is emphasized over the resource efficiency. Modig & Åhlström (2013, 31) have summarized three main laws in Lean which prevent (or support) processes to flow. The laws are Little's law, bottlenecks and variation.

Little's law covers the concepts of lead time. Lead time (throughput time) is total amount of units or people in the process and the average time for how long it takes to process the unit or serve the people. Lead time is related to the boundaries set around the process. There is a start of a process and the end. (Modig & Åhlström 2013, 34 – 35.)

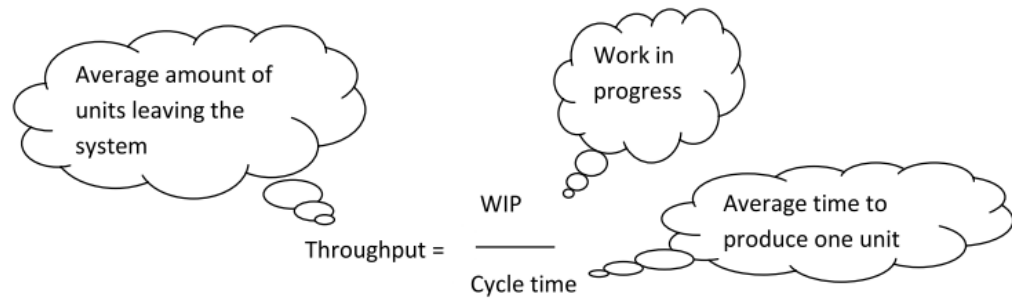


Figure 8: Little's law

In figure 8 The law of Little is explained. As an example, let's assume there is a process running in which throughput (TH), the number of units we produce, is 50 units per day. Work in process (WIP), the number of units in various stages of production, remains relatively constant at 200. Given these conditions, the cycle time, the average time it takes to complete one unit, is four days ($CT = WIP/TH$, $CT = 200/50$, $CT = 4$). (Abilla 2014). Little's law is very crucial for the case company to understand what happens when the task is not completed in the expected time period. It'll increase the amount of WIP in production and eventually will increase CT. This will cause delays to deliveries for sure, if there is no solution to fix the lost time. The case company struggled with WIP (incomplete buses in production). There were more buses in production line than expected due to the deviations such as lack of materials or incomplete drawings. According to the law, the CT increases when WIP increases. This explains very simply why it took too long to manufacture a bus and not meet the delivery date agreed with the customer.

Bottlenecks limit the flow in the process. For example the security check at the airport is a bottleneck. There can only be a one piece flow in the checking point and the checking takes certain average of time. The more the persons are in the queue the more it takes time to complete the whole queue. The lead time increases when there are more people in the queue. Lead time also increases if there are people who for example are not aware of the instructions. It'll take more time for those people to pass the checking, if they have coins in their pocket, too much liquids etc. (Modig & Åhlström 2013, 37.) An important thing about bottlenecks,

which is relevant to the research, is that bottlenecks determine the throughput of a supply chain. This means that if the capacity of a bottleneck in a supply chain improves, the throughput will increase. Therefore in order to improve the throughput of the supply chain, the bottlenecks need to be either eliminated or improved. (Imaoka 2014.) Bottlenecks can be identified in different ways from the process, visually and statistically. Visual methods will be discussed in chapter 2.2 and statistical ways in chapter 2.3.

The bottlenecks appear because there is *variation* in the process. In order to understand flow efficiency it's important to understand the meaning and impact of variation. Variation can be caused by resources, for example if a machine breaks or when having a doctor's appointment there is variation between the doctors for how long to examine the patient and so on. The flow units in processes also cause variation. For example repairing a car takes different amount of time as different cars have different problems. Another example can be found in hospitals as patients do not arrive evenly to the E.R. Also external factors can cause variation. (Modig & Åhlström 2013, 40 – 41.) Regardless of the type of the variation, it always effects on time (Modig & Åhlstöm 2013, 41). In a production system variability will be buffered by some combination of inventory, capacity, and time according to the law of variability buffering (Factory Physics 2014). In TPS takt time is crucial concept, where all the workers are expected to perform value-added work in perfect synchronisation and in takt. The waste is minimised in the process in order to control the variation and in worst cases if variation increases too much the production can stop. (Liker & Convis 2012, 91.)

The aim of the thesis is to find the bottlenecks from the supply chain process and find the root causes of the variation. In coming chapters there are different methods and tools presented to discover the bottlenecks from the process.

2.2 Defining abnormalities

Different principles of Lean have been presented during the past. In 1990's three principles were identified: identification of value, eliminating waste and the generation of smooth flow (Womak et al. 1990). This thesis focuses on two

principles of Lean –JIT and jidoka presented by Modig & Åhlström (2013). These two principles are also known as the pillars of TPS house (Lean Enterprise institute 2014).

The main idea of this chapter is to present some of the tools which help organization to define and *see* the deviations to be able to *stabilize* the processes. The tools are strongly based on visual effect to help the organization to have a better holistic picture of the current status of the supply chain process.

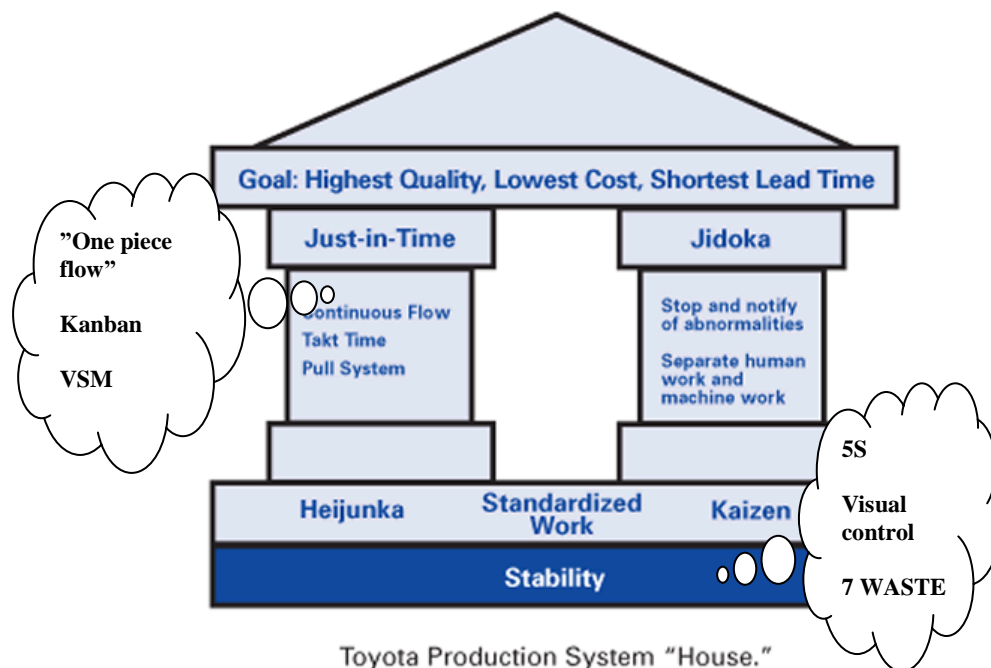


Figure 9: Toyota Production System house (Lean Enterprise Institute, 2014).

In figure 9 the basement of the house contains tools such as 5S, Visual control and Seven waste. The basement of the house is about creating a normal situation, stable standardized status. The pillar JIT contains value stream mapping (VSM) and Kanban, which both contribute the organization to build a one piece flow. In order to stop and notify the abnormalities in jidoka, one needs to recognise the normal state first (DeLong 2011). This chapter focuses on the tools mentioned in the figure 9.

2.2.1 Principles of Lean: Jidoka & JIT

In order to understand the meaning of the cross-functionality in the thesis the Toyota Production System (TPS) is presented as Toyota Motor Company has been the pioneer of the Lean-concept. Figure 10 below shows the ideology of Toyota Production System. Values are the core of the culture in the company and principles guide how and what needs to be prioritised in the business. The principles are summarized in two main concepts being the two sides of the same coin, just-in-time (JIT) and jidoka. (Modig & Åhlström 2013, 130 – 132.)

In this chapter jidoka and the other principle of Lean JIT is introduced. Chapter 2.2.2 presents how these principles JIT and jidoka can be utilized in cross-functional supply chain management by using visual methods and tools in order to see the holistic picture of the supply chain.

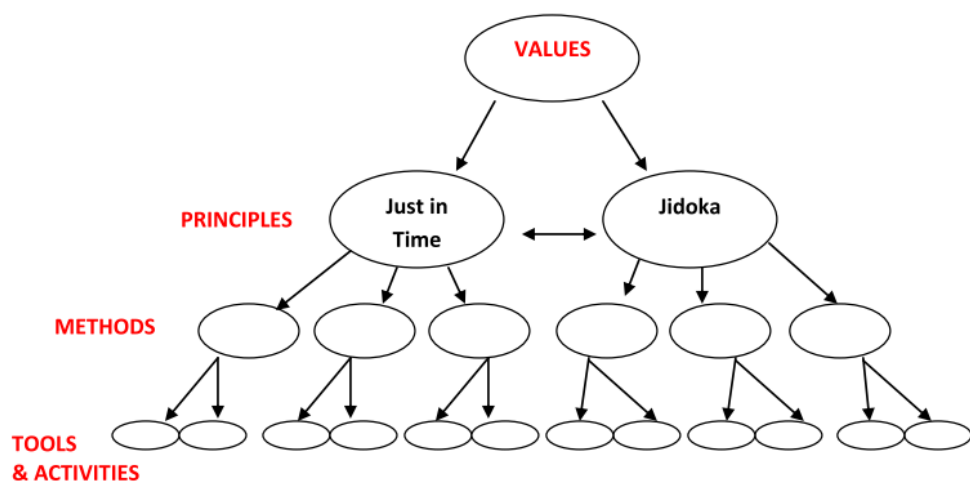


Figure 10: Toyota Production System (Modig & Åhlström 2013, 138).

In figure 10 the TPS is introduced. “*Just-in-time is about creating a flow, while jidoka is about creating a visible and clear picture so that anything that happens to, hinders or disturbs the flow can be identified immediately*” (Modig & Åhlström, 2013, 134).

Jidoka-principle reflects problems to be visualized and abnormalities to be detected. If abnormalities are not seen, it’s hard to manage the process. *Jidoka* can be put into different scales. According to Masaaki (1997, 95) the machines

equipped with jidoka will stop the moment when a reject is produced, but on the other hand according to Modig & Åhlström (2013, 134) in larger scale jidoka is about awareness where all the workers can see the current status of the factory through strong customer focus.

The principle of *just-in-time (JIT)* is about creating a flow (Modig & Åhlström 2013, 132) and it's all about what customer wants to pay and not to pay. The customers do not want to pay anything which is waste, but the customer is willing to pay for the value-adding activities. JIT is also known as “A system for producing and delivering the right items at the right time in the right amounts” (Wood 2004). Commonly JIT has been used when referring to suppliers' just-in-time deliveries, but to benefit from the suppliers JIT deliveries the company must first establish efficiency in its own internal processes. JIT is a way to reduce costs while at the same time to ensure the best reliability of the deliveries for the customer. (Masaaki 1997, 145.)

Many insights can be found in JIT productions. First, as jidoka notices the rejects by JIT the amount of rejects can be maintained low, as the system can quickly respond to the abnormalities. Secondly, the lead time can be reduced dramatically with the help of visual signals like *kanban* (production order slip). (Masaaki 1997, 147 - 148, 260.) Third, by limiting the work in progress by producing only the amount ordered the bottlenecks can be revealed and one can address them (Peterson 2009).

2.2.2 One piece flow

Lean compliments visual methods and tools to improve the overall understanding of the supply chain management. Methods and tools help the organization to recognise the deviations in the early stage of the process. By jidoka and JIT principles one can *see* and create the state where deviations are not hidden, but found and eliminated. JIT-production aims at eliminating waste and non-value adding activities to accommodate the fluctuation in customer orders. JIT-production is supported by different methods of which one is one piece flow. One piece flow is referred to as “single piece flow” or “continuous flow,” and is a key

concept within the Toyota Production System. One piece flow means that units are pulled through the operations with no or only few work in process (WIP). (Dolcemascolo 2014; Masaaki 1997, 8 - 9.)

This chapter presents few basic tools such as value stream mapping and kanban to help identify and see the deviations better and earlier in the process.

By one piece flow the idea is to eliminate waste and add value to the customer. It decreases the lead time and the deviations are visible in the place where the unit or service is being processed. One piece flow can be created with the help of a tool called *Value Stream mapping*. (Väisänen 2013b.)

Table 2: Benefits of value Steam Mapping (Väisänen 2013b)

BENEFITS OF VALUE STREAM MAPPING
• To have a holistic picture of process including information and material flow
• To see the problems and waste
• To see the bottle necks, storage and WIP
• To see the potential risk of safety
• To have a common language in the organisation
• To see the daily functions of the operations

Benefits of the VSM are listed in table 2. Mapping helps to identify the current state of the process and helps to see the waste. According to Wood (2004, 16) and Väisänen (2013b) VSM also gives the participants involved in the mapping process a common language, which can improve communication level in the organization. Mapping helps the organization to see what is preventing the process not to flow smoothly and to identify the bottlenecks (Väisänen, 2013b).

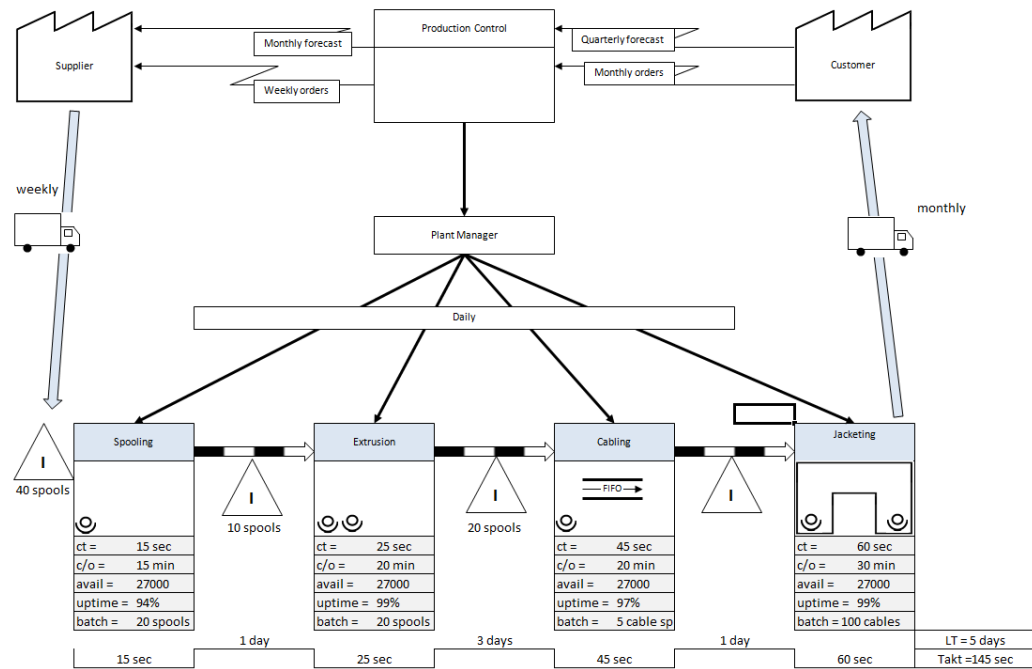


Figure 11: Example picture of VSM (BreezeTree Software 2014)

In figure 11 an example of VSM is presented. Value stream mapping can reveal bottlenecks from the process (Väisänen 2013b). In the figure 11 for example the inventory between 'extrusion' and 'cabling' is totally 20 spools, which takes three days from the total lead time (5 days). This can be considered as a bottleneck in the flow. This bottleneck inventory should be examined if it could be reduced in order to decrease total lead time. The side effect of VSM is the amount of potential improvements seen in the process. It can decrease the impact of improvements as the big picture might blur due to the large amount of improvement seen in the process. (Väisänen 2013b.)

"Kanbans are "self-evident signals" that indicate what work is to be done and when" (Hanover 2011). Kanban signals supports the ideology of one piece flow, where units are passed to one operation to the next and not before the signal is given. Signal can be e.g. an empty pallet, card or a system called two-bin, where the empty bin launches an action to refill the bin. (Hanover 2011.) Both Kanban and VSM support the organization to build one piece flow system.

2.2.3 5S

5S, five steps of housekeeping, is one of the main activities when companies start their Lean journey, *kaizen* (continuous improvement) (Masaaki 1997, 63). 5S is about stabilizing and standardising the current state. When everything is in order, one can immediately notice what is wrong and see the abnormalities. (DeLong, 2011.)



Figure 12: 5S (TPF Europe bv 2014)

In Figure 12, The method of 5S is explained. Sort means that all unnecessary items are removed from the place. After that the place can be stabilised (set on order) and everything has own place enabling an easy access when needed. When everything is in order, the working place is cleaned properly (shine). In standardisation phase the rules are set for the working place. The rules are clear and visual to ensure everyone to understand how the working place should look like. The last phase is important. It's about sustaining the maintained level. In this phase everyone is trained to ensure the 5S application. The application is monitored and audited. (TPF Europe bv 2014; Ross, G. 2013.)

Value Stream Mapping, Kanban and 5S help to identify the present state and improve the working environment. In addition, visualising the physical environment and information flows, the performance of the processes can be visualized and controlled through visual tools too. The subject is discussed more in chapter 2.3.1.

2.3 Lean Six Sigma

The name Six Sigma derives from control of variation during the manufacturing process. Carl Frederick Gauss (1777-1855) introduced the concept of the normal curve and a measurement standard in product variation. Walter Shewhart (in the 1920's) showed that three sigma from the mean is the point where a process requires correction. The pioneer of the "Six Sigma", however, is Motorola company (1986), where the engineers kept variation in their products down to a level where the tolerance limits for the product were at least six standard deviations (sigma) away from the mean measure on the both sides. (The Innovation Consultancy Partnership 2014.)

In earlier chapter 2.2 visual tools were introduced to see the abnormalities, Six Sigma tools help to identify what *needs* to be improved. These tools are discussed in this chapter.

2.3.1 Measuring performance

Measuring performance has a big role in managing the business and supply chain. It provides essential information for decision making. It is crucial to measure right things at the right time in the supply chain process in order to have immediate actions. (Azharul, K. et al 2013, 170). Companies often fail to develop performance measurement metrics which measures the efficiency as usually the metrics are based on finance. (Gunasekaran et al., 2004; Gunasekaran et al., 2007.) In Lean management the KPIs are visualised and controlled. The purpose is to focus on the process and make it easy to compare expected versus actual performance (Mann 2010, 53). Performance tracking charts are the most common

visual charts seen in Lean production. Performance charts cover typically dimensions such as safety, quality, delivery and cost (Mann 2010, 95.)

SUMMARY, PRODUCTION_level2

MNU/11.12.2013

KPI's

SUPERVISOR:

	TEAM					TEAM					TEAM				
	MON	TUE	WED	THU	FRI	MON	TUE	WED	THU	FRI	MON	TUE	WED	THU	FRI
PERSONNEL															
PRESENT															
ACCIDENTS															
QUALITY															
DEVIATIONS															
Q-OBSERVATIONS															
INSPECTION CHECK-LIST															
SPEC (OK/NOK)															
SS (OK/NOK)															
WASTE															
MISSED TAKT (h)															

Figure 13: Example of KPI-chart in production

In figure 13 KPIs are visually monitored. When performances differ from what was expected the organization can react accordingly. Monitoring is done in sequence depending on the takt time in the production.

Based on Azharuls (2013) study the time-related measures are the most significant for Lean performance evaluation and measurements. Time is a crucial concept in the thesis point of view where the case company has suffered not to meet the planned schedule resulting in poor reliability of the deliveries. The aim of the thesis is to provide improvement suggestions to be able to improve that particular key performance index (KPI) and to find indicators which could create actions earlier in the process before it's late.

2.3.2 SPC-theory –variation

Statistical process control helps to identify *what* to improve in the process. To be able to understand SPC-theory it's vital to understand normal distribution and Sigma-limits. The theory is shortly presented in this chapter.

In Six Sigma variation is based on normal distribution. In figure 14 the variation is presented in Sigmas and defect parts per million. In Six Sigma the focus is to strive for perfection and allow for only 3.4 defects per million opportunities for each product or service transaction. (The Innovation Consultancy Partnership 2014.)

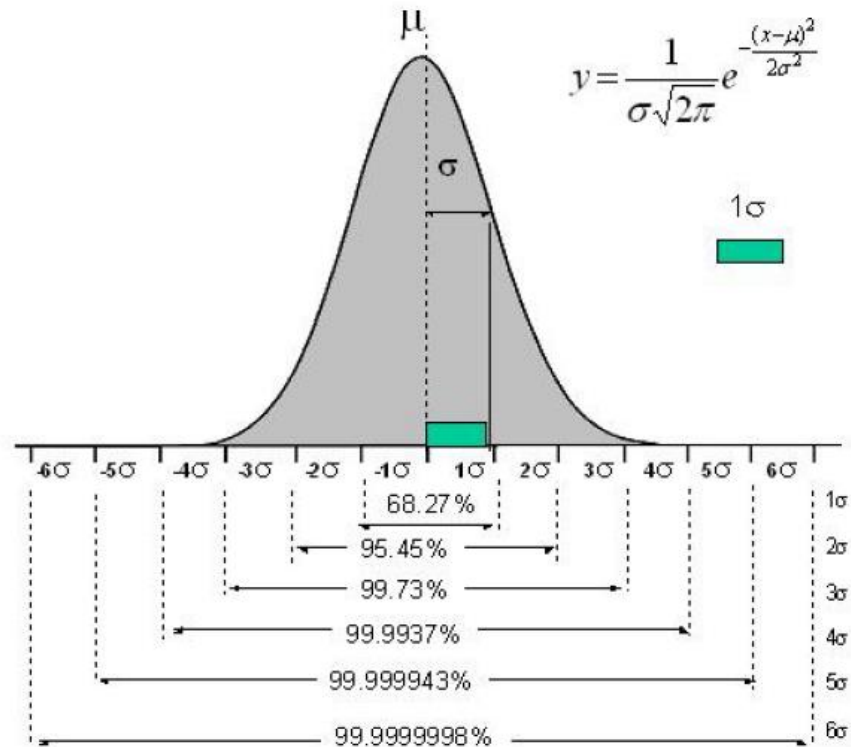


Figure 14: Six Sigma, normal distribution (The Innovation Consultancy Partnership , 2014).

In statistical process control the tools used to identify the limits of three Sigmas are called control charts. With the help of the control charts the process can be monitored and the directions for improvements can be shown (Breyfogle F., 2003.) The charts work as visual tools helping the organization to see what needs to be improved. The main purpose of all of the charts is to separate signals from noise and show when data is out of normal distribution. Control charts define common and special causes and show what needs to be improved in order to decrease variation in the process and to have the process in control. There are different charts for different purposes and the charts used are selected according to

the data available: continuous data or attribute data. Continuous data = measures a characteristic of a part or process, such as length, weight, or temperature. The data often include fractional (or decimal) values. Attribute data = Counts the number of defective items or the number of defects per unit. (QK-Karjalainen 2012.)

Different options of the charts are not presented in the thesis; charts are presented only in general level.

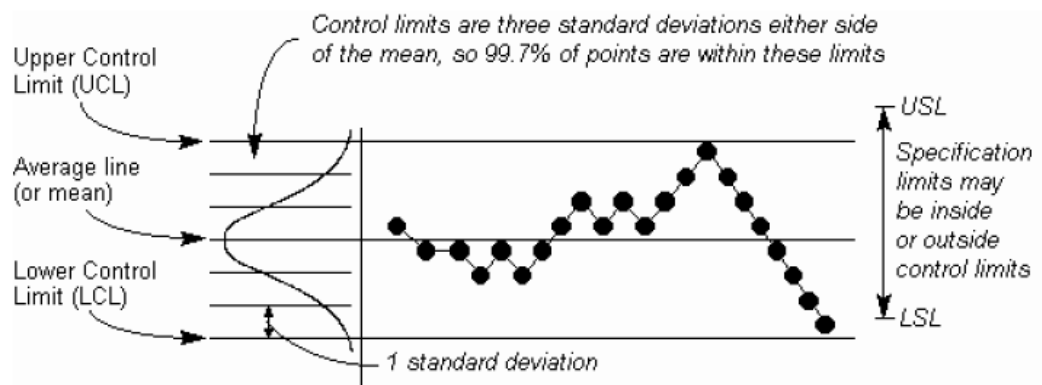


Figure 15: Control chart and normal distribution (Straker 2014).

In figure 15 the top line is called the *upper control limit* and the bottom line is called the *lower control limit*, and the plots falling outside these limits are considered as being out of control. These limits are often abbreviated to UCL and LCL. (Straker 2014.) The aim is to examine the plots outside the limits and improve them in order to get the process back in control.

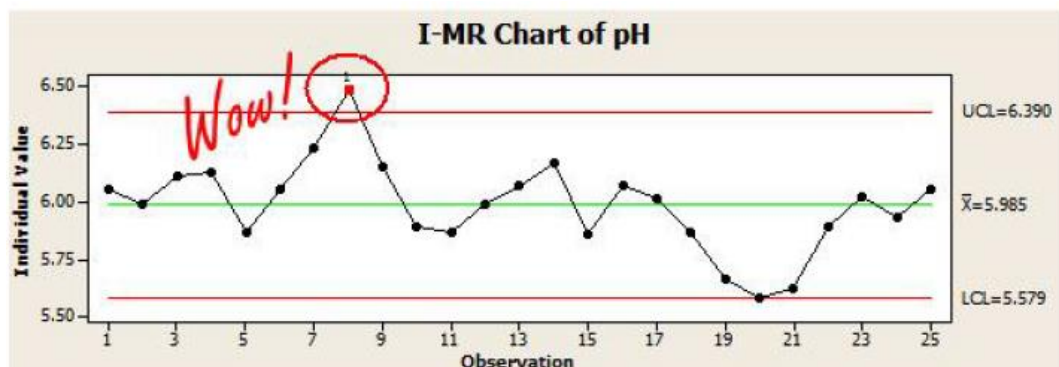


Figure 16: Example of a control card (Runkel 2012).

In figure 16, the chart indicates one special cause. The special cause is above the upper control limit. When using the control charts the special causes should be handled immediately, not after a period of time, in order to decrease the variation in process. Other plots in the chart are inside the normal distribution –no immediate actions should be taken. (Runkel 2012.) After the special causes have been solved, the variation in the process has been diminished. With the help of the control charts organizations can save time and money by focusing on the right causes. In figure 17 the variation in the process has been decreased. If only common causes occur, the process can be improved with other Six Sigma tools, like Design of Experiment (not presented in the thesis). (QK-Karjalainen 2012.)

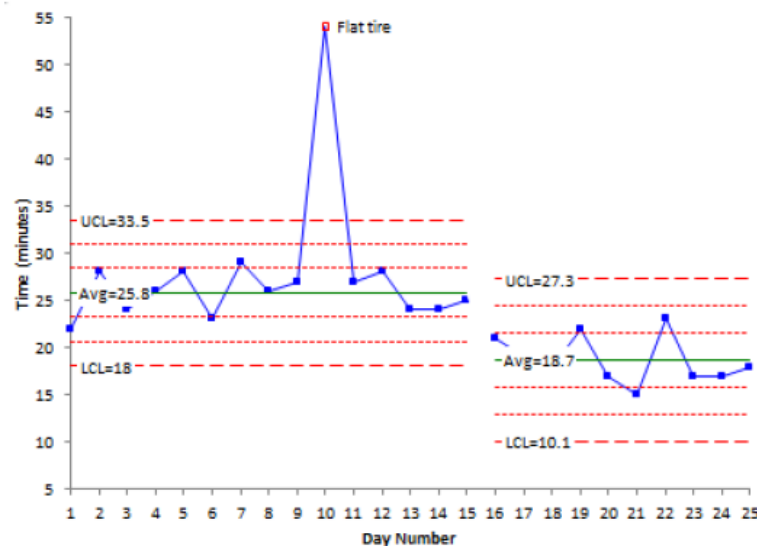


Figure 17: SPC-chart before and after improvement (McNeese 2012).

In figure 17 the SPC-chart shows the improvement after the special cause has been removed and improved. By improving the right causes the variation decreases. Also the average can be decreased when the special causes above the upper specification limit are improved. (McNeese 2012.)

Variation is limiting the organizations to reach the perfect state (presented in chapter 2.1.3). In order to reach the perfection variation should be controlled and minimised when it comes to demands (customer needs) and to supply (the organization's resources). (Modig & Åhlström, 2013, 100-101.)

2.3.3 Identifying bottlenecks

VSM can be used to help identifying the bottlenecks from the supply chain, but as mentioned in chapter 2.2.2 in an environment where waste exists everywhere and potential improvement tasks are numerous it can be hard to prioritize where to start. Statistical tools help to define what needs to be improved. In this chapter basic tools such as pareto and histogram are presented.

Pareto-chart is a helpful tool to identify the common causes or chronic problems from the manufacturing process while the SPC-theory is useful for the special causes (chapter 2.3.2). Pareto-principle means that 80 percent of the deviations come from 20 percent of the problems (i.e., the vital few problems). Pareto-chart is a graphical tool which identifies the vital few from trivial many and the principle is named after Vilfredo Pareto. (Breyfogle 2003, 1113.)

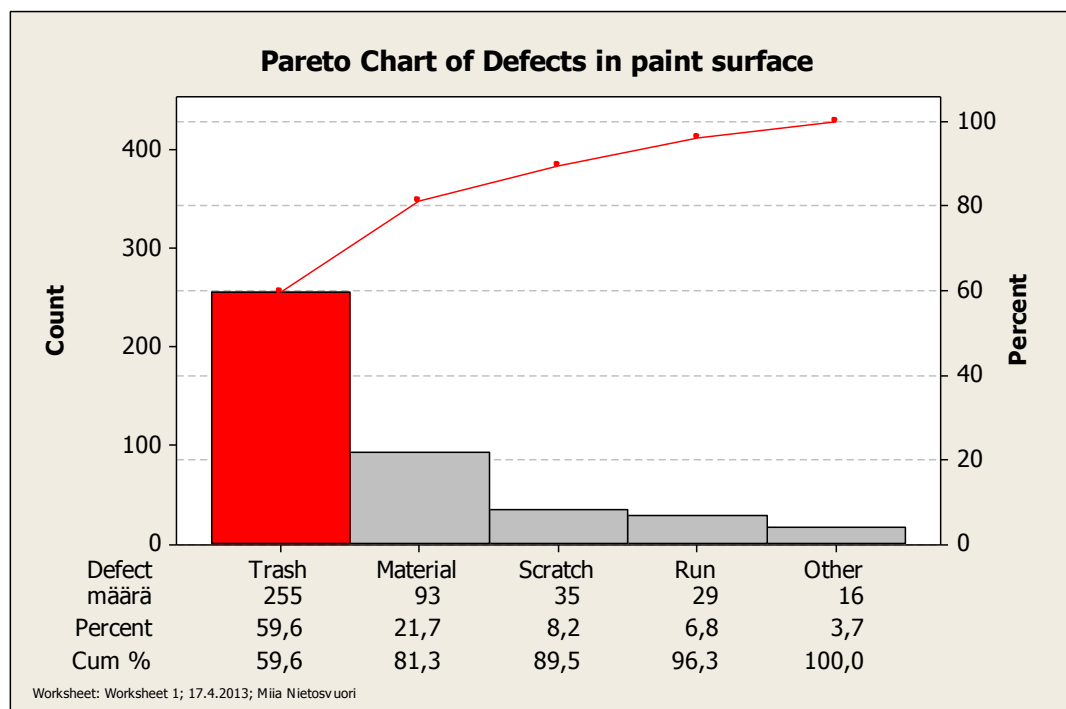


Figure 18: Pareto-chart, paint defects

In figure 18 an example of Pareto-chart is presented. In the example trashes and material faults cause total 80 percent of the deviations found from the painting process. By improving these two the paint quality will be improved tremendously.

Histogramm is a graph where frequency of occurrence of values is presented. (Breyfogle 2003, 80). In histogram the sample values are divided into intervals, categories. Bars represent the number of observations falling within each category (its frequency). Because each bar represents many observations, a histogram is most useful when there is a large amount of data available. (Minitab, StatGuide, 2014)

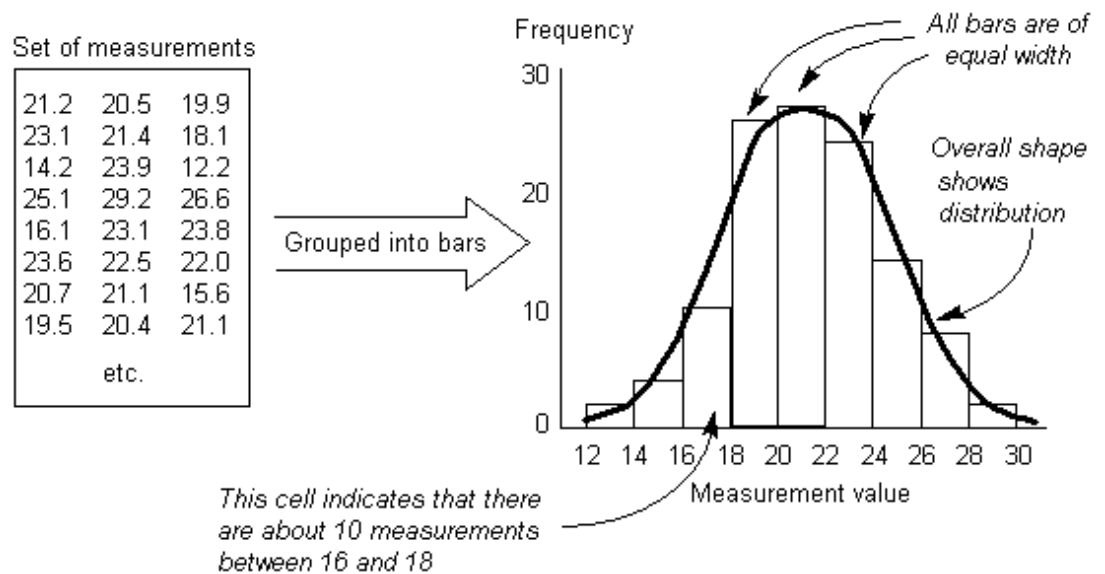


Figure 19: Example of a histogram (Straker 2014).

Figure 19 explains how a histogram is build. With the help of a histogram one can interpret where the frequencies are peaked indicating possible bottleneck(s) and also interpret the variation. If the distribution of the histogram is wide, there is a lot of variation in the process and when it's narrow the variation is low. (Minitab, StatGuide 2014.)

2.4 Towards Lean management

The aim of the thesis is to learn how to manage supply chain cross-functionally. To understand the word cross-functional it is also important to compare what is *not* cross-functional. In this chapter Lean management is compared to conventional mass production management. In conventional mass production the way of thinking differs a lot from Lean. Mann (2010, 19) emphasises the matter:

“work-related habits are just as difficult to change as personal habits.” So, it’s important to understand that changing ‘the way we do here’ is actually changing the culture of the company.

“Culture is no more likely a target than the air we breathe. It is not something to target for change. Culture is an idea arising from experience!” (Mann, 2010, 4).

Mann (2010, 15 – 16) has characterised both conventional and Lean supply chain management. This is presented in table 3.

Table 3: Visible attributes of different cultures in Mass and Lean production (Mann 2010, 15 - 16).

CULTURAL ATTRIBUTE	MASS PRODUCTION CULTURE	LEAN PRODUCTION CULTURE
Inventory	<ul style="list-style-type: none"> - Managed by the computer systems - Ordered by forecast - Held in bulk containers/ordered in large bulks 	<ul style="list-style-type: none"> - Managed visually - Ordered to replenish actual use (pull system) - Stored in FIFO-racks - Small amounts delivered to the actual place in use
Production status	<ul style="list-style-type: none"> - Checked at the end of shift, beginning of next shift or in the end of week - checked by managers or higher level supervisors 	<ul style="list-style-type: none"> - Checked by the team leaders several times an hour - Checked by the supervisors many times per shift - Checked by the value stream managers once or twice per shift - Updated for all involved in a sequence of brief daily reviews of the previous day’s performance
Process improvements	<ul style="list-style-type: none"> - Made by technical project teams - Changes must be specifically “chartered” 	<ul style="list-style-type: none"> - Can be and routinely are initiated by anybody, including operators - Regular, structured vehicles encourage everyone from the floor on up to suggest improvements and perhaps get involved in implementation - Improvements are continuous
Problem solving	<ul style="list-style-type: none"> - Do what ever it takes to hit today’s numbers - Work around the problem; just meet the daily/weekly production/productivity goal 	<ul style="list-style-type: none"> - Record immediate circumstances of the miss, interruption or breakdown - Put temporary countermeasures in place (Short-term solution) if needed to serve the customer - Assign task to identify and then to eliminate causes of problem

In table 3, the differences between conventional mass production and Lean production are introduced. The table shows that in Lean culture the actions have

been empowered to each level in organization, but in mass production culture the actions are taken by the certain team or the decisions are made by the managers.

This chapter introduces Lean management and examines the success factors of implementing Lean culture in conventional mass production culture.

2.4.1 Four elements of Lean management

Every organization needs a vision and a set of goals to be reached. At Toyota the goals are determined by the board of directors, a process from top to down. To make it down to up process Toyota has implemented daily accountability process through KPIs connected to the main KPIs determined by the board. The system is visualised and bases on kaizen (continuous improvement). At each level the targets and KPIs are connected to the main goal. (Liker & Convis 2012, 148-149.) The leadership therefore is linked with KPIs, which makes the organization cross-functional.

Mann (2010) introduces in his book four elements of Lean management. These are leader standard work, visual controls, daily accountability process and discipline. In this chapter these elements are presented shortly. In Lean management everything is linked to each other, the functions are interdependent, in other words –cross-functional (Mann, 2010, 23). Lean management is not just tools and techniques, but it's heart lies in people (Saurin et al., 2011).

Leader standard work means that as the work for the blue collar in production, also the leaders work is standardized. Standardised work allows the leader to organise his/hers work. Standardized work gives a frame for the daily work, it guides what to do and what not to do. (Mann 2010, 40.)

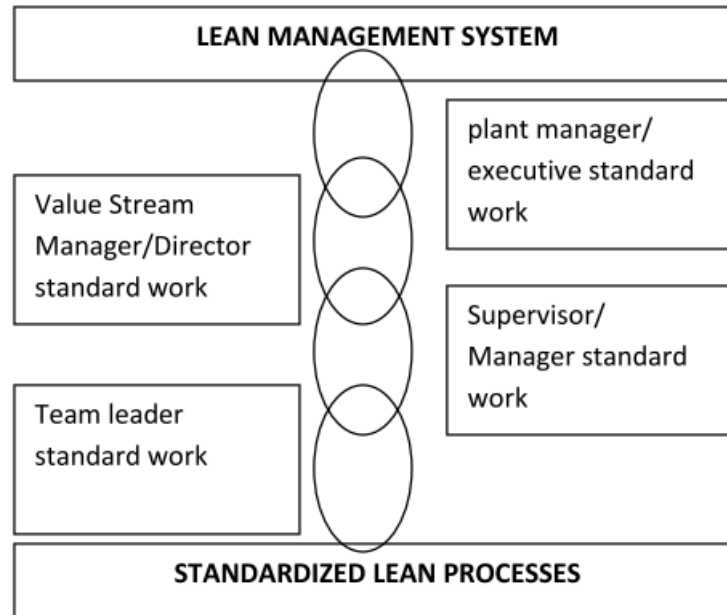


Figure 20: Lean management system (Mann 2010, 43).

In figure 20, the Lean management system is presented as layers tightly contacted to each other. The standard work includes scheduled pulse-meetings, where the content of the meetings is clearly defined including for example checking the KPIs, deciding the corrective actions, planning and naturally continuous improvements. (Mann, 2010, 37-51.) Monden (2012, 26) presents establishing a project team, which is related to the Lean management system presented by Mann. Monden (2012) emphasises the meaning of organising training and practises in all the levels of organization and the leaders of each level consist a project team.

Visual controls compare the expected versus actual. It is important leaders to understand why they follow the performance indicators and how they should commit those to actions in response to performance data to finally turn the actions into improvements. (Mann 2010, 55.) Visual controls help to transform the discipline in Lean management into directly concrete practises (Mann 2010, 83). The key reason for Toyota to be dedicated to visual management is that it clarifies the expectations, determines the accountability and ables to track the progress and measure each department's self-development (Liker & Convis 2012, 115).

The daily accountability process takes place in daily meetings, which are very brief, structured and located in the shop floor. The agenda of the meeting is well defined. In the meetings the KPIs are examined and if any deviations are found, the deviations will turn into activities. The activities are visualised as are the KPIs. The activities are always followed in order to make sure nothing is forgotten and not to make the same mistakes again. (Mann 2010, 85 – 104.)

The three tiers of daily meetings are part of the leader's standard work.

1. The first tier: The production team leader meets the other team members
2. The second tier: The supervisor meets the team leaders
3. The third tier: The value stream manager or production manager meets the supervisors
4. The fourth tier: The fourth tier is between the supportive functions and the value stream manager/production manager

(Mann 2010, 85 - 104.)

The meeting practice ties the visual management with daily performance figures together. The KPIs are compared to the targets. (Liker & Convis 2012, 171).

Creating the leader standard work, having daily meetings, observing the visual signs of KPIs, taking actions and improving needs *discipline* (Mann 2010, 24 - 25). The leaders must be committed and devoted for the system in order to succeed in Lean management.

Lean management is all about focusing on the process: stabilize, standardize, and improve by exposing and seeing the deviations and eliminating them. Visual controls are the keys to see the problems easier and to see the current status of the process. The standard work of the leaders ensures the visual controls are maintained and actions are taken. (Mann 2010, 86.)

2.4.2 Lean transformation

There are several reasons why organizations fail in their Lean journey. For example, only less than ten percent of the companies in UK have accomplished a

successful Lean implementation. According to the literature even nine out of ten reasons are people related including poor communication and change resistance. As mentioned in the beginning also the case company failed in Lean transformation which first started at 2009. Any strategy which it is outside the bounds of an organization's culture will not be accepted. (Bhasin 2012.) Lean transformation is about changing, and changes are led by people. *"No matter what tool is used the determining factor for success is leadership at every level, but particularly in the groups that do the value-added work."* (Liker & Convis 2012, 144).

In figure 21 the people behaviour in matter of change is presented.

The Change Curve

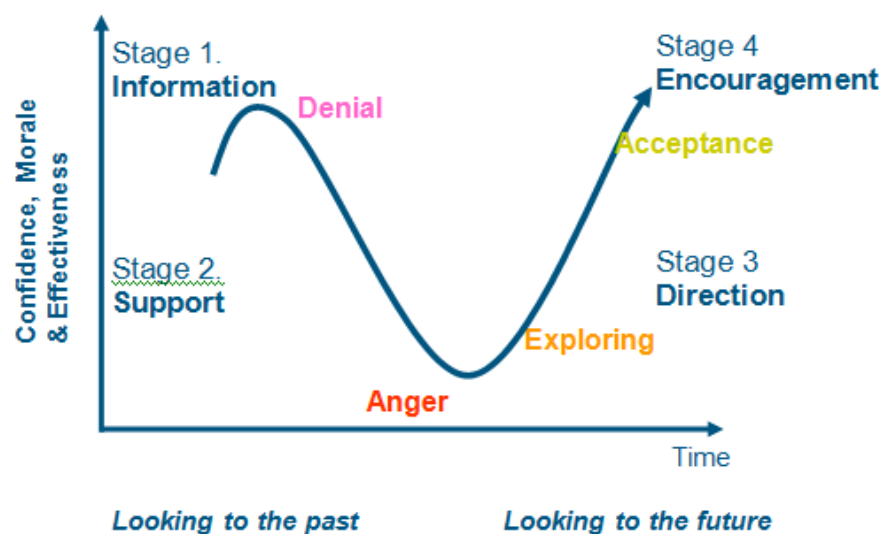


Figure 21: Kübler-Ross curve (Lee 2014).

In figure 21 the change curve presents the path people go through during the process of change. The curve was originally founded by Elisabeth Kübler-Ross by illustrating how people deal with the news of terminal illness. Later this curve has been utilised in business life too by illustrating how people deal any kind of a change they are going through in an organization. (Lee, 2014.) It's typical that people object the changes and try to defend (anger) and find different

counteractions for not to change. Eventually people do accept the change, but they need to go through the path first.

There is no universal formula how to implement Lean, which should be taken into consideration when companies are transforming their culture towards Lean, but some general rules apply. Having a carefully crafted implementation plan for Lean is a key for succeeding in implementing Lean as otherwise organization might get distracted by the daily challenges and other problems they'll face. The plan is for managing the Lean implementation and to keep the focus on the plan. Other key factor is to have the key people involved in the organization, those with the power. The best persons to implement Lean or any cultural change are the ones who are from internal staff. The plan should be visible for all the stakeholders and work as a road map for the organization. The third key factor for the success is belief, taking the courage to step on Lean path. People will change easier if they witness the benefits. (Chaneski, 2005; Bhasin 2012.) According to Bhasin (2012) the Lean systems are interdependent and need a lot of attention. This means that people should be reminded that the journey will not be just an easy project, but an ongoing process, which needs to be taken care of (Liker & Convis 2012).

Monden (2012) introduces five steps how to implement JIT production in Toyota Production System. These steps apply when focusing on the JIT-pillar of the TPS system, and when the steps include elements from organization structure presented by Mann (2010) in chapter 2.4.1. Both Bhasin (2012) and Monden (2012) emphasize the meaning of planning in order to succeed in Lean transformation. Step one emphasizes the role of an upper management. It's important to have the upper, not middle management, to launch the effort of Lean implementation to the blue collars. Step two is about having a project team comprising all the organization levels. Their role is to train the techniques and organize JIT for different levels of organization. The ideology is very similar to the organizational structure presented in chapter 2.4.1 by Mann (2012) in figure 20. Step three is about setting an implementation plan and a schedule and starting the JIT implementation by selecting a pilot project, which is step four. According to Bhasin (2012) engaging and involving the employees to implement the changes

and to develop the skills of improvement removes the anxiety and fear in transformation process. Step five is about moving from downstream process to upstream process. (Monden 2012, 25 - 28.) As mentioned earlier, the success lies in the people and failing is people related in nine out of ten cases, the organization is not afford to have negative sub-cultures if they wish to succeed (Bhasin, 2012; Womack et al., 2005).

According to Masaaki (1997, 63) continuous improvements (*kaizen*) and Lean transformation in companies should start with three main activities: standardisation, 5S and eliminating waste (*muda*). According to Monden (2012) implementing should start (before the techniques) with making a schedule, setting a goal and providing education and after that 5S is implemented (Monden 2012, 28). The success of Lean transformation normally depends upon organizational characteristics, which means that there is no such approach as “one size fits them all” for implementing Lean (Shah and Ward, 2003). Eventually it seems that it’s important to focus both in techniques (standardisation, 5S etc.) but at the same time the focus should be in cultural change issues and in change management, like education and setting goals.

3 RESEARCH APPROACH AND METHODS

The research method chosen is an action research. The method serves the purpose of the study extremely well as in an action research the idea is not only to describe the phenomenon but to change it. The people in the organization have an important role in the research as they have a role in the research; they are active participants of the study. (Kuula 2006.) The advantage of the action research is to give a better and deeper understanding of the phenomena, which helps to utilize the results in development work. (Järvenpää & Kosonen 1997, 22). The method combines the theory and practise and is a part of the daily routines in an organization. Meanwhile the material is gathered and at the same time the improvements are made while the research is running. (KAMK 2014.)

In this case study, deep understanding of the processes and organization culture is vital in order to be able to analyse the whole supply chain and make improvement suggestions. In an environment where there is a suspicion of lack of cross-functional management, action research method approach with quantitative method presenting the findings as numeric facts was seen as the best method to avoid any misunderstandings. (Dick 2014.) The idea of the action research method was built around leader standard work presented by Mann (2010, 37 - 39), covering the upper level of the organization; The method covered meeting practice held twice a week, where the responsible operators (i.e. upper level managers and directors) were involved in the study and they were accountable for raising deviations and being responsible for taking actions. The method was followed through a visual tool (white board), where all departments had their response times visualised based on the schedule/takt. The method was called TITO. The idea of the tool was to take first steps towards cross-functional communication and tie the organization more closely together by discussing through the KPIs tied in takt time (response times).

In chapter 3.1 the case company is presented briefly and in chapter 3.2 the reseach method TITO is introduced more detailed.

3.1 Lahden Autokori Oy –introduction

Lahden Autokori (LAK) is a bus body builder for Scania: Scania delivers a chassis to LAK and LAK builds a body on the chassis. The product is called OmniExpress and belongs to Scania's product family. Scania is responsible for the after markets e.g. distribution of the spare parts, publishing the documentation etc., but as a subcontractor for the Scania LAK provides needed information to Scania. LAK owns the product rights but the design of the bus body is partly defined by the Scania.

Table 4: Basic information: Lahden Autokori Oy



In table 4, basic information of the company is presented. Lahden Autokori Oy has been under big structural changes after deciding to end the Scala production line in Villähde (Feb 2013). The story of LAK ended at 12.9.2013 when the company filed for voluntary bankruptcy from Lahti District Court. Despite of the bankruptcy the production re-started and the order-book will be completed. Scania has signed a contract in which the company will be owned by Scania starting at 1.5.2014. The case study research was made before the bankruptcy.

Table 5: History in brief

1945	Established
1967	First aluminium bus body (before wooden)
1973	New production bay: the last wooden body and new production hall
1989	Expansion of production lines
1996	National entrepreneurs price and expansion of production facilities
1997	ISO9001-certificate
2005	Contract with Scania till 2014
2007	New factory at Lahti: OmniExpress production starts
2013	Bankruptcy
2014	Ownership changes, new owner: Scania

The history in brief is presented in table 5.

Lahden Autokori manufactures bus bodies in three different heights: 3.20, 3.40 and 3.60 meters. The product family is called OmniExpress. The length of the coaches varies between 11 and 15 meters. The bodies are built on Scania chassis': KIB/KEB 4X2 and 6X2 x 4, engines 280-470 hp (Euro 5/Euro 6). Customer can choose different options such as kitchen, toilet units, audio/video devices etc.



1945-67: Trucks, mobile grocery buses, wooden bodies
1967: Lahti 10, first aluminum body
1986: 400-serie, Eagle 450/Falcon 430
1992: Low Entry Lahti 402

1996: 500-serie, Eagle 560/ Falcon540/ Flyer520
2001: Scala, Low Entry
2003: Eagle/Falcon, facelift
2007: OmniExpress 340/360
2011: OmniExpress 320



Figure 22: History of the products made by Lahden Autokori Oy

In figure 22 different models are presented. The bodies have been built from the beginning of the company's history starting with the wooden bodies, then aluminium and finally stainless steel (ferritic). The product range is introduced in figure 22. The latest models have been developed during the period of being under bankruptcy estate. Gas bus with height 3.20 meters will be manufactured in April

2014 and also 3.20 LE (low entry) bus will be taken into production line at April 2014.

The markets are in Europe, mainly in Northern countries. The biggest order batches at the year 2013 came from Germany and Norway, which can be considered as increased quality level of the product as both of the countries are famous for demanding high quality.



Figure 23: Sales and export countries

The sales and export figures from 2012 are presented in figure 23. Norway is the biggest customer.

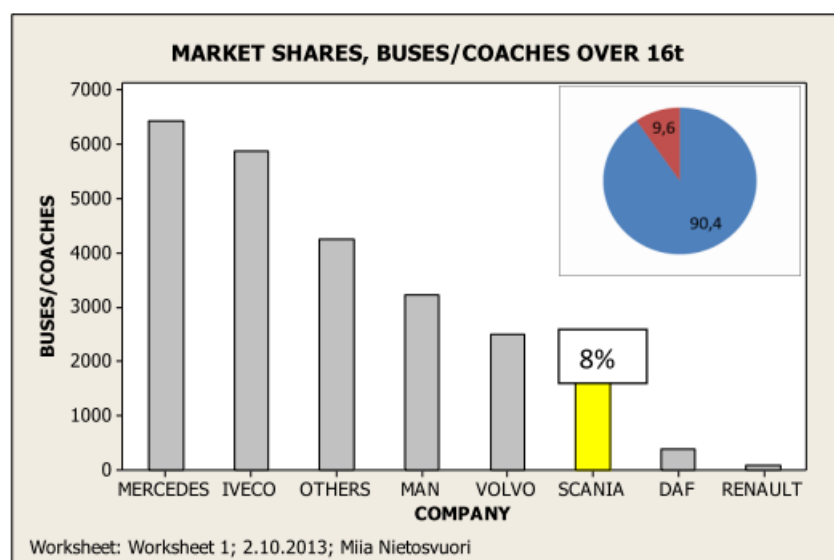


Figure 24: Market shares, buses/coaches in Europe over 16 ton (Autobei 2012)

Figure 24 indicates the Scania's market share in 2012, which was 8% of total European market (buses/coaches over 16 t). LAK's share was 9,6% from the Scania's share.

3.2 Research method and visual tool, TITO

The actions research consists of observation, interviews and method called TITO consisting of a meeting practice and a visual tool. This chapter presents the TITO-method and the tool.

The research method is a meeting practice called "TITO-meeting" which was held twice a week where all the deviations and warnings (potential deviations) were raised by the operators and written on the visual white board. Operators were responsible persons of each department (Sales director, R&D director, Work Planning manager, Purchase Manager, Design Manager and Production Manager). The up-dates of the solutions of the each deviation were followed and each deviation had a responsible person to solve it. The meeting was divided into two parts: first the up-dating of the previous deviations and warnings, possible solutions and also writing down the root causes, the second part consisted of raising the new deviations and potential deviations (warnings). Meetings were short, only 15-20 minutes and held by the author. The data was collected continuously approximately three months.

The original idea of the method is from Slupsk Poland and the original name of the method is "Get orders to flow", created by J. Dabrowska-Balasz.

The tool used was a visual white board seen in figure 25, where all the orders flew. Each coach or a batch of coaches had an own card. The white board was divided into two sections: one where the orders flew and the other section where the deviations and warnings were written down and followed. The first section of the white board was divided according to the response times to show *when* each operator should have completed their work. The idea was to emphasize the

meaning of takt time by visualizing the response times. Total theoretical lead time (days to manufacture a bus) is 80 days, from order to delivery.

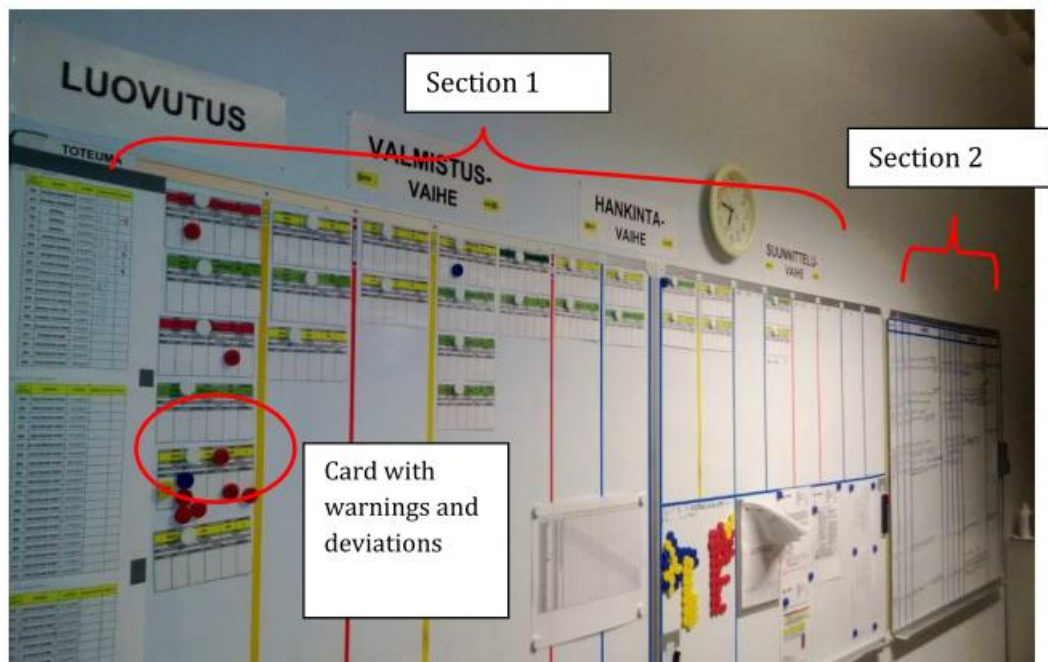


Figure 25: TITO, a visual tool, white board

Section 1 in figure 25 includes 4 phases: luovutus, valmistusvaihe, hankintavaihe and suunnitteluvaihe. In English these are delivery, production, purchase and designs. Section 2 is for writing following up the deviations and warnings.

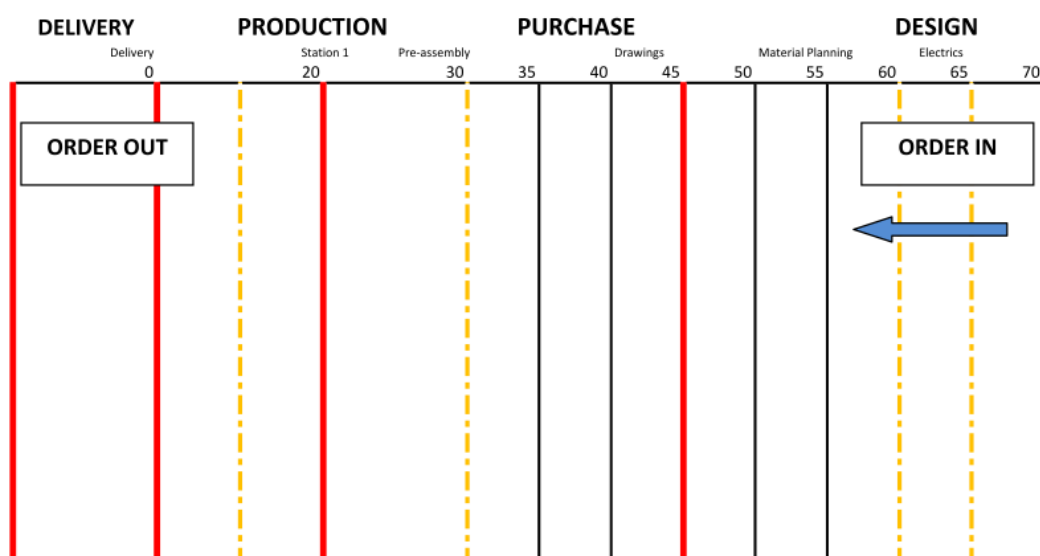


Figure 26: Structure of the white board, section 1.

Red lines in figure 26 indicate response times (deadlines) and when something (designs etc.) *must* be ready. For example at day 45 (=45 days before the delivery) all design drawings must be finished. Yellow lines are guide lines. At day 30 the production starts from pre-assembly line.


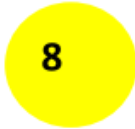
Body no		Customer		Model	PCS
XXX		XXX		XXX	X
Market		Salesman		ID	
XXX		XXX		XXX	
NM		SV		L1	
				L	
				16.4.2013	
				16.5.2013	
SALES	R&D	DESIGN	WORK PL.	PURCHASE	COLOUR CODE
					2

Figure 27: The card

Each coach or a batch of coaches has a card (figure 27). Deviations are divided into 2 categories: Red (Deviation) = Will affect on the final delivery and the delivery date will be delayed (the promised delivery date is in danger), Yellow (Warning) = The operator has missed the deadline and/or the delivery date might be in danger. The colour of the card (upper part of the card) is either red, yellow or green depending on which category the bus belongs to. Red means a proto bus, meaning that there are a lot of new features in the bus which have not yet been designed earlier or it's totally a new model. Yellow means special, which means that there are some customer specific features, which needs special attention from designers and in some cases also R&D needs to be involved. Green means a bus, where all the features have been designed earlier.

Num ber	Date	BODY	DEVIATION	Days before delivery	Resposi ble org	Respon sible person	FUP	SOLUTION	ROOT CAUSE	closed
1	12.4.	100	djfhrrh	20	workpl	Mtu	25.4.	xxx	yyyy	27.4.
2	17.4.	400	fkjgjh	25	purch	Sle	27.4.			
3	22.4.	300	klilllfhgh	30	sales	Psa	29.4.			
4	22.4.	500	dashifkfo	15	desing	Era	29.4.			

Figure 28: Structure of the white board, section 2

All items, deviations and warnings, are written on the white board (figure 28) and are followed up in the meetings and. “Days before delivery” are written on the board in order to use the information later on in the research analyses for finding the bottlenecks.

The operators had to announce the follow up date. The operator needed to ask him/herself “when do I think I’ll have the solution?”. This saved time because all the items were not needed to be followed at every meeting, but only then when the solution was available or the operator thought the solution should have been available. The operators were expected to find the solutions by the date they had announced.

4 RESEARCH FINDINGS

The aim of the analysis was to find the bottlenecks from the supply chain process in order to see what prevents the flow, and why the deliveries are being delayed. The analysis revealed a lot more: not only the bottlenecks, but also the lack of cross-functional management in the organization. This is more discussed in the chapter 5, where the conclusions are presented. The most important findings through the data and observations were:

1. The theoretical process lead time, the time from order to expected delivery, was 62 days, not 80 days as previously expected. The total process time of manufacturing the buses was actually 22 % less than expected.
2. The amount of deviations, which caused the actual delays of the deliveries, was three times greater than the amount of warnings, and more importantly, the deviations were accumulated at the end of the production process, where they were more critical with respect to on time delivery. There were no correlation between complexity of the bus and the amount of deviations and warnings.
3. Two of the departments were indicated as bottlenecks in the process: Sales and R&D/Design. The defined response times, for both of the departments, are at the early stage of the supply chain process, and if the response times were not met, the problems accumulated at the end causing severe consequences.
4. Even though the response times were defined and agreed, it was noticed during the research, that the operators, who had to deliver the drawings or another deliverables, were not fully aware of their response times. It was also observed, that the response times were not followed regularly. Also there were no adequate systems to support the following of the response times.

In this chapter the main findings are explained more detailed. The theoretical lead time is opened and explained together with the amount of deviations and

warnings. The bottlenecks are identified, but on the other hand, the action research gives a deeper understanding for the root causes of the bottlenecks and why the reliability of the deliveries was poor. This is explored through the matter of response times. Deeper discussions can be found in chapter 5.

4.1 Theoretical lead time and variation

Variation is one of the Lean laws, which prevent the unit to flow (Modig & Åhlström 2013.) The variation of the time, when orders are received into the internal supply chain process, varies a lot. This is explained in the figures below.

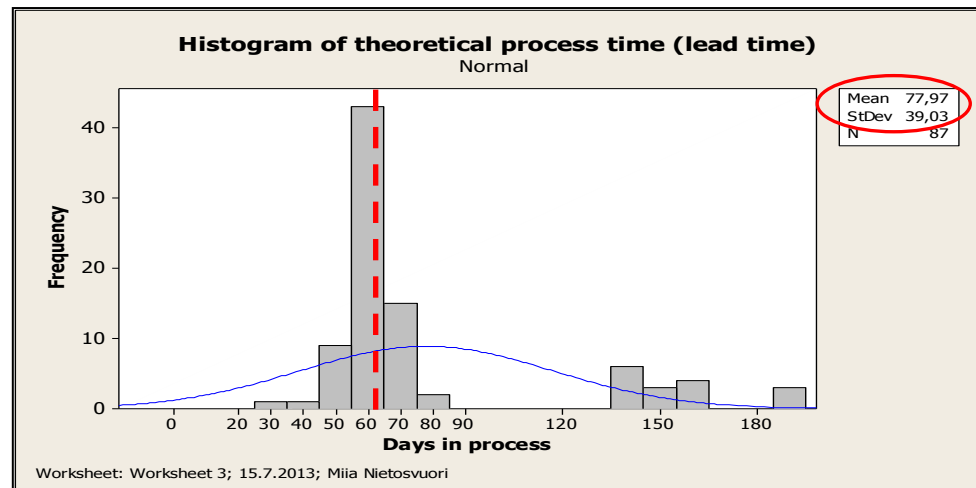


Figure 29: Theoretical process time, histogram

In figure 29, there can be seen a huge variation of theoretical lead time (starting from the point when the order comes in the process and ending when the bus is expected to be delivered). The bars in the histogram are spread widely, and the blue curve in the figure is very flat. So, the figure shows that the orders were received into the process between 180 and 30 days before the bus was expected to be delivered. It is clear, if there is only 30 days time to deliver a bus instead of agreed 80 days, the organization struggles to have the information, materials, drawings etc. in time.

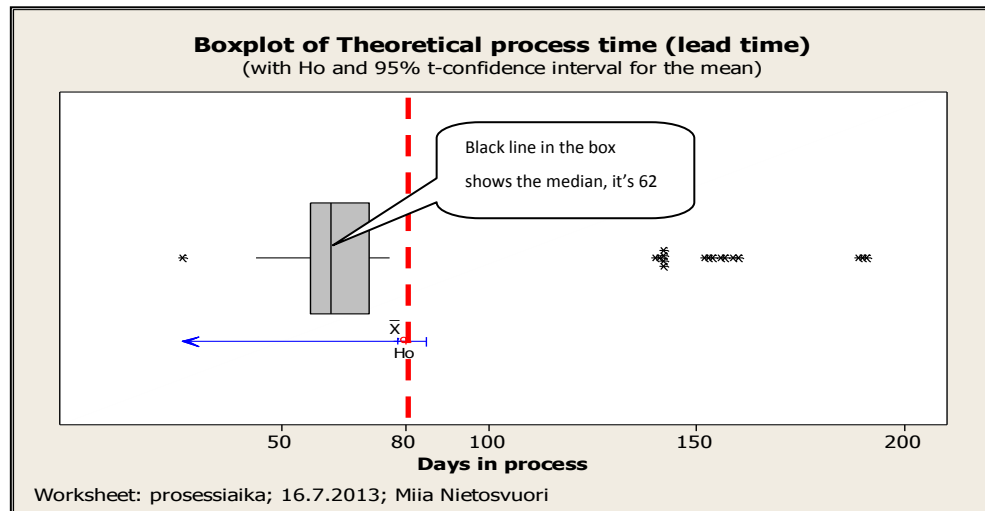


Figure 30: Theoretical process time, boxplot

Figure 30 confirms the fact, that the most of the orders were received a lot later than expected. The boxplot shows (grey box with black lines on each side), that more than 75% of the orders are received into the process less than 80 days before the expected delivery. Both of the figures (figure 29 and 30) indicate the significant fact, that the organization lives in an false assumption, where it has 80 days time to complete a bus, but the reality states, it only has 62 days (Median).

4.2 Amount of deviations and warnings

The amount of deviations and warnings were analysed. Total amount of deviations were 100 and warnings 32.

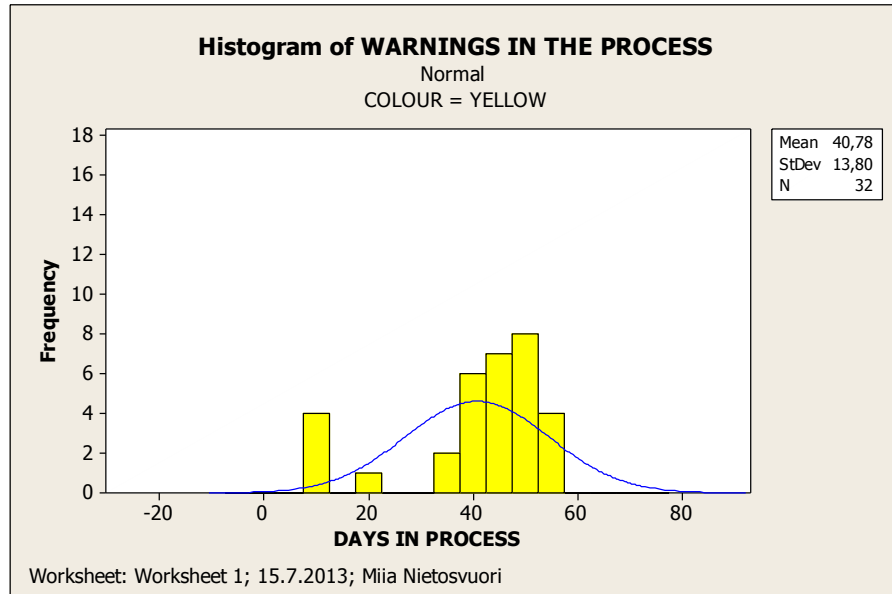


Figure 31: Amount of warnings

In figure 31 the amount of warning can be seen, total 32.

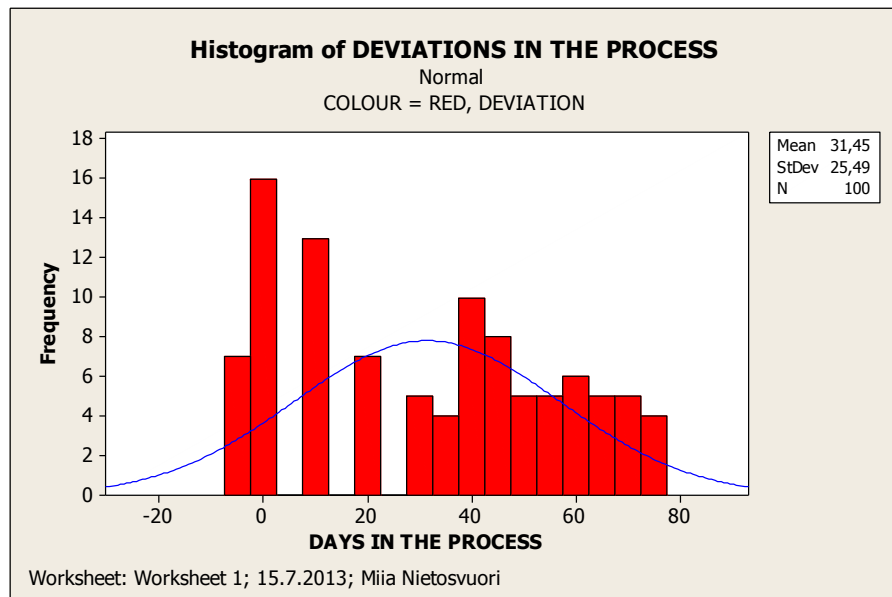


Figure 32: Amount of warnings

In figure 32 the amount of deviations can be seen, total 100. There are three times more red deviations (N=100) as there are yellow warnings (N=32). Red warning means that the delivery will be delayed and the yellow means that the final delivery date might be in danger. Warnings have been mainly identified at the time where the drawings should have been completed (40-45 days), but the

deviations have been clearly accumulated at the end of the process, meaning just before the bus is delivered.

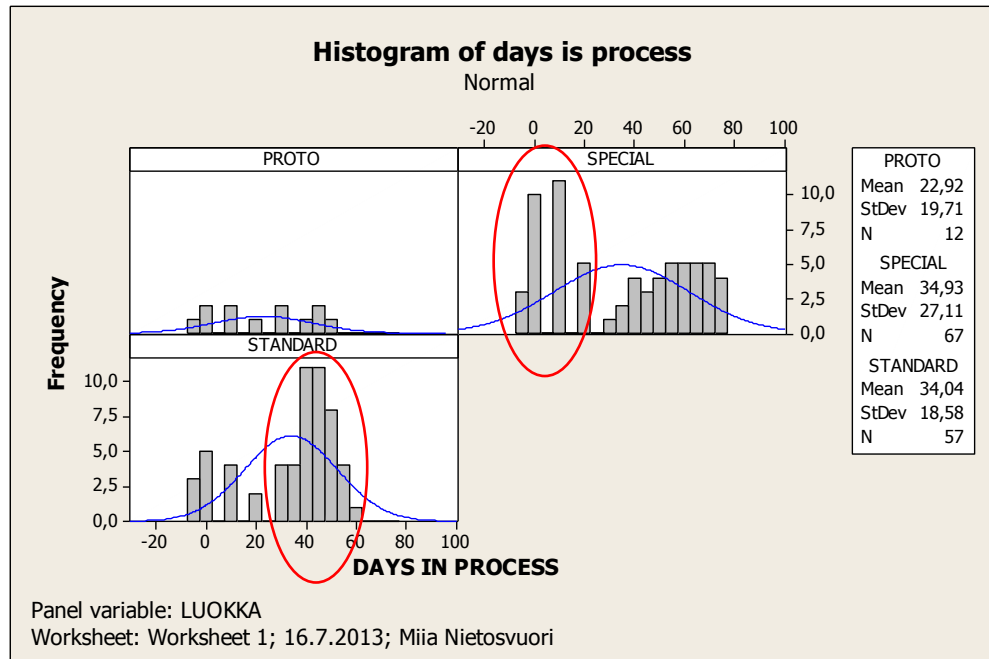


Figure 33: Standard, Special and proto: Amount of deviations and warnings

In figure 33 the amount of deviations in three different categories is presented. It can be seen that the problems are cumulated especially when there are special buses. The deviations were mostly announced by the production manager and in the end of the production line. There were also difficulties to complete drawings for the standard buses, which can be seen bars at the days 40-45. Those were mainly warnings. The analysis showed no correlation between complexity of the bus and the amount of deviations and warnings.

4.3 Bottlenecks

It's important to detect when do the most of the deviations occur and which department is responsible for taking care of the deviation, therefore the bottlenecks are presented several ways; in time, in departments and in solution time.

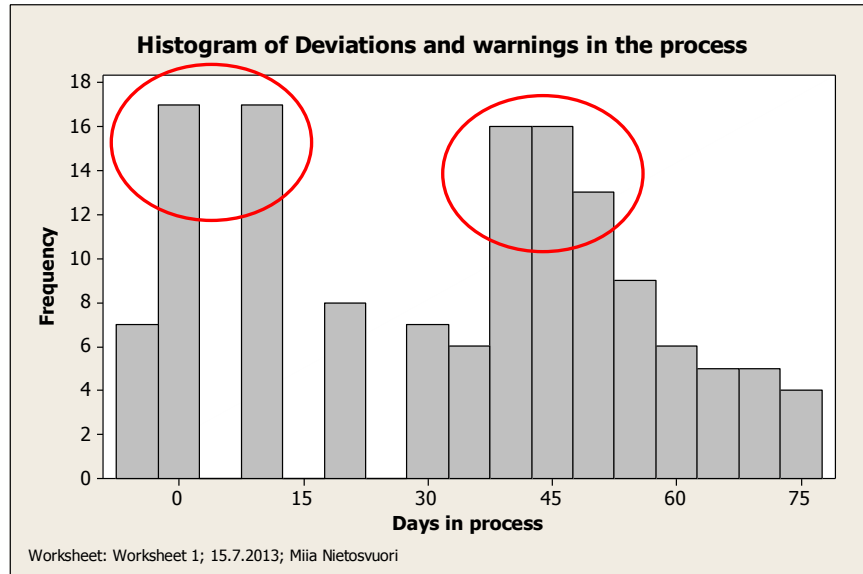


Figure 34: Bottlenecks in timeline

In figure 34 the amount of deviations and warnings can be seen in time line. There are two spikes (inside the red circles), one at the end of the production line, but also at day 40-45. Having such an amount of deviations and warnings at days 40-45 indicates mostly that the drawings were not completed in time by the design/R&D department. At the end of the production line the deviations were mostly announced by the production manager, which meant that the problems were not indicated earlier during the process. No one announced warnings before it was too late.

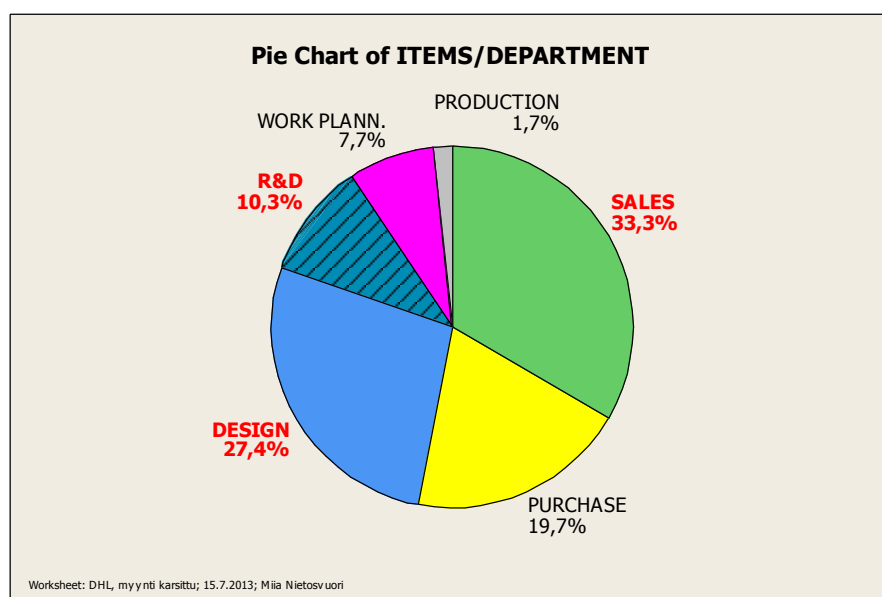


Figure 35: Bottlenecks in departments

In figure 35 the pie chart shows the amount of deviations and warnings per department in percentage. There are two departments, which can be identified as the bottlenecks in the process: Sales and R&D/Design. R&D and Design departments are very close to each other and the functions are mixed, therefore these two should be observed as a one department. Sales and R&D/Design departments make total of 71% of the deviations and warnings in the process. The reported root causes in general, for the deviations and warnings, were mainly missing information or the order was received too late (less than 80 days), also the drawings were late due to the lack of resources and naturally due to lack of information.

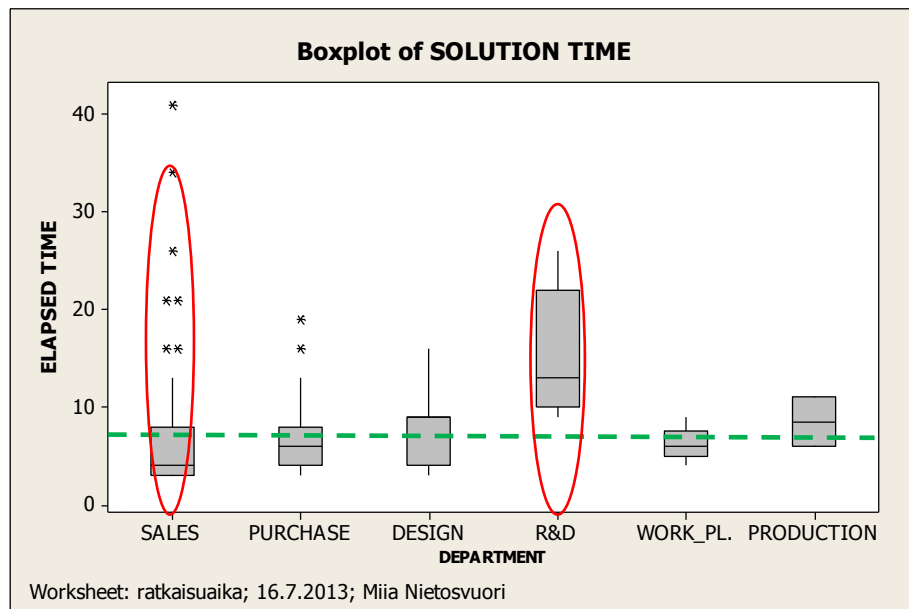


Figure 36: Bottlenecks in solution time

The average time to get a solution was 8 days (green line in figure 36). In figure 36 it can be seen, that Sales has quite a big variation in having the information for the rest of the organization in time, even though the boxplot (the grey box) is located under the green line meaning that sales has been able to find answers in time in general. In Sales the grey box without the black line indicates that 50% of the problems have been solved before 8 days, but in some cases it has taken even 40 days to have the final information. R&D has struggled to have their solutions

in reasonable time. In fact, the problem solving has taken constantly more than 10 days, as the grey box is located above 10 days.

4.4 Response times

The research method was based on response times and following them. If the response times were not met, the responsible operator had to announce about it. At first, people felt very uncomfortable about visualizing the problems and to announce deviations and warnings. Earlier the organization culture was used to handling the deviations in their own departments, in their own offices, so the TITO-method was a real cultural shock for the organization. Operators felt that they were being blamed, when deviations and warnings were brought up. There needed to be a change in the organizational culture. One of the main findings of the case study was that the operators did not have sufficient tools to follow the schedule and takt time, or some of them were not even aware of their actual response times. In addition, the agreed response times have been agreed many years ago and therefore there is a suspicion of if those are valid anymore. This was based on the fact that warning signs were not detected and announced early enough; therefore they were announced as deviations by the production manager.

5 DISCUSSIONS AND CONCLUSIONS

The research findings together with observations conclude the fact that the organization is lacking of cross-functional supply chain management. In this final chapter the research findings are discussed and connected with the research questions and with the theory leading the reader to the improvement suggestions. In the end the thesis is summarised.

5.1 Discussions: theory meets practise

The main research questions were how to manage supply chain cross-functionally and how to improve the poor reliability of the deliveries. In chapter 2 the theory focuses on Lean and explores what is the meaning of cross-functionality. It's essential to understand the meaning before answering the question. The study reveals that that the company has not a culture which works cross-functionally, but it is a classic example of a conventional supply chain management culture. How to be cross-functional and how to transform the culture is discussed through the improvement suggestions in chapter 5.2, but in this chapter the research findings are compared to the theory to show why the case company is not cross-functional and why the reliability of the deliveries were poor. How to improve the reliability of the deliveries will be discussed further in chapter 5.2 as improvement suggestions. The sub-research questions will also be discussed in this chapter.

The theory and the case study reveal that the organization is fallen deeply into the conventional supply chain management culture. The people in the culture concentrate on minding their own businesses and there is no holistic way to focus on the flow, which in this case would mean respecting time. The organization is a classic example of being an organization where there are efficient island here and there. This was discussed in chapter 2.1.3. (Modig & Åhlström 2013, 98.) There are no common rules in the organization, in this context there are no common response time rules. According to the observations, the Sales department does not know the deadlines for each change the customer would like to make, and this was considered to be one of the most critical issues in causing the deviations in the internal supply chain process. The changes were made too late in order for the

entire supply chain to react. Additionally, the other departments were also lacking adequate control in their response times, which in fact defines the response times (dead lines) for the Sales also. Some of the people were not even aware of their response times meaning that they didn't not know when exactly they should have completed their work task. In this situation when people do not know when they should complete their task, it is almost impossible to control the variation and detect what needs to be improved. The matter is revealed in the case study findings, where most of the deviations were found during the production process and then announced by the production manager. Also the fact of having less time (theoretical lead time to manufacture a bus) than expected reflects lacking of control in the process and missing a holistic picture of managing the organization. *"TPS is a system where everything is connected"* (Modig & Åhlström 2013, 139.) This sentence does not apply in the case company; the company is not working cross-functionally and therefore falls into the conventional supply chain management culture.

Lacking of control and lacking of common focus on flow and time explains also why the reliability of the deliveries was poor. Controlling the process needs methods and tools, but the case company is obviously missing adequate control systems. There were no systems to identify the problems earlier in the process, or even if some departments had their own systems, the systems did not provide information for the other departments. There was no cross-functionality between the control systems. In production the matter of flow is inevitable as the line moves and one can see very concrete what is the status of the process, but for the other departments the matter of flow is not so clear. When there are no methods or tools to show what is the status of the process, it'll lead the company to lack of materials, drawings, resources etc. and the production will eventually reflect what went wrong. The only solution used in the case company to catch up the takt was to hire more people to the production line. This is a classic example of the Little's law. When WIP (work in progress) increases, CT (cycle time) increases too. This is not only revealed in production, but in other departments too. That can be seen when investigating why the organization struggled even with the standard buses when the drawings were not completed in time for the production. There was no control or signal to detect problems earlier in the process, which led designing the

special features to be severely delayed; the production had neither drawings nor materials. This means that the resources of the designers were used to fix the problems in the end of the production line, but at the same time the basic work suffered. However, no extra resources (engineers) were hired to fix the problem. Eventually, there were a lot of unfinished buses in the production line and only the production was increasing their resources. Work in progress increased, cycle time increased, the expenses increased. The law of Little states in this case causing the company to end up in poor reliability of the deliveries.

There are three sub-questions to be answered. First, how to measure the supply chain in order to find the deviations earlier in the process. In the case study a measurement tool had to be invented as there was no tool how to measure the process. It's clear that the tool invented is not enough for the organization as the warnings were not seen earlier in the process. The TITO-tool works as an upper-level tool, but the organization needs similar tools for each level of the organization. The focus in the tool was on response time. As the reliability of the deliveries was poor the main focus must be on time. Earlier there were no KPIs to support daily monitoring, however the KPIs were monitored monthly basis as discussed in chapter 2.1.1. The company was looking at the back mirror; how did we succeed? This is a typical way to monitor the KPIs in conventional supply chain management culture. In chapter 5.2 an improvement suggestion is presented how to measure the process earlier.

The second sub-question is what are the bottlenecks in the supply chain process and when do they occur. The deviations were escalated in the end of the production line as discussed earlier. There were found two bottlenecks, and according to the Pareto-principle discussed in chapter 2.3.3 these two should be eliminated in order to decrease the variation in the process. The third sub-question is what are the root causes of the deviations in the supply chain process. Instead of blaming which department is guilty and which causes the most of the problems, the research concludes the problems to be much deeper; the organization is lacking of common tools, methods and culture of managing the process cross-functionally. None of the departments is guilty, but all of the departments need methods and tools to be able to work cross-functionally and to be able to focus on

time and flow. The root causes are not just lack of materials or lack of resources, but lack of controlling the process –lack of cross-functionality. The chapter 5.2 focuses on giving an example how to improve and build a cross-functional system in the case company.

Being cross-functional means working together for the benefit of the company (Chuda 2013, 157). The findings of the research conclude the fact, that the case company is missing effective cross-functional management as the company is not working together and not having a common holistic way to achieve the common target. The chapter 5.2 focuses on finding an improvement suggestion how the company could take first steps out of the conventions supply chain management culture and step on the path of Lean.

5.2 Improvement suggestions

The case company started Lean transformation in 2009, but as many other companies, the case company also failed. In chapter 2.4.2 success factors in Lean transformation is presented. There are few main factors that prevented the case company to succeed in 2009; the key persons were not involved and the change resistance was too strong, and also the focus in the transformation process was mainly on techniques and on production processes, not in management. The study reveals that the problems lie at earlier stage of the supply chain process and the production is just a reflection of the actions performed earlier.

In chapter 2.4.2 there are presented different approaches how to start Lean implementation. It's clear that there is no one way to do it, but utilising the information provided in the chapter and connecting the theory and study results this chapter gives an improvement suggestion how the case study should re-start the Lean journey in order to succeed controlling the reliability of the deliveries. This chapter presents shortly how to get started and what is recommended to be done.

5.2.1 The plan

As discussed in the chapter 2.4.2 there should be a plan for the implementation. The house is a perfect frame for a plan. As the company will be a part of the Scania, it will take the Scania house as a guiding principle for the company. To make people understand the meaning of the house and the techniques in the house, the house could be presented block by block meaning that the techniques such as 5S etc. presented in chapter 2.2 would be added after introducing and educating them. Naturally the schedule must be created, but one must remember that the transformation is all about changing the people behaviour and it's people related, therefore the schedule must be flexible. (Bhasin, 2012; Womack et al., 2005).

In chapter 2.2.1 figure 10 shows the idea of Toyota Production System. The values guide the principles followed by methods and tools. The idea supports the fact of taking the house as a planning frame giving the company the core values and the principles and after that methods and tools take place. The first attempt to launch Lean transformation in the case company at 2009 focused on tools. There were no chances to succeed as the principles were not there.

5.2.2 Lean management

The theory in chapter 2.4.1 is strongly recommended to be implemented in the company. The company needs a structure for the organization to be able work cross-functionally; see the deviations, measure the process, improve the process, be accountable for the actions taken, make improvements and control the system in real time. These all are the elements in DMAIC-process (define, measure, analyse, improve, control) mentioned in chapter 1.4.

First the organization structure should be built to support daily steering.

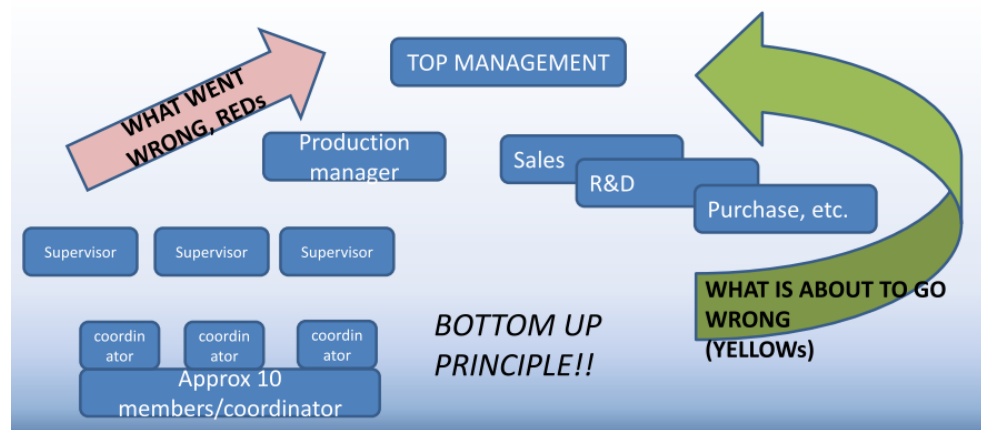


Figure 37: Structure of the organization

In figure 37 the structure of the organization is presented. It follows the idea of how Scania has structured their organization (Tham, 2014). The daily meetings are structured in different levels meaning that each level of the organization will have their own meetings and the warnings and deviations are brought from bottom to up. This gives the company a chance to monitor the system daily basis and to react immediately.

As the company struggles to see the deviations, there must be methods and tools to support it, therefore visual KPIs are strongly recommended. The KPIs should be implemented in each level of the organization, not only at the upper level, as before, and the KPIs should launch immediate actions, if they indicate the actual is not versus expected. The idea is to connect the key indicator to the lower level of the operations and guide the operator to make improvements and activities before the final product, in the case study a bus, is ready for the delivery. The main KPIs and targets should be determined by the upper management (Liker & Convis 2012, 148-149). When the main KPIs are determined they should be transformed to lower levels in such form that they can actually launch immediate actions. For example, the reliability of the deliveries should be transformed to each department in different ways in their response times. In addition to the visual KPIs additional visual tools and methods are recommended. A tool such as TITO could work either as an upper level tool or it could work for the R&D/Designer department. Nevertheless the idea is to visualise the projects and to see the

potential deviations to be able to be proactive, not only reactive. It's all about controlling the variation.

The organization structure and the visual tools combined with daily meeting routine is a key to control the process. It's vital to demand accountability and follow the deviations daily basis. Scania uses very simple post-it white board to follow the actions.

TEHTÄVÄT, TUOTANTO_Taso2 (Koordinaattorit/Työnjohto)
 ACTIVITIES, PRODUCTION_Level2 (Supervisors/coordinators)
 TYÖNJOHTAJA: _____

	VKO					VKO				
TYÖN	MAANANTAI	TIIKSI	KE	PERJANTAI	PERJANTAI	MAANANTAI	TIIKSI	KE	PERJANTAI	PERJANTAI

Figure 38: Example of a activity white board (Scania 2013)

In figure 38 there is an example of a post-it white board. Similar boards are used in Scania in different factories around the world. The idea of following the activities is to ensure the deviations and actions towards them are not forgotten, or those are not just based on individuals' memory, but they'll be visually seen. The same idea is in TITO-meeting practise. The actions are followed, which creates accountability and makes it easier to control the process. This is important for example, if someone is out of office the others can see what needs to be done.

The daily steering routine presented by Mann (2010) in chapter 2.4.1 is recommended to be implemented as soon as possible for the entire organization to support the company to have a chance to react in right things at right time.

5.2.3 Focus on time

Regardless of the type of the variation, it always effects on time (Modig & Åhlström 2013, 41). The Lean management system is first step towards stabilizing the process. When everyone is focused on time, it's expected to help the production and the whole organization to keep the takt and improve the reliability of the deliveries. The focus must be on time. When the focus is on flow and time, it means that in some cases one needs to increase inventory or resources in order to buffer and control the variation (FactoryPhysics 2014). The company has mainly focused on resources when trying to fight against the variation. The purchase department has tried their best to keep the turnover high and also to keep the value of the inventory low. The company should start focusing of the flow and time and build the resources and inventories around the response times, takt. Whenever a decision is made, it must always be reflected on time.

After the plan (the house) is made and the Lean management system is built, the organization can start focusing on the tools and methods inside the house. Longer term aim should be decreasing the lead time by eliminating waste by restructuring the present response times. The two principles in Toyota house presented by Modig & Åhlström (2013) are JIT and jidoka. Both of the principles focus on time and how to see the abnormalities. This should be kept in mind when creating the tools in the organization. The company need to find tools how to be more proactive in order to turn the behaviour other way around; announce the warnings instead of detecting just deviations.

5.2.4 Continuous improvement

The Lean management system and turning the mindset towards focusing on time will give a platform for continuous improvement. The long term target should be decreasing the theoretical lead time by eliminating waste. There are many tools and methods to start with, which 5S is highly recommended. According to Masaaki (1997, 63) the Lean implementation should start with standardization, 5S and eliminating waste. For the case company implementing Lean Management is the first step towards standardizing and stabilizing the process. When the work

tasks are performed in the normal positions in production, stations, it's a lot easier to start 5S when one can work in his/hers own station and not jumping around trying to catch up the lost takt. The personnel should be educated to understand the meaning of seven waste before starting 5S.

For future improvements, not only the supply chain process, but the other cross-functional processes should be examined and evaluated. There are different cross-functional processes, where the unit flows through the entire organization, for example whenever a design change or a new innovation is implemented. These processes should also be controlled through visual planning and KPIs.

Continuous improving should be proactive. The case company tended to repeat same mistakes year after year, therefore using statistical tools and analyses are recommended. Only a system, where reactive actions take place is not enough, but in this case the first step is to stabilize the system by creating a system where actions are seen and followed. The data should be collected and continuously analyzed to see where the bottlenecks are formed and also to detect if the bottlenecks are the real root causes of preventing the flow, or are they just symptoms of something else. Chapter 2.3 gives an overview of basic statistical tools which can be utilized when analyzing the processes. As with the KPIs, also analyses should be performed in different levels.

5.3 Conclusions

The case study reveals more than expected in the beginning. In fact, it revealed that the case company needs their own production system. Against the expectations from the organization the improvement suggestions are not focusing only on some of the departments, it focuses on the whole management system in the company. The theory and practise walks hand in hand through the research, which was seen as very appropriate approach to start growing organizations' awareness towards changing the old conventional supply chain management into cross-functional supply chain management culture.

The research can be stated to be *valid*. The research method chosen serves the purpose of the study well as it is able to measure and find the answers for the

research questions. (Järvenpää & Kosonen 1997, 30). The TITO-method acted both as reactive and proactive method and gave answers to the research questions. Another validity criteria's is how well the group of people act together and how they are involved and how they bring the information to the research. (Anttila 1998). In the beginning, the group was little afraid to announce the warnings and deviations in the meeting. They rather stuck in the old routines and wanted to work as they used to work earlier, therefore the validity, in that sense, suffered a little. On the other hand, that observation strengthened the suspicion of not having enough cross-functionality and not having sufficient communication between the departments. Different opinions and change resistance launched very fruitful discussions and eventually made people to re-think and re-evaluate their present tools and methods. Reflecting to the observations mentioned, the validity of the research can be stated good as it confirmed the lack of cross-functional actions. Third criteria to have a valid action research is to have a deep understanding of the organization with sufficient professional skills and knowledge base. (Anttila 1998.) All of the representatives in the meeting were the responsible persons from the different departments covering the comprehensive knowledge base from each department. Also the author's experience is enough to make the research valid. The author has been working in the company since 2008 in different positions and in different departments and has made several studies on different processes. She has been educated to understand Lean and has implemented many improvements in the factory during the past years.

Reliability relates to claim that the data collected is accurate. Findings are less credible or reliable if the number of participants is small or the number of times data was collected is limited. (Field 2014.) If a participant could not participate the TITO-meeting him/her self she/he always had to have a substitute. The time period of the study was three months in total, which also makes the research reliable. In addition, to accomplish a reliable research the data must be accurate, but the research should be repeatable too. (Kaisla 2014). The method is used at least in Poland, but not in such form. There it works as a reactive tool, meaning that the data is not collected nor analysed. It would be extremely interesting to perform the same study in some other Scania plant/manufacturing unit to see what kind of results could be achieved. It would be also interesting to see the results

how they differ in an environment where Lean principles have been implemented already some years ago. The research is possible to repeat in another environment making the research reliable, but the author is recommended to be experienced and to have sufficient knowledge base of the organization's internal processes.

The conclusion of the study is that the case company is missing cross-functional management and instead of focusing improving just one or two particular department, the focus needs to be on time and in management. It's recommended to start the Lean implementation with creating a house by benchmarking it from Scania to give the organization clear values and principles. The house works as a plan and as a roadmap for the company. Secondly, the company needs Lean Management System, which focuses on time and proactive actions by empowering people to take responsibility through reporting the KPIs and to be accountable for their daily actions in order to achieve the expected targets. By having a control over the processes, abnormalities can be easier detected and improved. Eventually the aim is to control, improve, eliminate waste and finally make the unit flow, which will lead the company to have a better reliability of the deliveries and finally decrease the theoretical lead time. After the cross-functional management is implemented and the mindset is changed from reactive to proactive, the company is ready to implement Lean techniques such as 5S and eliminating seven wastes.

There are a lot of positive indicators to support the organization to succeed according to the literature review. These are: support from upper management, engaging the internal staff to implement the changes and the real motivation. (Monden 2012; Bhasin 2012). The support comes from Scania, which has implemented Lean already since 1997, and the motivation derives from a will to survive in the business. The organization has realised, it needs to change. Referring to Chuda (2013, 157), it's now all about how people can work together for the benefit of the company.

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