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AMMATTIKORKEAKOULU

LEAN MANAGEMENT PHILOSOPHY IN TECHNICAL SUPPORT

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JONI HARJU:
Lean Management Philosophy in Technical Support

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Tämän opinnäytetyön tavoitteena oli tutkia miten Lean -ajattelutapaa voi hyödyntää asiantuntijatyössä, jossa työmäärien ennustaminen ei ole yhtä selkeää kuin tuotantolinjalla. Lean johtamismallin otettiin käyttöön teknisessä tuessa ja tutkittiin miten se vaikutti työprosessiin.

Tutkimuksen toimeksiantajana toimii kansainvälinen ohjelmistoalan yritys DDS Wireless, jolla on yksiköitä Kanadassa, USA:ssa, Englannissa, Ruotsissa ja Suomessa. Tutkimus tehtiin Suomen yksikön teknisessä asiakastuessa. Tarkoituksena oli käyttää Leanin työkaluja ja menetelmiä sekä tutkia niiden vaikutusta teknisen tuen prosessin tehokkuuteen. Löytää ongelmakohdat ja ratkaista ne Lean ajattelutavan mukaisesti.

Tutkimusmenetelmänä käytettiin kvantitatiivista tutkimusta, joka toteutettiin toimintatutkimuksena. Tulokset perustuivat neljän kuukauden jaksoon, jolloin tekninen tuki toimi Lean johtamismallin mukaisesti. Tutkimuksen tulokset analysoitiin ja tuloksia verrattiin lähtötasoon.

Toimintatutkimuksessa asiakastuki alkoi käyttämään neljää Leanin työkalua ja menetelmää. Gemba kävelyn avulla löydettiin ongelmakohdat prosessista ja Kanban taululla konkretisoitiin näkyväksi työprosessin tila. SPC:n avulla parannettiin työmäärän ennustavuutta ja havaittiin resurssien puute työmäärään nähden nopeammin. PDSA mahdollisti parannuksien tekemisen prosessiin nopeasti, joka helpotti työn sujuvuutta.

Opinnäytetyön tärkein tavoite oli selkeyttää ja nopeuttaa asiakastuen toimintaa Leanin avulla. Tämä tavoite onnistui ja antoi asiantuntijoille työkaluja ja menetelmiä työn toteuttamiselle. Työ saatiin näkyväksi ja hukkatyötä saatiin poistettua, mikä koettiin tärkeäksi asiaksi prosessin toimivuuden kannalta.

Asiasanat: Lean, johtamismalli, asiakastuki, asiantuntijatyö

ABSTRACT

Tampereen ammattikorkeakoulu
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Lean Management Philosophy in Technical Support

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The purpose of this thesis was to study how Lean philosophy can be used in technical support work of a specialist, where the forecasting of workload is not in harmony with the production line. Lean management model was adapted to be used in technical support to determine how it affects work flow.

The Customer of this research is an international software company DDS Wireless, which has operations in Canada, USA, England, Sweden and Finland. This research has been done for the technical support in Finland. The purpose was to use Lean tools and methods to determine the performance of the technical support unit, identify issues and find possible solution using Lean methodology.

Research method used was quantitative. The empirical part focused on statistical methods by using action research methodology. Results were based on four months period of technical support act by using Lean management philosophy. The results were analysed and compared to the initial report of technical support.

In action research, the customer support started to use four Lean tools and methods. While Gemba walk exposed bottlenecks from the process. Using Kanban board resulted in concrete visible state of work process. Using SPC we improved the forecasting of work load and using Kanban board resulted in concrete. PDSA made possible it to improve the process and stabilise the working process.

The main goal was to accelerate customer support using Lean. The results of the thesis provided the intended outcome set for the research.

CONTENT

ABBEREVIATIONS AND TERMS

AR	Action Research
CE	Concurrent Engineering
CEO	Chief Executive Officer
CRM	Customer Relationship Management
DMAIC	Define, Analyze, Improve Control
FIFO	First-In-First-Out
FMEA	Failure Modes and Effect Analysis
JIT	Just-In-Time
KPI	Key Performance Indicators
MBWA	Management by wandering around
PDSA	Plan-Do-Study-Act
QFD	Quality Function Deployment
Six Sigma	Set of management techniques
SLA	Service Level Agreement
SPC	Statistical Process Control
TQM	Total Quality Management
WIP	Minimized the work in process

1 INTRODUCTION

Customer support is most important part of the company. It is important to build strong relationship with customer and it is not possible without excellent service. Companies needs to offer agile service with good quality for customers from different channels.

Lean management philosophy is agile method development 30 years ago by Mr. Taiichi Ohno for Toyota production system in Japan. Toyota has begun one of the biggest car manufactures in world because of Lean. After Toyota success story other industries across the world also started to use Lean with excellent results. Now days Lean is very popular management method in many different industries for example health care, manufacturing and banking.

This Master Thesis focuses on taking Lean management philosophy an integral part of technical support. Purpose is to determine standardized processes in technical support and recommend common tools and methods for specialists. The aim is to reduce the amount of time used and to improve the quality of services to customers.

The second chapter introduce the research design. Gives an overview of the company behind the technical support and background of the research. It also introduces the research questions, the aims of the research and research method used in study.

The third and fourth chapters discuss Lean Philosophy, tools and methods, which used in research. The fifth chapter introduces the operational excellence and phase needed to start process flow working using Lean fundamentals.

Chapter six includes Lean in practice. How Lean tools and methods in production managed and the kind of results achieved after four months period. Chapter seven focuses on research validity, reliability and evaluation of the research methods. The last chapter discusses the results of the research and conclusions from the research.

2 RESEARCH DESIGN

This section discusses research design. First, it introduces the case study company where technical support started to use Lean fundamentals. Second, it gives a background of the research. Third, explains goals and objectives more detailed. Fourth, it describes research question. Fifth, it introduces research method more detailed.

2.1. Case study Company

DDS Wireless is an international company in mobile apps, cloud-based fleet management, and it dispatches software solutions for the Passenger Transportation and Mobility industry. DDS portfolio includes real-time demand-based dispatching, routing and scheduling vehicle location, and tracking and communication systems to private and public-sector verticals worldwide including taxi and transit sectors. DDS support customers 24/7 through offices in Canada, Finland, Sweden, the UK, and the US.

Tampere Finland office was used as a case study. Goal is to extend case study to other offices, if the results are applicable to help improve existing situation in the technical support.

2.2. Background of the research

DDS Wireless provides technical support services to customers. Customers receive assistance for technical problems, questions and other technical support for products. Range of customers could be from taxi driver to CEO of a big taxi company. Technical support is available from 8AM to 4PM and the research study focuses on that. The research does not include duty line, which is a 24/7 service.

Technical support is provided in second- and third-lines support and employees work as system specialists. Support cases come from different channels, like direct phone calls to specialist, support calls to different support lines, emails, ticketing system, meetings or colleagues in the office as described in Figure 1.

All channels need to be managed and controlled. DDS supports taxi dispatching systems that run 24/7. When the support availability and case resolution times are in very critical state, SLA's made with customers' must be achieved.

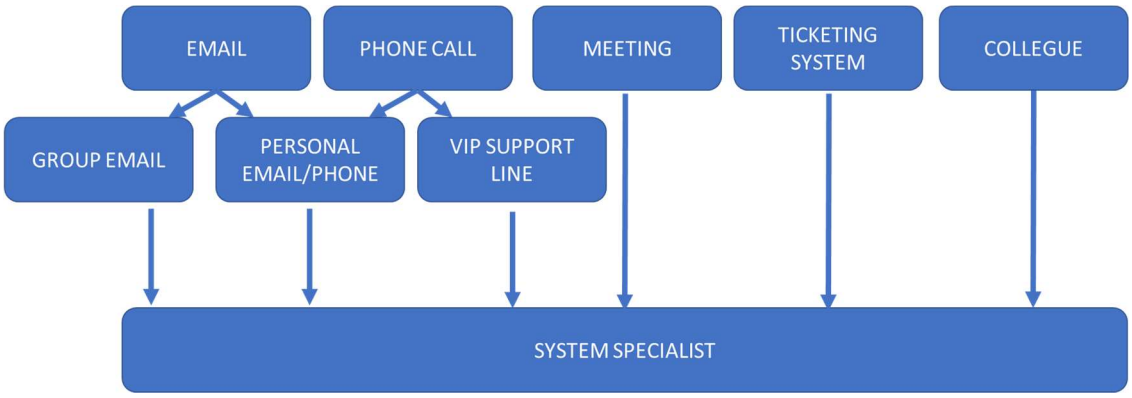

Figure 1: Channels of technical support

The existing model of the technical support was not effective. System specialist become frustrated as a result of many different channels that are needed to be attended to. Work was difficult to prioritize and to monitor. There are many different channels to follow increasing the workload. This makes it difficult to follow carefully the requests to make sure the important ones to manage first.

Managers also find this model difficult to use. It is tedious to get all channels in the same reports and the metrics for monitoring the support. The result of this complication is an increasing communication with specialists for assistance.

2.1. Goals and objectives of the research

Goal of this research was to start using Lean management philosophy in technical support to determine whether it will improve service offering. The research was quantitative and the empirical part focused on key metrics. The purpose was to determine whether Lean can be used in technical support and whether it can help in forecasting and improve quality of service.

Other objectives were to learn Lean principals, tools and methods and take these into use. In this research focused on PDSA, Gemba, Kanban and Statistical Process Control (SPC), and way to improve technical support with these tools and methods.

Part of this research was to centralise all support cases in same system as described in figure 2. Move from multichannel system to single channel system, which means ticket should be issued for all cases in order for specialist to manage them.

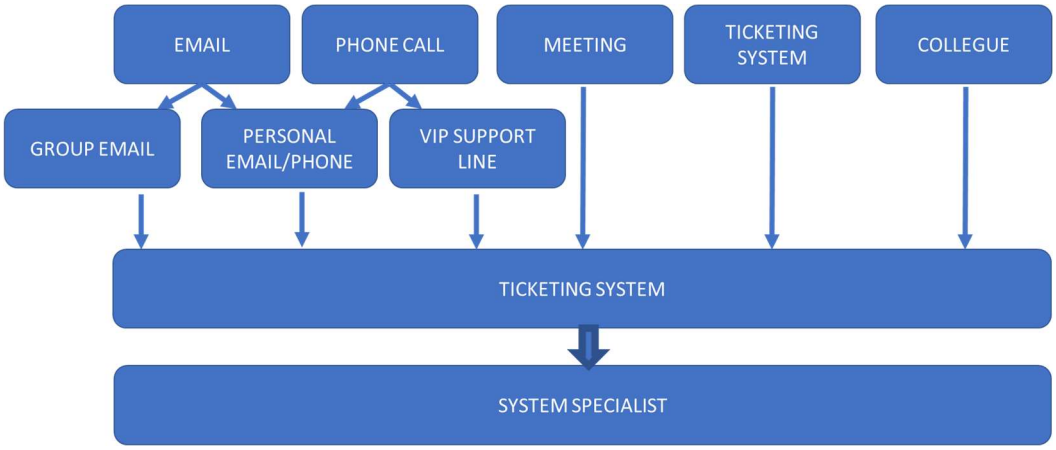

Figure 2: Channels of technical support

2.2. Research questions

Research questions in this thesis are:

1. Can Lean Philosophy be applied to Technical support?
2. Can KPI's be improved using Lean?

First question was very challenging. Is it possible to use Lean process in technical support, where it is nearly impossible to forecast the day's work? Will Lean tools and methods lead to better working environment than the current situation? Will help in providing accurate answers to questions from specialist in technical support?

- What should be done when a customer technical support?
- What information is needed to get the service flow?
- How should be the next step?
- How each one knows that we are in schedule?

Second question focused on the KPI's in support. There should be statistics before and after Lean project, which helped us to show exact results. The initial goal of this research was to improve our metrics. KPIs:

- New cases per day.
- Closed cases per day.
- Total of open cases per day.
- Average of case resolution time.

2.3. Research method

Research method used in this thesis was quantitative. The empirical part focused on statistical methods by using action research methodology. The statistical part focused on the most important KPIs for our technical support. This research was conducted in normal production environment, so follow SLAs was followed during the project.

Technical support team at the Tampere office included two system specialists, one repairperson and a team manager. The starting point for collecting data was May 2017. Daily cases per specialist and average time for a case were calculated and forecast. The actual research period was between October 2017 and January 2018.

Analysis of research was based on four important KPIs. It also included a new measurement to our technical support; a new forecast, closed and open cases. Most important KPIs for this research was an average case resolution time. Statistical Process Control (SPC) was used for the analyses.

Action Research (AR) was used in this research. AR was defined by French and Bell in 1973. They defined it as a research technique that relies on the application of the scientific method of fact-finding and experimentation to practical problems requiring action solutions and involving the collaboration of scientists or non-scientists. (Narayanamurthy, Gurumurthy & Chockalingam 2017) In this research, the researcher is a participant rather than an independent observer. The researcher was part of the team and participated in research as one of the team members, doing research at the same time.

Spiral as illustrated in figure 3 is based on Susman and Evered research 1978 where they describe that AR has five different stages: diagnosing, action planning, action taking, evaluating and specifying learning where the spiral means to repeating these stages as much as needed. (Durcikova 2018, 242)

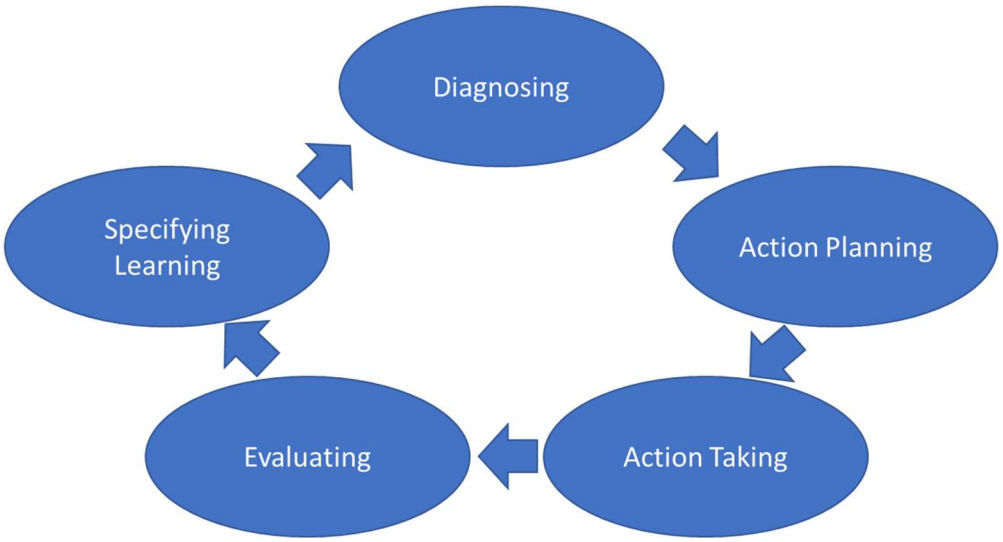

Figure 3: Statistical AR (Durcikova 2018, 258)

AR is an iterative approach where past cycles inform later cycles, which allows for flexibility and responsiveness to a changing environment and unexpected outcomes, which helps to make changes in Lean environment. (Harzl 2017)

In this research, there were different action for every stage in AR spiral as described in figure 4.

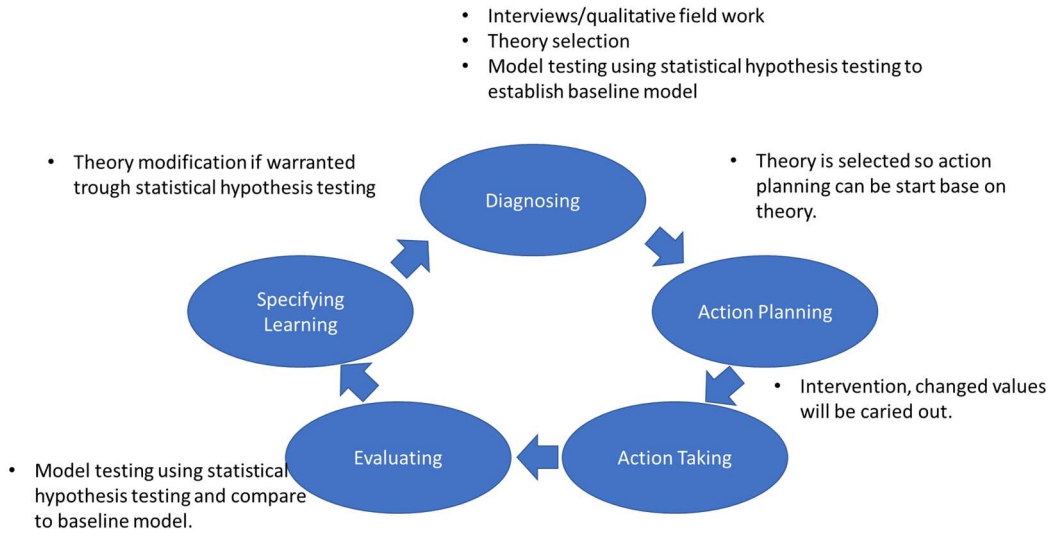

Figure 4: Statistical AR in action (Durcikova 2018, 249)

The first stage was diagnosing the situation of the technical support. Investigate how the process works and what the problems are. Data were collected by means of interviews and fieldwork for the base line model. Next stage was action planning, where planning for action base on chosen theory was initiated. The third stage was when the theory used to implement the value changes. The evaluation stage was model testing using statistical hypothesis and compared it with the baseline model. The final stage, specifying learning stage was the theory modification. (Durcikova 2018, 249)

3 LEAN MANAGEMENT PHILOSOPHY IN PRACTICE

This chapter discusses the overview of Lean management philosophy. Starting with introduction of the Lean management, its history and background. Then last section will go more deeply in Lean principles.

3.1. What is Lean management

Lean thinking and practice have become one of the most successfully approach to business improvement of our generation. Organizations adapt Lean management, in all kinds of industries across the world. In IT development, health care, finance, government and construction, the agile model has played a significant role. Nowadays many large companies have use Lean program to improve internal group performance. The best practices are based on Lean thinking. (Netland and Powell 2016, 27)

Lean management system was development 30 years ago by Mr. Taiichi Ohno for Toyota production system. Mr. Ohno summarized it thus: *"All we are doing is looking at the time line from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that time line by removing the non-value added wastes."* (Oppenheim 2011, 12-13.)

" Lean " concepts are deeply rooted in the Toyota Production System. In its purest form, Lean is about the elimination of waste and the increase of speed and flow. Although this is a high-level oversimplification, the ultimate objective of Lean is to eliminate waste from all processes. (Goldsby and Martichenko 2005) With Lean Toyota has been delivering superior performance in terms of time to market for new products and better product quality using less money and human resources, hence lowering costs in production. This has helped Toyota to grow one of the largest and innovative car manufacture in the world. Toyota continues to act as a powerful reference model for Lean practitioners in taking the next steps on their Lean journeys and to clarify the confusion that surrounds Lean today. (Netland and Powell 2016, 27.)

The organization that can deliver pure value to its customers without waste, while continuously innovating to improve the service, product, and processes, will be successful in the future. This vision arose in Toyota from some very special people, starting with the great inventor Sakichi Toyoda who started a great journey of Lean. (Netland and Powell 2016, 40.)

3.2. History and background

Toyota production system started from the need to produce efficiently. The oil crisis in the fall of 1973 was followed by a recession that affected the whole world. In 1974, Japan's economy had collapsed to a state of zero growth and many companies were suffering. During the same time, Toyota's business was booming better than other companies were. This made other become interested in what is happening in Toyota. (Ohno 1988, 1)

After World War II no one forecasted that the number of manufactured cars could rise to today's level. In America companies needed to reduce costs and started to make fewer cars models but massive amounts. However, the Japanese wanted to manufacture several different car models in small quantities in order to reduce costs. Between 1959 and 1974, Japan experience rapid economic growth because they started to manufacture many models in small numbers cheaply. Thus, the principal objective of the Toyota production system was to produce many models in small quantities. (Ohno 1988, 2.)

After World War II there was understanding that the ratio between Japanese and American work forces 1-to-9 that means that work takes nine times more from Japanese than American. Toyota started to search for where time was wasted. If waste can be eliminated, productivity would rise. This idea started the process named after Toyota Production System a starting point for Lean thinking. (Ohno 1988, 1-3.)

The term Lean as an industrial paradigm was introduced in the United Stated in the best-selling book *"The Machine That Changed the World: The Story of Lean Production"*, published by the MIT International Motor Vehicle Program (Womack, 1990) and popularized in their second bestseller *"Lean Thinking: Banish Waste and Create Wealth in Your Corporation"* (Womack and Jones, 1996). They identified a fundamentally new industrial paradigm based on the Toyota Production System.

The paradigm is based on relentless elimination of waste from all enterprise operations and requires the continuous improvement cycle that turns all front-line workers into problem solvers to eliminate waste. Lean strives for minimum waste to deliver high quality and defect-free products meeting customer demand just-in-time, at the rate ordered, with minimum inventories, at minimum cost, and in minimum time. Lean is driven by a unique management culture of respect, empowerment, openness, and teamwork. (Oppenheim 2011, 12.)

Lean thinking is an evolutionary industrial paradigm incorporating elements from paradigms of TQM and CE and key elements of Six Sigma. In common with TQM and CE, Lean focused on designed-in/built-in quality, Edward Deming continues improvement cycles, and engagement of frontline workforce in process improvement. It goes beyond TQM and CE to adopt a value stream focus, connecting tasks and processes into the flow of value-adding effort and a relentless pursuit of waste elimination. While Lean, TQM, and CE all focus on process improvement, Lean particularly focuses on streamlining flow between the processes. Sharing with Six Sigma a data-driven approach to eliminate process variation, it differs by being more bottom-up in its improvement strategy and less reliant on formalized qualifications of improvement experts. (Oppenheim 2011, 12.)

3.3. Lean Principles

The process of creating value without waste has been summarised into six Lean Principles titled: Value, Map the Value Stream, Flow, Pull, Perfection, and Respect for People. Womack and Jones (1996) formulated the first five. The sixth is often called “the second pillar of Lean” (Sugimori, Kisunoki, Cho and Uchikawa, 1977). It plays a critically important role in Lean. (Oppenheim 2011, 17.)

Value

Lean is customer demand process where value is defined by customer, who could be internal or external. The external customer who pays for the service or system defines the final value for the deliverable. Internal customer receives the output of the task and usually does not pay for it. In Lean, there are two types of value, value-added and non-value-added. The term value-added refers to activity, which add more value for customer like good quality and responsibility to customers’ technical problems with product.

The term non-value-added refers to activity, which takes more time, material or space to complete the product or deliverable. It will not increase the value of product. (Oppenheim 2011, 18.) (Carreira 2005, 2.) Customer expected to get value from the vendor when they started to use the product and help in reasonable time.

Map the Value Stream

Value stream includes all tasks, decisions, phases and links in process. Mapping the different categories of waste in value stream is the first step towards eliminating waste. In Table 1 below, Morgan and Liker identified seven different types of waste: overproducing, waiting, conveyance, processing, inventory, people motion, and correction.

Seven Categories of Waste, Based on Morgan and Liker [2006]		
SEVEN WASTES	**WHAT IS THIS?**	**PD EXAMPLES**
Overproducing	-Producing more than the next process needs -Reinventing the wheel	-Creating too much information -Engineering beyond the precision needed -Over dissemination = sending information to too many people -Sending a volume when a single number was requested -Ignoring expertise
Waiting	-Waiting for information or decisions -Information/decision waiting for people	-Long approval sequences -Waiting for data, test result, information, decision… -Late delivery -Poor planning, scheduling, precedence -Unnecessarily serial effort
Conveyance	-Moving information from place to place	-Hand-offs/excessive information distribution -Disjointed facilities, political, lack of co-location -Uncoordinated complex document taking too much time to create that is obsolete when finished

Processing	-Doing unnecessary processing on a task or an unnecessary task	-Stop-and-go tasks -Redundant tasks, reinvention, process variation--lack of standardization -Creating documents that nobody requested -Point design used too early, causing massive iterations -Uncontrolled iterations -Work on a wrong release -Data conversions -Answering wrong questions -Many of contractual obligations -Unclear or unstable requirements -Excessively complex software monuments
Inventory	- A build-up of information that is not being used	-Batching -System overutilization -Arrival variation -Poor configuration management and complicated retrieval -Lacking central release
People motion	-Excessive motion or activity during task execution	-Long travel distances -Reductant meetings -Superficial reviews -People having to move to gain or access information -Manual intervention to compensate for lack of process
Correction	-Inspection to catch quality problems -Fixing an error already made	-Rework, Rewrite, Redo, Reprogram, etc -Incomplete, ambiguous, or inaccurate information -External quality enforcement

Table 1: Seven Categories of Waste (Oppenheim 2011, 18-20.)

In the mapping process, it is essential to search and remove all non-value activities and enable the remaining activities to flow without rework, waiting, backflow, or stopping. There is a need to identify what is important to the customer. Mapping process in technical support is different inform that of production environment. Different working methods with specialist should conform with the search for non -value activities. Specialists are required to adapt different working methods to resolve cases. Uneven working hours should be harmonised to remove non-value activities from the methods. For instance, similar tasks might take either 15 or 30 minutes, depending on the method used.

The information flow between tasks and people needs to be clear and understandable. In Lean philosophy, this means detailed planning, common databases, rapid and pervasive communication, and frequently integrative events like daily stand-up meetings. Also, other techniques and methods should be used to keep information flowing. For example, arranging training for employees in the best communication and coordination practices. (Oppenheim 2011, 18-20.)

Flow

Flow means the work or task trough is planned and streamlined, includes value adding steps and processes without stopping or time waiting, unplanned rework, or backflow. Flow needs to be designed without any bottlenecks in steps or processes. To get flow working it takes time and re-thinking. In Toyota it took several decades to perfect its system. (Oppenheim 2011, 21.)

Smooth flow in technical support can be achieved with value adding steps. It is important to have clear process with common tools and methods to ensure specialists are aware of next tasks without asking.

Pull

Just-In-Time (JIT) method is the idea of pull. In Lean, this means that every task owner should be in close communication with customer to understand fully, his or her needs and expectations and to coordinate the work. Customer needs to understand Lean-thinking, because uncontrolled requests will affect to hole Lean process. (Oppenheim 2011, 21.)

In technical support, specialists communicate with customer to clarify situations. Normally, such communication includes extra questions, which are asked before or after work is done or the customer acknowledges the problem is solved.

Perfection

Lean is far from perfection. Continues improvement in processes is required. However, it is impossible for an organization to allocate resources towards improving the system. Perfecting the work output in each task must be bounded by the overall value proposition, which defines when an output is good enough.

Which process we should improve, or should we improve all process in the same time. In Lean advocates for identifying all bottlenecks in the workplace and make them visible, prioritize and eliminate the biggest bottlenecks from flow. (Oppenheim 2011, 21.)

KPIs are a good measure of process improvement in technical support. If improvements help to keep promised SLAs then process is good enough. Of course, it is a continuously process in Lean but you can concentrate smaller tasks in process and improve those.

Respect for people

In Lean, main source of success originates from the people. They are the most important resource for high performance work practices. Problems are identified through brainstorm about root causes, corrective actions, and effective solutions are planned together. Employees from different levels with different experiences and knowledge provide excellent resources for Lean implementation in an organization. (Oppenheim 2011, 22.)

It is important to respect people who are using Lean process. Without people, it could be challenging to implement Lean in technical support environment. People are the best tool in this process, they know where the bottlenecks are and how those can be resolve.

4 TOOLS AND METHODS

Lean environment requires fast decision making to identify bottlenecks and warning signals at the early stage of the process. Therefore, there a need for tools and methods for measuring and controlling value process. Lean offers many different tools and methods for controlling value process.

This section introduces the common tools and methods in Lean. There are several tools that can be used in Lean but thesis focuses on carefully selected tools and methods, which are used in practice. The first section focuses on PDSA method as part of the Lean process. The second section introduces Gempa and Gempa walk. The third section focuses on Kanban and how a process can be visualized with Kanban. The last section focuses on Statistical Process Control (SPC) and how it can be used in Lean to forecast KPI.

4.1. PDSA

Working process needs continuous improvement. Different methods including a trial-and-error approach have been used to improve processes. However, this method jumps straight into solution phase without identifying what to improve. This method does not always work and therefore an alternative should be used.

PDSA (Plan-Do-Study-Act) is a model of improvements method based on Deming Cycle. As illustrated in Figure 5, fundamental questions in this method are:

What needs to be accomplished?
How do we know that a change will result in an improvement?
What changes can we make that will result in improvement?

This is a trial-and-learn approach to improvement efforts, i.e. learn, develop changes, test changes and implement changes. (Provost and Murray 2011, 3-4.)

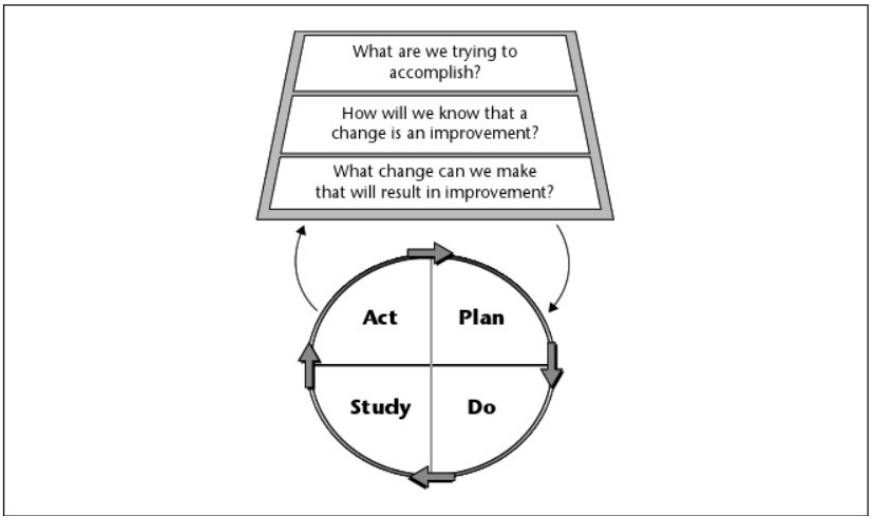

Figure 5: PDSA cycle (Provost and Murray 2011, 3-4.)

PDSA cycle can be used in small problems or to improve the entire value process in Lean. The starting point is the planning stage where the current situation is determined and analysed. For example in a technical support, common measurement of KPI is a case of time resolution and what to accomplish. There a need to collect the data to set up the base values and time to be followed during the PDSA process.

As described in Figure 6, in the planning phase, goals for the lean process are set. The right kinds of questions are asked to find answers to. The cycle (who, what, where, when) and the plan for data collection should be kept. In do phase, the planned process for implementation is executed. This phase includes planned goals and changes, documentation problems and unexpected observations. Data analysis also starts here. (Provost and Murray 2011, 8.)

Next phase is study phase, where the collected data and predictions are compared. The analysis of the data is conducted to determine current figure of resolution time from the collected data and compare it to the goals. The act phase determines what need to be implemented based on knowledge gained from the previous phases. The result will determine whether there a need for round PDSA. (Provost and Murray 2011, 8.)

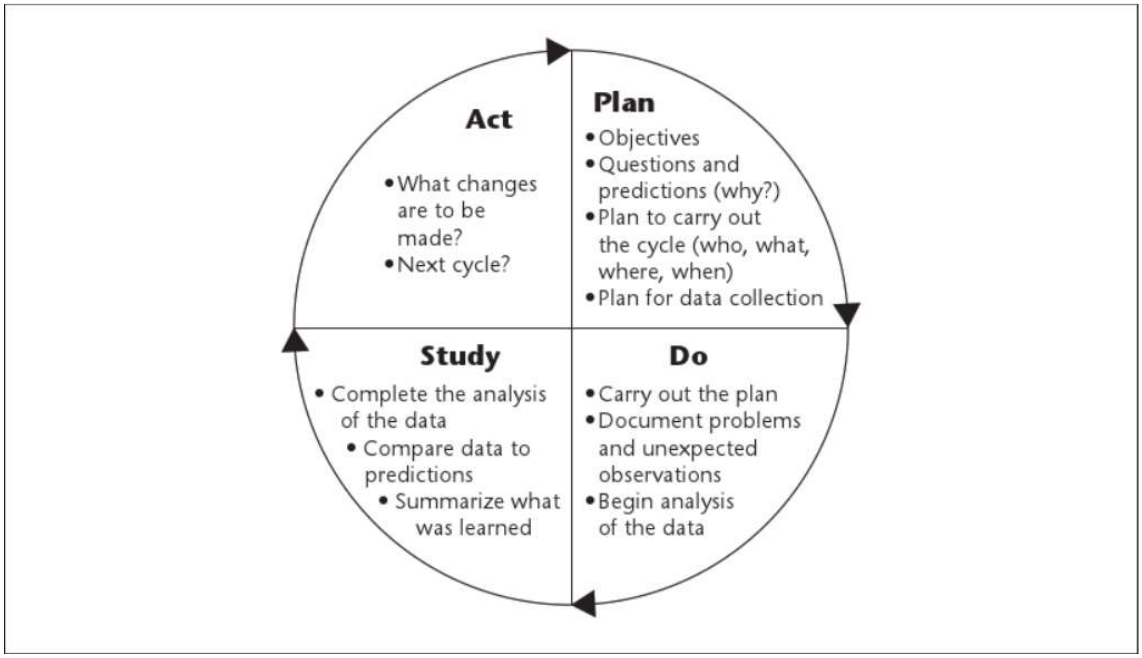

Figure 6: The PDSA Cycle (Provost and Murray 2011, 9.)

Having gone through the various phases, after do phase, the change should indicate whether there is an improvement or not. If case resolution time does not improving after the change in process, there is a need to investigate to find ways of improving the results.

As illustrated in Figure 7 this cycle shows continuous search for answers to the three questions mention earlier to achieve the better resolution time. It is a continuous process to improve processes and follow up changes and to make fast decisions. If there are no significant improvements, make agile changes. Each PDSA cycle is an answer to specific problem what team have. It is designed to test and adapt changes that team can use to solve problems. (Provost and Murray 2011, 9.)

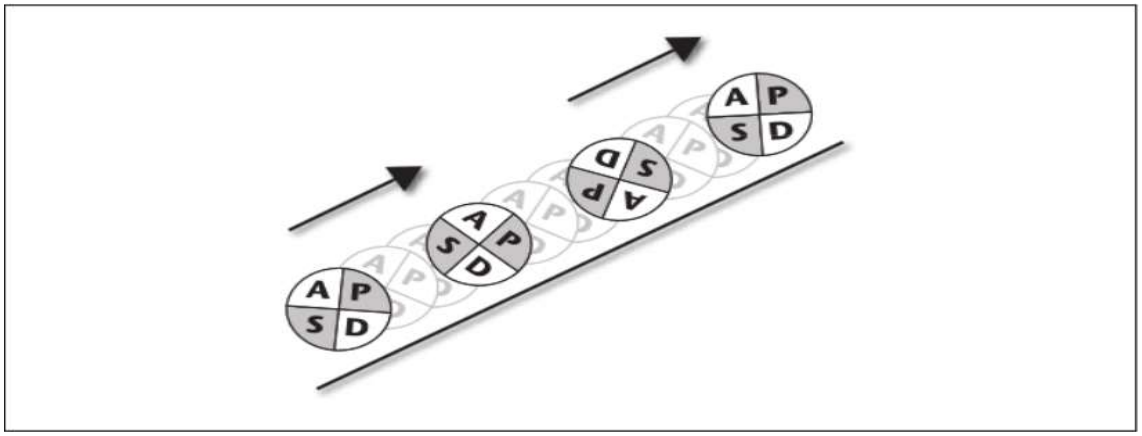

Figure 7: Sequential PDSA Cycle (Provost and Murray 2011, 9.)

4.2. Gemba

Gemba means" the real place" in Japanese. Japan police use the word gemba refer to a crime scene. Gempa is a very old method that Toyota managers used for getting real information on production. Managers walked in the production line in the area where things really happened. Gemba is part of Toyota Production System like Kanban. Field Managers build relationship with employees at a place named Gemba walk. They identify problem areas, the manufacturing flow, chart and record the key metrics of the production line and understand working methods. (Tunguz and Bien 2016. 88-90.)

Gemba came to western countries in 1970's and 1980's when Hewlett-Packard (HP) took the Gemba idea into "management by wandering around" (MBWA). HP managers asked randomly from workers about processes in the company. It helps managers to understand what works and what does not in the production. One of the new users of Gemba is Facebook. it started using Gemba with data analysists, because it wrestled with the question of structure of data team to maximize its impact. (Tunguz and Bien 2016. 88-90.)

Gemba is not only walking with workers, it is also a communication method, where managers need to ask the correct question to get more information about on existing situation. Like in Facebook, it had several questions about its workers. Typical question was:

How much data do we need to collect?
Which data to we need to collect?
How will the data be analyzed?
Who should the data be delivered to?
How frequently must this data be collected?

By asking different kinds of questions, the team and the manager can understand the needs of the project. It is important that manager documents these question and answer to ensure that a proposed solution meets the needs of stakeholders. Next phase is to take this proposed solution into action, educate the team or other parties, and measures the performance of the solution. It is like learning phase and If solution is not helping to improve the performance, then manager will do the new Gemba walk and try to find solution for better performance. (Tunguz and Bien 2016. 88-90.)

4.3. Kanban

The Japanese word Kanban means a signboard. Literary it is synonymous with demand scheduling. Kanban was started late 1940's and early 1950's in the Toyota production system by Taiichi Ohno. Ohno developed Kanbans to control production between Toyota processes and to implement Just-In-Time (JIT) manufacturing. Kiichero Toyoda, the founder of the Toyota Motor Company, was the first to implement JIT manufacturing, but Mr. Ohno developed the strategy of Kanban. Worldwide acceptance for Kanban came over 20 to 30 years later in 1970's when it was used to minimize the work in process (WIP). Originally, Kanban was developed to reduce costs and manage machine utilization before Toyota started to use the system to identify impediments to flow and opportunities for continuous improvements. (Gross and McInnis 2011, 1-2.)

The core idea in Toyota production process was to use visual cards in downstream production stages indicate that a task has been completed and a replenishment of assembly components or material is required to be able to continue working. This system reduces inventories to a minimum and the problems in the production process become immediately apparent when the assembled products suddenly pile up in the upstream stages of productions. The idea to get this work was limit the number of Kanban. When you can only feed as much work into the system as the available visual card permit. Toyota realize in the early that simplest way to optimize the flow was to let the bottleneck itself determine how much it could currently process and showed visually. (Leopold and Siegfried 2011, 12-13.)

The goal of Kanban is to establish a continuous workflow, which generates more value for the customer. Kanban helps to make processes of work visible and the associated problems that are limiting the workflow. Visualization makes clear what causes the problems that for limiting the workflow. It helps people in the organization to communicate directly with each other to improve their processes. The Kanban focus is in the workflow, which means that everything that appears like blockers or bottlenecks will receive attention. The motto is: work on your problems first before going on to new task.

Communication is the common link between all measures related to control and the measurement of the workflow. The Kanban process includes daily stand-up meeting where team members discuss their work to others. The goal of these meetings is to coordinate operations and maintain the workflow in daily level. In this meeting, every team member tells what they have done, whether there have been any problems or comments related to done work and that they will done next. Also, daily meeting is good place for general discussions. This meeting needs to be short and with specific agenda for example 15 minutes.

Weekly meetings also known as retrospectives are more targeted improvement meetings and are also important feedback events. In weekly meetings, the participants can give more detailed feedback and review of last period. This meeting is also an important meeting to schedule the next week's work and resources. Kanban's goal is to develop and teach a kaizen culture step-by-step. Kaizen is a culture that is focused on providing better results for the organization in economic and give better working atmosphere for employees. (Leopold and Siegfried 2011, 18.)

Kanban's core practices are:
1. Make work visible.
2. Limit work in progress (WiP).
3. Manage flow.
4. Make policies explicit.
5. Implement feedback mechanisms.
6. Improve collaboration (using methods and models).

Kanban is not a method to tell how something needs to be done, rather it is more of suggestions that something should be done. (Leopold and Siegfried 2011, 18.)

Visualization is the main task for the Kanban team. Only the team knows how it flows. The identified steps in the process flow are listed in columns according to their operational sequence. As illustrated in Figure 8 board shows a sample workflow of analysis, development, and testing represented to the board. Tasks could be named differently. It depends on what the main tasks in team for process the workflow is. For each step, all team members need to share same understanding of when the work was done and can be moved to next phase.

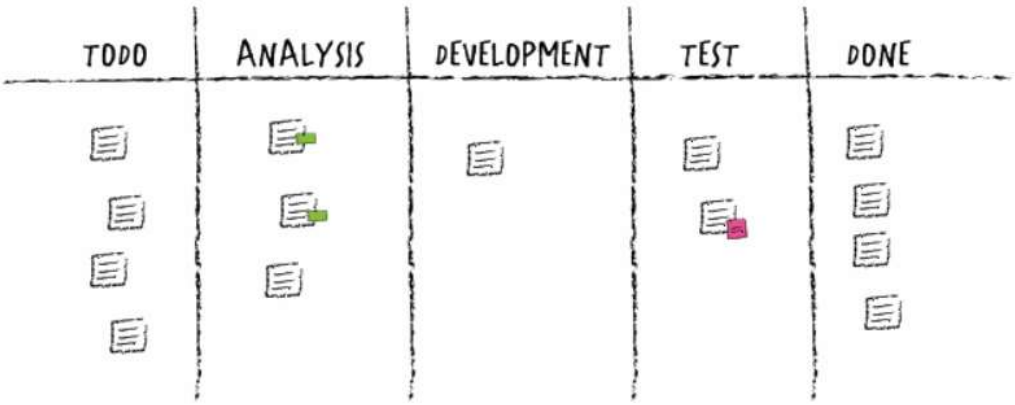

Figure 8: Example representation of a Kanban Board (Leopold and Siegfried 2011)

These so called work items that are showed in the Kanban board will move only during the daily meetings. These tickets can be showed with Post-it notes or cards in the board. Figure 9 shows detailed information about the work item.

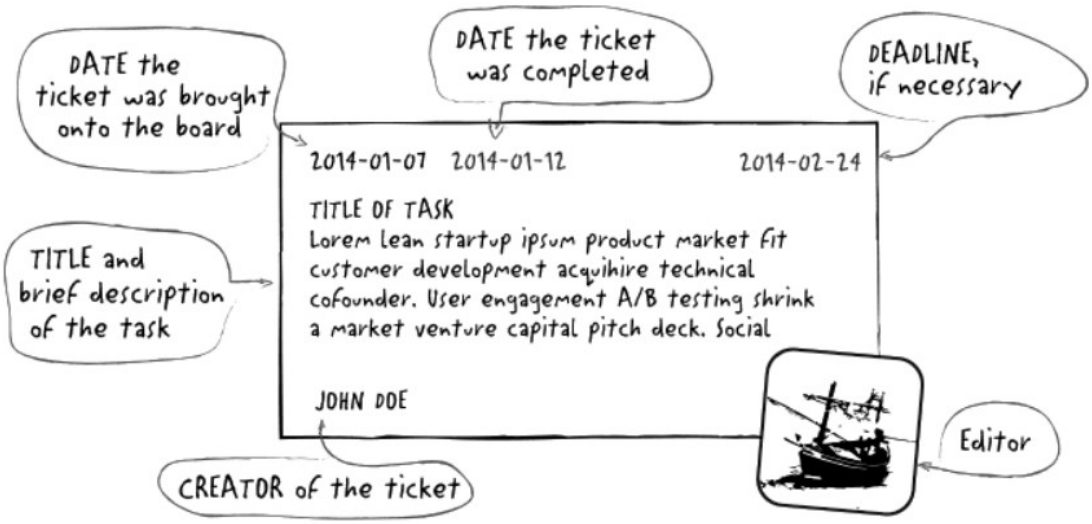

Figure 9: Example of a working item ticket (Leopold and Siegfried 2011)

Ticket includes, for example, detailed title explanation of work that needs to be done, creation date, planned deadline and completed date or other important timestamps. The creator of the case is also the editor.

The reason for a ticket is to show detailed information of one case and the size of tickets in queue. This visual image with information will give us a deeper insight into the factors disrupting the workflow. In this example ticket, there is a deadline but with Kanban single-minded world of deadlines are avoided. We like to be in position where we can deliver reliable expected dates of completion to our customers based on our observations and measurements. (Leopold and Siegfried 2011, 28-29.)

A continuous workflow is one of the main goals in Kanban, and therefore, the removal of blockers interrupting the workflow should be a high priority to all. In Kanban, FIFO (First In First Out) and smooth workflow without bottlenecks is the key factor to success.

4.4. Statistical Process Control (SPC)

The principles of the SPC as a system-monitoring tool originated from Dr. Walter A. Shewhart during the end of his employment at the Inspection Engineering Department of the Western Electric Company between 1918 and 1924, and continued from 1925 to 1956 at the Bell Telephone Laboratories. He summarized his work on statistical control of industrial production processes in the book made in 1931. Then he extended this work, which eventually lead to the applications of SPC to the measurement processes of science and stressed the importance of operational definitions of basic amounts in science, commerce and industry. He also summarized this in the book 1939. (Kruger 2012, 4.)

Dr.Vilfredo Pareto, who worked as a civil engineer after graduation in 1870, discussed the next pillar of the SPC. Pareto became a lecturer at the University of Florence, Italy from 1886 then from 1893 at the University of Lausanne, Switzerland where he postulated that many of system failures are result of relative few causes. These two pioneers of SPC has been culminated their research in different streams of SPC. Sherwart's research was based on observing a system and Pareto's research is based on a root cause analysis. (Kruger 2012, 4.)

The work that Sherwart did drew the attention of the physicists Dr. W. Edwards Deming and Dr. Raymond T. Birge and they publish an article that became a landmark article on measurement errors in science 1934. The article was based on principals advocated by Shewart's early work. Deming credited, and to a lesser extend Shewart, for introducing SPC as a tool to improved productivity in wartime production during World War II in the United State. (Kruger 2012, 4.)

After World War II, Deming became an ambassador of Shewart's SPC principles in Japan from the mid-1950s. The quality of Japanese electronics devices and cars is based on principles of SPC where pioneer Dr. Genichi Taguchi introduced the Taguchi methods 1986 for all organization levels including management. Same time the SPC has been embedded as a cornerstone a wider quality context 1980 under the Total Quality Management (TQM). Nowadays SPC includes concept such as Six Sigma, which involves DMAIC (Define, Analyze, Improve Control), QFD (Quality Function Deployment) and FMEA (Failure Modes and Effect Analysis). (Kruger 2012, 5.)

The aim of any type of data analysis is to gain understanding from data and when we collect the data we can see it varies. The information in this variation is important to the understanding of how the process is performing and statistical process control (SPC) is primary the tool for understanding variation in the data. The main tool in SPC is the control chart. Is a plot of the process characteristic, usually through time with determined limits? When we use this for process monitoring, it helps to determine the appropriate type of action to take on the process. (Stapenhurst 2005, 3.)

Figure 10 describes the process of data from hospital where an input like a raw material, a sick patient or a blank form. Then we do something with it to produce the output like a finished product, a well person or a completed form. A process of series of actions include people, materials, equipment. (Stapenhurst 2005, 3.)

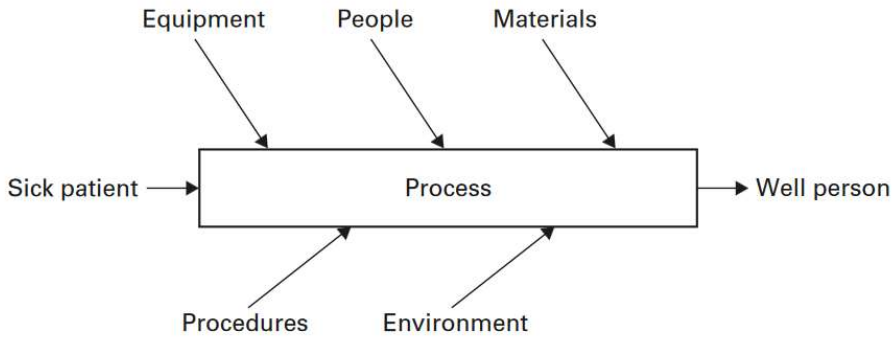

Figure 10: Process (Stapenhurst 2005, 3.)

Figure 11 shows variation in the process. Input-output and methods vary and SPC is needed to understand the variation. SPC is fundamentally about understanding and managing the variation. For example, number of accidents varies between days. (Stapenhurst 2005, 4.)

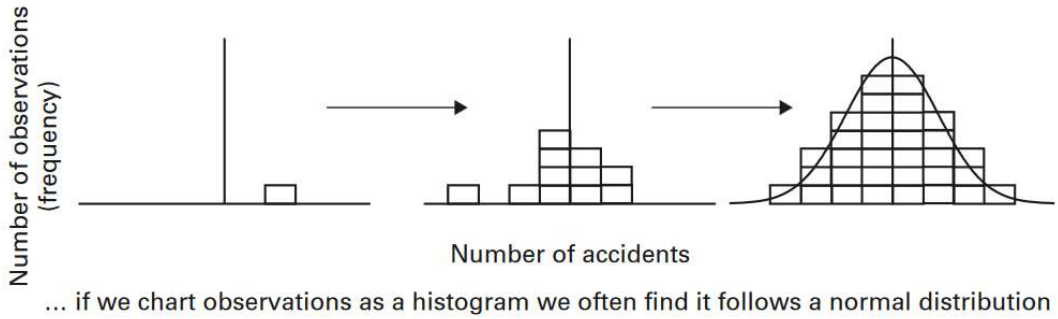

Figure 11: Observations vary from one another (Stapenhurst 2005, 4.)

When we measure some attribute of a process like number of accidents per day and we take our first observation we could plot the value on a histogram as illustrated in Figure 11. Then we take next observation and it will be different but when we take more observations we would gradually see the distribution of observations take on a pattern. As illustrated in Figure 12, often this distribution will take the shape of the bell curve, known by statisticians as the normal distribution. (Stapenhurst 2005, 4.)

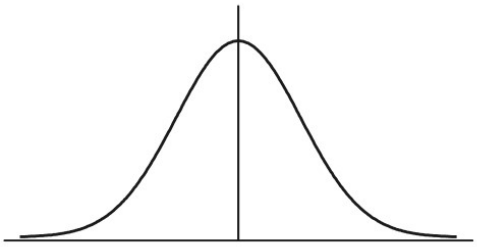

Figure 12: The normal distribution (Stapenhurst 2005, 4.)

Figure 13 below, shows that distribution can vary only in three different way, the central location, the shape or the spread of variability. (Stapenhurst 2005, 4.)

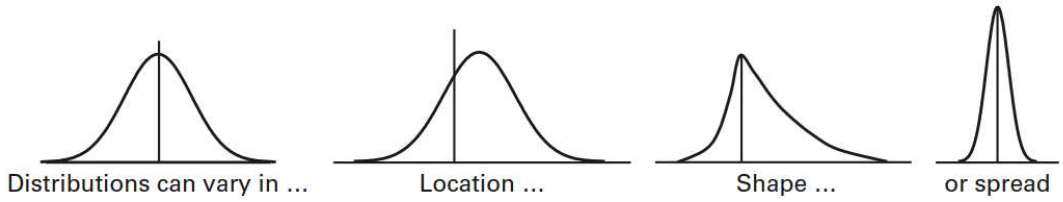

Figure 13: Distributions can vary in only three ways. (Stapenhurst 2005, 4.)

There are a few statistical terms relating to location and variation that are used when discussing SPC. In data collection, statisticians refer to the first value to collected as x_1, the second as x_2, the *i*th as x_i and the last one called *n*th as x_n. In our example, we use following set of data values: 3, 6, 5, 6, 4, 7, 2, 6, 4. This numbers could be the number of patients admitted each shift for the last 9 shifts. For this set of values n = 9 and x_1 = 3, x_2= 6 and x_n = 4. (Stapenhurst 2005, 4.) As described in Figure 14, to measure location there are three different options in SPC.

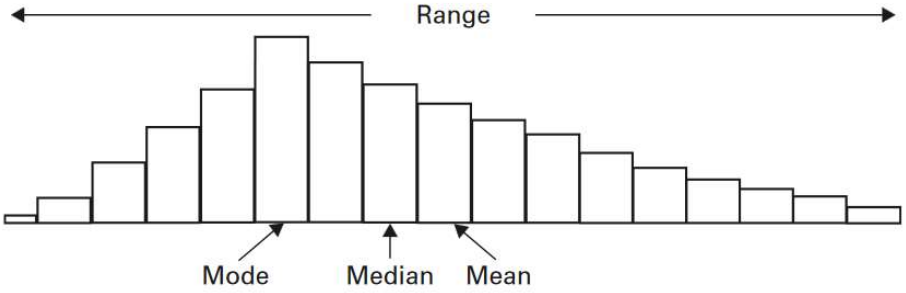

Figure 14: Common measures of location and variability (Stapenhurst 2005, 5.)

The mean denoted by statisticians as x(with line above) and it is calculated as:

$$\bar{x} = \sum_{i=1}^{n} \frac{x_i}{n}.$$

So, our sample data is calculated as:

$$\bar{x} = \sum_{i=1}^{n} \frac{x_i}{n} = \frac{3 + 6 + 5 + 6 + 4 + 7 + 2 + 6 + 4}{9} = \frac{43}{9} = 4.78.$$

The mean is the most common statistical measure used for describing the location of a set of data.

Median value is determined by ordering the values in ascending or descending order: 2, 3, 4, 4, 5, 6, 6, 6, 7 and selecting the middle number. In this sample data the median of our data set is 5.

The mode is the most occurring number observed and, in the previous sample the mode is 6. The common measures of variability are the range, the standard deviation and the variance. The range is (7-2) = 5. The standard deviation is denoted as *s*, and it is calculated from next formula:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{(n - 1)}}.$$

By using above data:

$$s = \sqrt{\frac{(3 - 4.78)^2 + (6 - 4.78)^2 + \cdots + (7 - 4.78)^2}{(9 - 1)}} = 1.64.$$

the variance is calculated from standard deviation. It's a square of the standard deviation: $1.64^2 = 2.69$.

Normally we like to see process distribution to be much the same. See Figure 15.

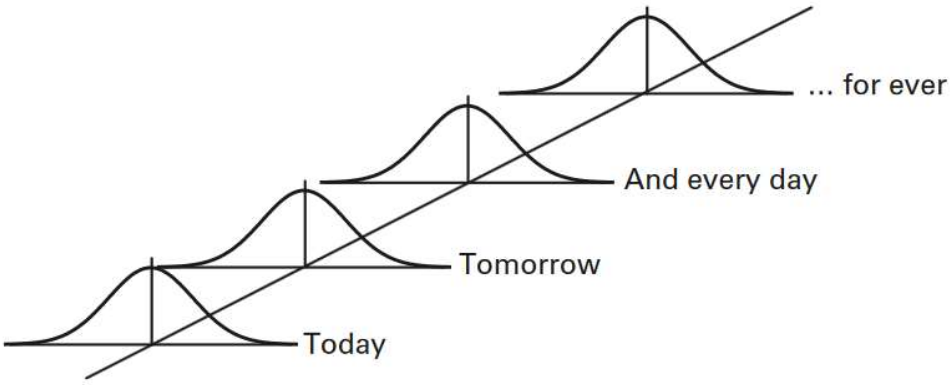

Figure 15: A process in control. (Stapenhurst 2005, 7.)

Management like to see this kind of processes that are in control. But when process is in linear it does not necessarily mean that is it works well. It means that normally it is stable and predictable and improvement is achieved normally by following procedures and methods. Processes that are in the distribution changes with each set of measurements as illustrated in Figure 16. (Stapenhurst 2005, 7.)

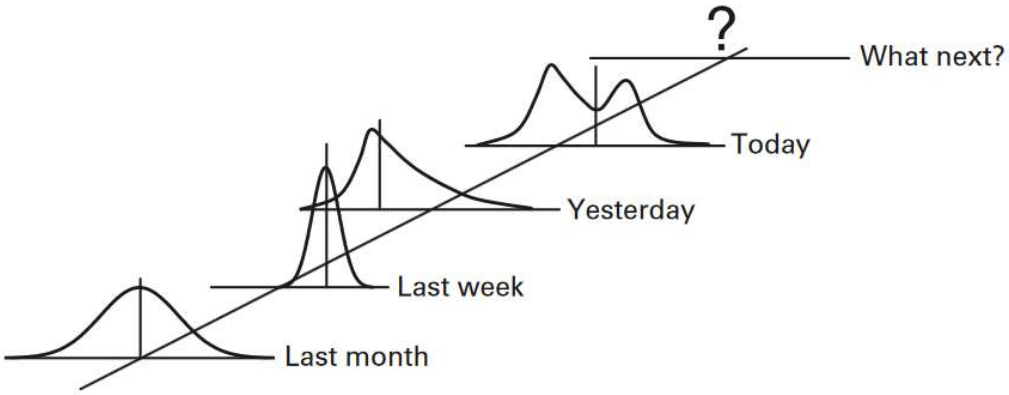

Figure 16: A process out of control (Stapenhurst 2005, 8.)

In this situation, the process is not in the state of statistical control. Table 2 bellow describes processes that are out of control are under subject *common cause variation* and *special cause of variation*. Special causes of variation are not always present in the process, when they occur, they change the location, the spread or the shape of the distribution of the process outputs. Reasons for this kind of change could be a new method of working, sick leaves, system failures etc. (Stapenhurst 2005, 9.)

Common cause variation	***Special cause variation***
Measurable	Measurable
Always present	Sometimes present
Many causes	Few causes
Part of the process	Not part of the process
Predictable	Not predictable
May be a problem	Usually a problem
Reduced by analysing and improving the process	Removed by identifying and removing the cause OR if the cause cannot be removed, mitigating the effects

Table 2: Common and special causes of variation (Stapenhurst 2005, 9.)

The control chart is the tool for understanding process performance and its development. Especially to determine whether process outputs exhibit common cause variation only, or whether, and when, special cause of variation is occurring. Consecutive observations are plotted on a histogram. (Stapenhurst 2005, 15.)

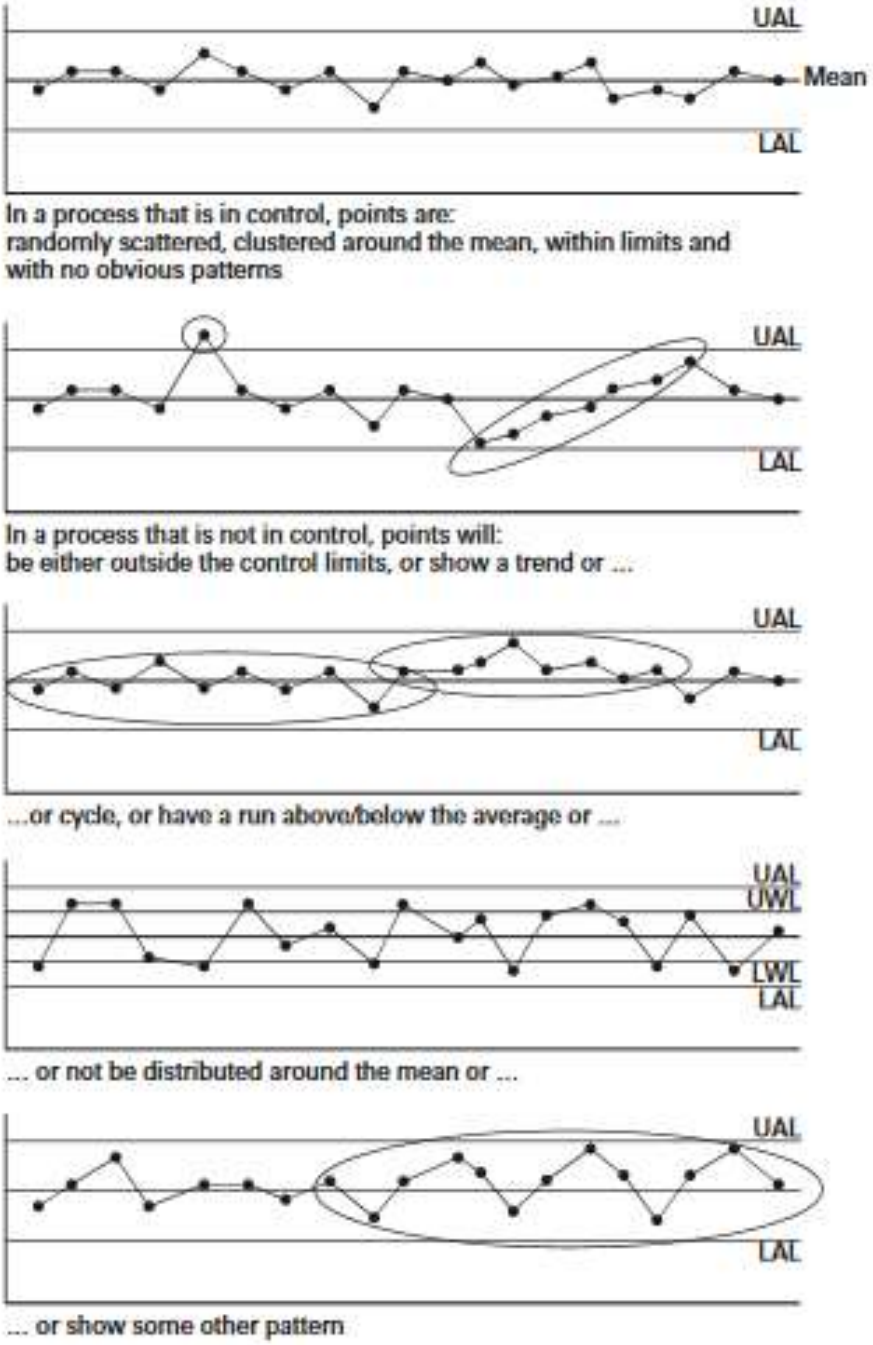

Figure 17: Control chart (Stapenhurst 2005, 15.)

As illustrated in Figure 17, the chart shows that that the data is randomly scattered around the mean and are within the limits. Upper action limits (UAL), and lower action limit (LAL), upper warning limit (UWL) and lower warning limit (LWL). These limits are known as control limits or action limits, estimated from data. When the data are randomly scattered and concentrated around the mean within these limits the current process is in a state of statistical control. When process is not in a state of statistical control over the UAL, it is important to realise how fast it declines, crossing to UAL because if data is over UAL then there is a problem in the process. (Stapenhurst 2005, 15-16.)

5 OPERATIONAL EXCELLENT

This section introduces Sari Torkkola's operational excellent process based on Kevin Duggan Design for Operational Excellent book 2012. Duggan's original operational excellent included nine steps but Torkkola added four more steps. These steps are:

1. Figure out the big picture and choose the process you want to use.
2. Measure and stabilizes the process.
3. Describe existing situation with value flow chart.
4. Analyze demand.
5. Build part-time cells for getting continuously flow.
6. Start use FIFO (First-In-First-Out) method.
7. Design the workflow cycle that removes need for scheduling.
8. Design the data transfer between teams and processes.
9. Standardize to get stable flow.
10. Define start point for process where tasks are prioritized.
11. Visualizes the state of process.
12. Be prepared for change of demand.
13. Visualizes the not normal state of process and create standard methods for these s states.

Next sections are based on these 13 steps. (Torkkola 2015, 129) First section discusses the existing situation. It is important to find out the big picture of different processes and choose the right processes for improvements. Second section discusses Gempa walk and value stream mapping. Third section discusses customer expectations, which needs to take care when improving process. Fourth section continuously flow by using FIFO method that includes the greatest number of events or is the most important one to get fix. Fifth section describe how work need to be standardize to get stable workflow. Sixth section visualizes the state of process by using Kanban and the last section introduce SPC which helps to prepared for change of demand.

5.1. Existing situation

Find out the big picture and parse different processes in high level. There are tools for parse different process that are in use. For example, process family matrix. Matrix will give us the high-level image of the processes from starting point to end. You can use tool or just choose one process for more detailed investigation. Process that includes the greatest number of events or is the most important one to get fix. After that descripted your selection to other team members. (Torkkola 2015, 129)

This is the continuously process so in the next round you will choose another one process for detailed investigation. In our investigation, we need to answer for next questions:

- What is the purpose of this process in customer view?
- What is the target level of the process? For example, average case resolution time.
- How you limit improving steps for this process?

Finding out the base level of the process is important before starting design improvements to the process. First task is to measure the existing performance of the process. For example, what is the average case resolution time before changing the process.

For getting process stabilizes you need to understand current metrics and find out which work tasks or changes make the variation in the metrics to get process predictable in future. For customer view only to get case resolution time process predictable and stable is a huge improvement in customer satisfaction. (Torkkola 2015, 129-130)

5.2. Gempa walk and value steam mapping

Value stream mapping gives an overview of the process. It's a good tool for describe the existing situation of the process and present it in visual way to others. Before you can use this tool, you need to understand the existing situation of the process. For getting this understanding best way is to use Gempa. Value stream mapping means all task that needs to do to get service work for customer. For example, in the average case resolution time you need to describe and understand all different task that are related to that process as described in figure 18. (Wright, 2017, 57.)

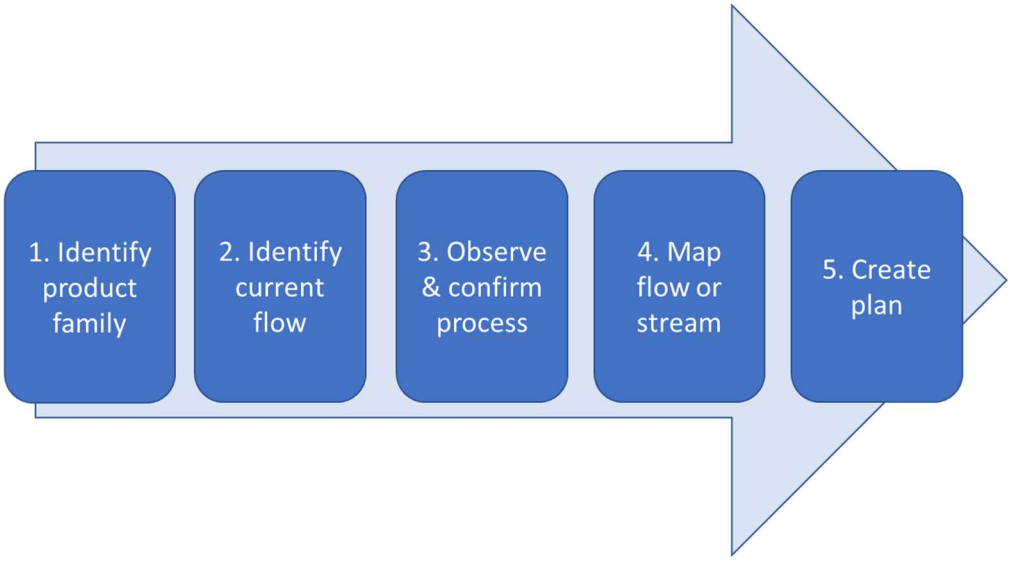

Figure 18: Value stream mapping process (Wright, 2017, 57.)

Goals of value stream mapping:

1. Identify product family which means that you need to identify different products that are to be included in value stream mapping review. Generally, you add products that are following same kind of process in customer support.
2. Identify current flow, where you can use existing flows and think the flow as a customer perspective.
3. Observe and confirm process starts with Gemba walk which is a walkthrough of the location where the process is performed. Its easiest way the identify the waste from process by seeing actual process in action. Gemba will give you a better understanding of the actual process in practice than the charts or statistics.
4. Map flow or stream means analyses from current process where you need to identify those steps that are:
    1. Value adding activities – creates value for the customer
    2. Non-value adding activities – not creates value for the customer and can be eliminated from the process.
    3. Value enabling activities – values that not create direct value but cannot be eliminated from the process.
5. Create plan is basically a map which has been created of the ideal value flow. This map excludes areas of waste, including reducing the time for processing if possible. This form could be like project plan to move the desired flow with reduced waste/cost and more streamlining and should increase the quality for the customer. (Wright 2017, 57-60.)

5.3. Customer expectations

You need to understand the demand of customer If you want to success with analyses. In this case demand means tasks that customer is expecting customer support to manage. With analyze you can forecast how much work needs to be done regularly. You can have based the expectations to SLA's that customer and vendor has been agreed.

5.4. Continuously flow by using FIFO

In this task, you established a work group or work cell where you manage one by one all work cases that are in this specific queue. You need to have the understanding how many cases come weekly in this process from customer. Resources you need for this process is based on your understanding of the weekly work load from that process.

In office work every worker is one shared resource. Office worker cannot do this kind of specific process full time. Solution for that is to arrange part time cells do to the work and it could be weekly event. For example, every Tuesday starting at 2 pm and it least 2 hours. You need to have needed knowledge in the work group to get work done and these part-time cells needs to be in the different space where all workers are working and communicating together like a team. For example, in meeting room. It's important that all workers are commitment to do this exact work during that time. Work flow will be fast because no need for emails or other communication method than talking.

Continuously flow is the most effective way to do work:

- You can define case resolution time.
- For singe task, you don't need separate schedule or prioritizing so time spend to that task can be used to other cases.
- Cases will not have interrupted because you have all needed knowledge and time to resolve the case in the same time.
- No waiting time between work tasks because resources are available to move work from one to next one. So, no need for monitoring.
- Relativity will remove need for questions. All members know what to do next.

- You will get more working time for other work tasks because you can get all work done during this part time cell.
- You can see fast when work stop and do needed action for get work stream to continue. (Torkkola 2015, 136)

It is important to know how you organize your work. FIFO is very effective way to get work done. In this method cases will be done in that order what they come starting from the oldest one. If order of performance changes it will increase variation in resolution time and the predictability is not possible anymore. Non-variation in process is the key metric to get process to be effective. FIFO is the prerequisite for process If you are not using FIFO don't analyze variation of the process because it is not matters without FIFO.

Standardize the order of performance will crease variety and remove duty to prioritize the work. Then worker do not need to ask help from manager for prioritizing which remove resources and time for another task. There is no need for worker to check from work list what worker can do next because worker always select the oldest case.

FIFO will give answer for next question:

- How I know what do to next?
- Where I get my work tasks?
- Where I deliver my work after I have done it?

Common answer for all these questions is from FIFO queue. (Torkkola 2015, 138) The workflow cycle is important planning principal in the office environment because it will stabilize the data stream. Everyone knows when and where they can get needed information or contribution. There is no need for asking what the best time is to get help. For example, manager can give singings every Monday at 1:00PM to 2:00PM. This workflow cycle is good way to organize tasks that are continuously like travel expenses, reports, invoicing etc. If you arrange a workflow cycle for these works then there is no need for interrupted anyone to get signing etc. for getting data workflow transfer from team to team smoothly. When first team gets work done then they move that case to another team. This is also design for data transfer that happens rarely for example quarterly reports. (Torkkola 2015, 134-137)

5.5. Standardize to get stable workflow

In this step, we standardize work tasks which are important ones for smooth workflow. Standardize is a method which describe how different work tasks needs to be done. How data moves and how FIFO works? It's important to standardize these things to get data stream and timing to work. Next things should be standardizing:

- Place we can save unfinished work.
- Maximum amount of unfinished work for different work phases.
- FIFO
- Resource that we book for work phase.
- Cycle and way how we collect information for learning.

It is difficult to standardize work phases especially in office environment because workers have different methods in use when they resolve cases. They have been choosing the work method for themselves. You need to have common rules before you can start standardization. It is difficult to get process to flow from start to end. You need to recognize the starting point for flow. From that point, you need follow FIFO. Plan who can analyze tasks and make decision of prioritization.

After planning you can give forecasted resolution time for customer because we do not do changes after process is defined. There is no need for more than one point where make the prioritization for cases. If customer contacts straight to specialist and ask resolution time, then we lose control for standard timing because specialist will give his own forecast and it is not based on common decisions and forecasts. (Torkkola 2015. 138-139)

5.6. Visualizes the state of process by using Kanban

For get better understanding of the stat of process it is best to use method to visualizes the process, then everyone can see is everything going as its plant. This method visualizes the process and we review this in a certain time when we know are we on schedule. For this step, it is good to use SPC charts and Kanban boards.

Before this step all planning is based on existing state of workflow. But it will not be standard, so it will variety by creasing or increasing. Flow needs to be reviewed regularly is change to big. If it is too big then we need to go back to step four and start planning again. There could be forecasted changes like holiday seasons that needs to observe an advance.

5.7. SPC: Be prepared for change of demand

Every process will have a non-normal state for example process just stop in one day. What we do if that happens? There needs to be standard work process for these situations. This method main goal is to give tools for specialists resolve this state without asking help from manager. Manager role is to define these tools for specialists.

First thing is to define what is the non-normal or normal state in process. Good tool for visualizes clearly the state of process is the SPC chart. Next thing is to define steps without need for manager because these things can be happened anytime. For example, system failure, more case requests or sick leaves. Team needs to agree action points for these situations like someone will stay for over time or get extra resources from another team. It's important to make non-normal state in process to work without need for manager. Manager role is to communicate with customers and partners to get more work to the team and more revenue for the company.

6 CUSTOMER SUPPORT AND LEAN IN PRACTICE

This chapter discusses use case, customer support and Lean in practice. First section describes steps what has been done for design the operational excellence in customer support. Second section includes Kanban in this use case. How team used Kanban for visualizing the state of process. Third section describes how team used SPC for get needed information from data. Fourth section will discuss results of the operational excellent in use case by using tools that are described in other sections.

6.1. Design for Operational Excellence in Practice

Design for operational excellence started by researching the existing situation in customer support. For this investigation, we chose May 2017. For getting more detailed view what is happening in customer support processes we made Gempa walk and made the value stream mapping. Next thing was to check what are the customer expectations for customer support. What kind of KPI's are in use and what are the customer expectations. To get process to work smoothly and continuously we needed to start new method named FIFO and standardize work to get the stable work flow in customer support.

6.1.1 Existing Situation in Customer Support

In case study, focus was on technical support process. How support team can improve customer experience and average case resolution time by using Lean methods in practice. Focus was on Tier 2 and Tier 3 level technical support. Tier 1 is outsourced, and they will escalate tickets to Tier 2/3 If needed as illustrated in figure 19.

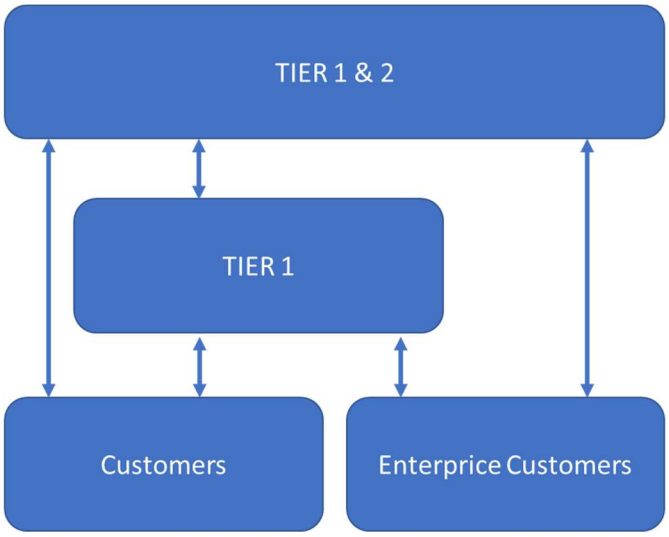

Figure 19: Overview of Customer Support

Customer experience will include the communication, quality of work and improvements in KPI's. So focusing to get average case resolution time faster team will improve customer experience. When team will get communication, quality of work and resolution times better it will also affect straight to team spirit.

In this case study, we focus only daily support tickets and process improving around that in Finnish office. If process will improve and results are good, then we will use this master thesis as a best practice for other support office in the organization to get Lean in production.

6.1.2 Gempa walk and value stream mapping

First needed to find out the current state of the process and what are the bottlenecks. We used Gempa walk method for getting the overview of current work load and how team communicate with customer. What are the customer expectations? How team prioritize work and what kind of channels team have in use? We also start focus on measure the existing performance of the process.

So, our question in Gempa walk were:

How we communicate with customer?
What customer expects from us?
How we prioritize our work?
What channels customers can use?
What KPI's we need to measure to find out the existing state of the process?

For getting answers to these questions we used Gempa walk and value stream mapping to visualize an overview of the process. We described all different tasks that were related to this process as described in figure 20.

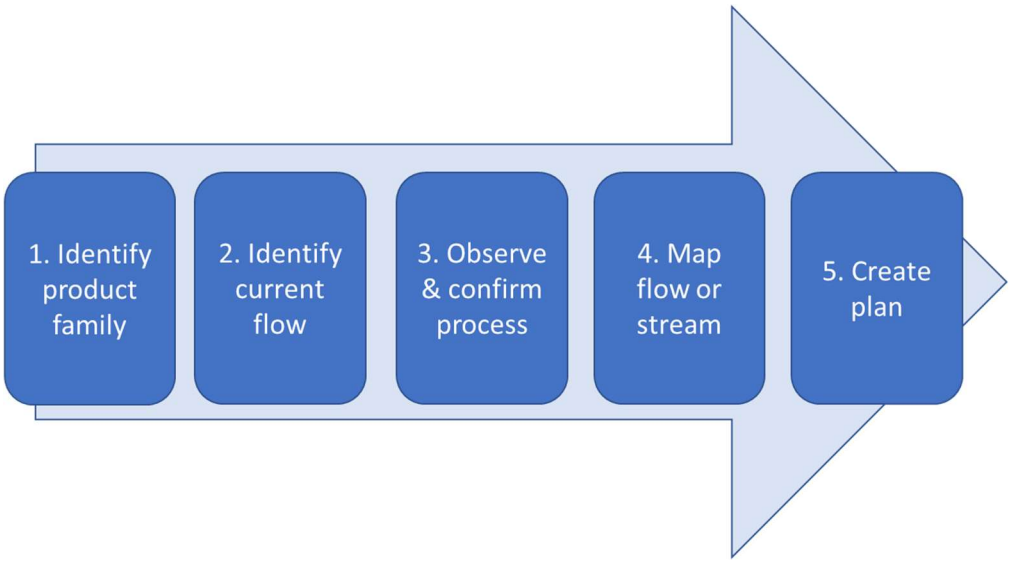

Figure 20: Value stream mapping (Wright, 2017, 57.)

Visualization started from customer contact. What will happened when customer contact support, and specialist will create the new case? When specialist have the last contact to customer? What happens between first and last contact? What is current performance and methods to solve the case? Is it possible to improve that process? What changes needs to be done for get more better results? This visualization gave us a common language for discussion. It also made action points of streaming visible what helped to understand more of the process.

It helped manager to see the points where work needs to be priority and where support needs other teams help. Which action controls and schedules the actions and how much needs to be done? What kind of rhythm of work and volumes support have. Helped to understand the complexity of system.

6.1.3 Customer Expectations

Team started prioritized cases in different categories based on customer expectations and case urgency. This categorize also helped specialists to prioritize their work when they choose next case from work queue. We had four different categories:

- Low: Not urgent, will follow normal FIFO rules.
- Medium: Not urgent, will follow normal FIFO rules.
- High: Urgent, will bypass to top in the queue and will be done when case is next in the HIGH prioritize queue.
- Emergency: Urgent and will be done immediately.

If case life time is more than four days that is limit for a case lifetime then its status will be change to high. Customer will choose the category when he creates the case by using our introduction, but specialist will check the case category when it comes to case queue and change it if it is not correct.

Emergency is always decided by specialist and these cases will mean system failure that effects to the system. High level cases need to be done in the same day. Medium and low will follow terms that are agreed with customer based on normal maintenance agreement.

6.1.4 Continuously flow by using FIFO

Team decided to start use FIFO. Before starting to use this method, all work needed to get in the same place. Team used SalesForce, that is the CRM system which is already in use in organization. We realize that all work was not added in the SalesForce. Specialist will get cases via email, phone, meetings, etc, and for get things done fast they just resolve the case without adding it first to SalesForce.

It was surprising to see how all started to add cases in the SalesForce and understand that all work needs to be in the same place to get work effectively. For example, email that came straight to specialist. Specialist sent the email to SalesForce that created a case then sent email back to customer that included the case number and ask customer to follow case from SalesForce. After couple emails customers started to add cases straight to SalesForce.

Specialist cannot plan working day with existing cases because the high priority cases will bypass straight top on the queue. It was still easy to get flow working even that high priority cases bypass in the queue. After standardizing the order of the work resolution time increase faster than were expecting. Other good improvement in the process was answers that specialists got for the next questions:

- How I know what do to next?
- Where I get my work tasks?
- Where I deliver my work after I have done it?

Before FIFO process specialists struggle a lot with these simple questions and it's was very frustrating. Team designed the workflow cycle based on Kanban. Team started to keep daily meeting every morning at 10:00. It was fifteen minutes meeting where team members had possibility to ask help and questions. Then team designed to have weekly meeting every Monday morning where an agenda was to check new cases that are not estimate yet. Also, team checked next week resources and other topics that will affect the week work flow.

For helping to keep this Monday morning meeting short team decided to have a special task for every day. It was named "cleaner" what was short task in end of office hours where you clean up the cases that has come to work queue. You give estimate time effort for cases and needed comments and change status. This small process helped to keep work queue in order and then specialist know when to do the cleaning. Also, this process helped to keep weekly meetings shorter because there was no need for give estimates for these cases anymore.

In the Lean building process, team find out product specific queues what includes special services and technical support. Then there were also product specific development requests from customers. For this specific area, team established a new queue what was called professional services for development as illustrated in figure 21. Support team could not solve those cases and normally these were more like enhancements to products than bugs. Of course, depending of urgency of bug it will prioritize higher state If needed and send straight to development but for enhancements and low priority bugs we create this specific queue.

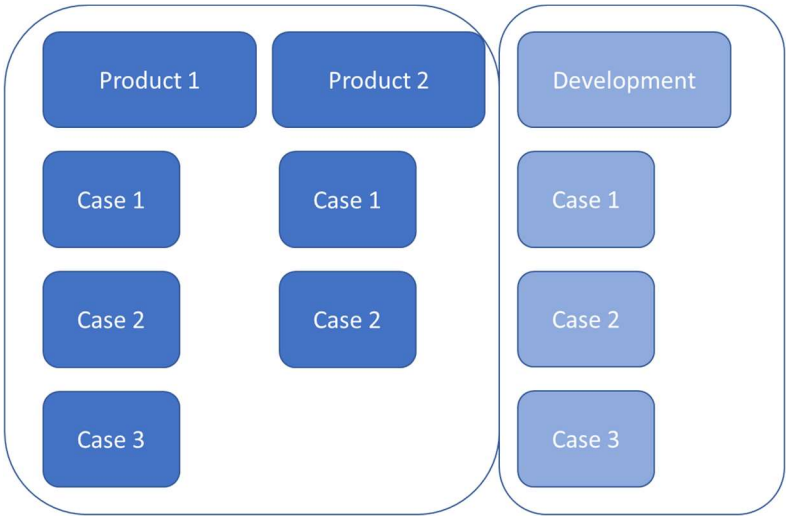

Figure 21: Different work queues

Then we arrange a weekly meeting with product owner where we checked new enhancements and status of the existing ones. In meeting participate only one person from support team and the product owner. By building this part-time cell helped us to get continuously flow with these cases without using too much resources to get things done. Team know that cases will be updated with needed information during these meetings. Between meetings the development team could done the work without support team asking the situation of the case. Meetings were with clear agenda and we got a lot work done during the meeting with small amount of resources.

We used Salesforce for the data transfer between teams. We named the key persons for different processes with another teams. Then we created a common rule for communication and action between teams. After case was moved to another team this team's key person took responsibility of the case. This key person follows up with customer and closed the case. Main response for the case was in the support team and they follow up cases in weekly meetings. Data transfer between teams worked very well and it's was very rarely when there was need for make request of the situation of the case owners.

6.1.5 Standardize to get stable workflow.

For getting work standardize team create a table for work estimates where they used Fibonacci numbers for estimates. Number one for 30 minutes work that is a minimum amount and then number 13 for hole work day as described in table 3. Based on calculation team decided that specialist average working amount is ten points per day.

Fibonacci	Used metrics
1	30 min
2	1 h
3	2h
5	3h
8	>4h
13	work day

Table 3: Fibonacci

Fibonacci table was used in every weekly meeting for estimating cases. How many points each one is? Team also added points per specialist in the table to get overview of resources. Example points of week is estimated in table 4. Normal working week with one specialist was ten points per day and fifty points per week. If we had three specialists in shift for hole week and all had normal working week then we had three times fifty and total 150 points per week and 30 points per day.

	Monday	Tuesday	Wednesday	Thursday	Friday	
Specialist 1	10	10	10	10	10	
Specialist 2	10	10	10	10	10	
Specialist 3	10	10	10	10	10	**Weekly Total**
TOTAL	30	30	30	30	30	150

Table 4: Weekly points

Team defined starting point for the process to be when a case comes to SalesForce. Team used defined common rules and standardization to get work done by using FIFO. For getting process flow smoothly team decided that specialist can decide of priority by itself. Specialist also estimate the case points at the same time. Team had dedicated work task for that and its named cleaner. It is explained more detailed in section 4.1.6. Of course, team were little bit worried about that will the estimates vary but after couple weeks where realize that they follow common forecast we had done.

6.2. Kanban: Visualizes the state of process

Team started to use Kanban for daily meetings. We designed a wall in the office near the team where everyone can see the situation of work load. First everyone made an avatar which was used for representing the specialist. Then team decided to have one queue for new cases. Board included todo, in-progress and done sections for each specialist. Cases were moved from right to left between specialist queues. After team started with Kanban board they realize that there are cases for different products or for two main products. Team decided to divide new cases between these products. So, team create two queues for new cases which helped to get clear picture of both products.

After couple weeks use of Kanban team needed to add section for cases that are on hold. On hold means cases that are waiting someone's action and it takes more time than week. Team used on hold also for cases that are more like in monitoring state. Team made also own queue for professional development services cases. So, in final state there were three different queues in new cases for products and for development as illustrated in figure 22.

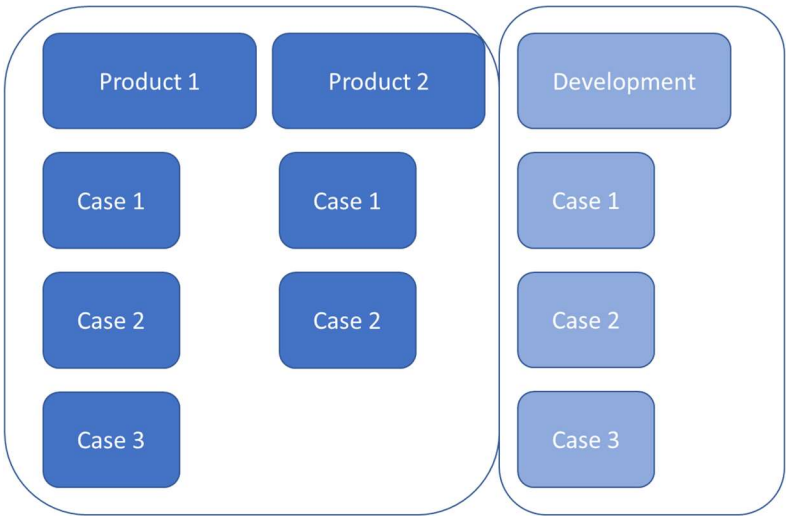

Figure 22: Different queues.

Note papers or cards were used for descripting cases. Specialists create these cards during the weekly meeting. Card include the SalesForce case number, created date, subject, customer name and the product name. These new cards were put on to the board after the meeting in the descending order. In the daily meetings specialist moved these cards between the sections. If specialist made cases that were not in the Kanban board then specialist create the note card and added that to the board. After Monday, weekly meeting we collect last week note cards away from done section.

Then team created this cleaner case what was scheduled task for every noon. Team choose the specialist for cleaner task in daily meeting. Also, there was a card for holiday. If someone is on holiday, we put the holiday card in in-progress section as illustrated on figure 23.

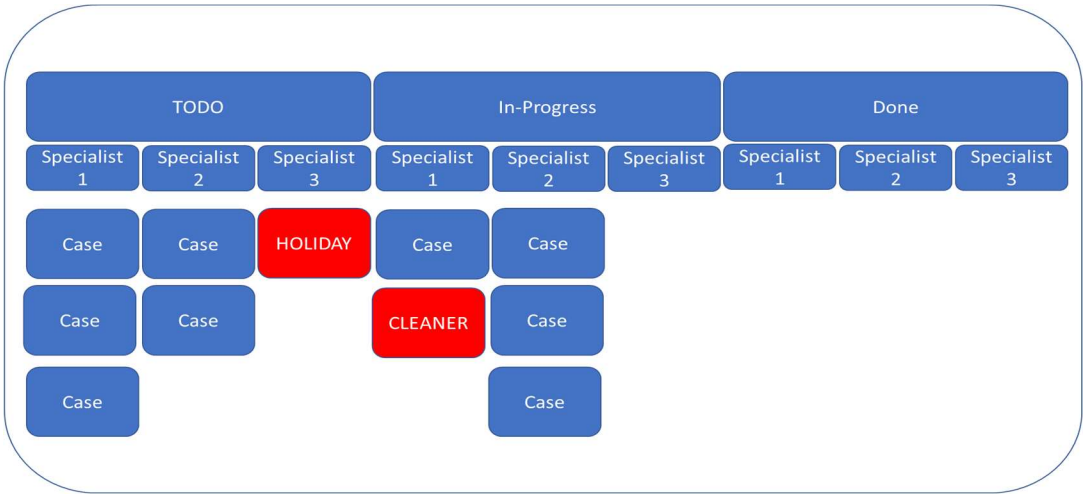

Figure 23: Kanban board with holidays and special tasks

6.3. SPC: Be prepared for change of demand.

When team started Lean we needed to understand the existing situation of the customer support.

How many cases we get per day?
How many cases we can solve per day?
How long it takes to close the case?
What channels our customers like to use and how?

First, needed to find out channels what customer used. Channels were SalesForce, group email, personal email, delicate support line for VIP customers, support line for drivers and personal direct phone numbers. Also, internal meetings and discussion with co-workers generated cases. It was very frustrated to get all needed information in Excel sheet, but it was something what needed to do because otherwise we could not forecast team's daily work.

May 2017 was chosen for more detailed investigating in research because work load of customers was normal. For example, school drivers, hospital drivers, business drivers etc. Also, we had all our resources in use during that month.

Then needed to identify the channels for research. Channels were:

- SalesForce
- VIP phone line
- personal phone line
- group email
- personal email

The common data was collected from reports and specialists were asked to collect data from personal emails that included open and closed cases per day. The period was 19 working days without weekends. Then a SPC chart was generated from each channel.

As illustrated in table 5 for the SPC chart. WEEKDAY was chosen for first column and it is not including weekends because technical support is provided only during weekdays. Next column is DATE. Third one is the UNITS which means units of cases. Fourth one is AVERAGE which includes the average of cases per day. Fifth column named MOVING RANGE where Excel formula is "=ABS(C2-C3)" and column C is UNITS. Next column is AVERAGE OF MOVING RANGE. Next column is UCL = upper control limit where used formula is "=D2+2,659*F2". Number 2,659 is standard mathematical generalization which with average and average of moving range can be calculate the limit of three standard deviation. It's based on Walter A.Shewhart empirical research for calculation when you have only few observations for use.

WEEKDAY	DATE	UNITS	AVERAGE	MOVIN RANGE	AVERAGE OF MOVING RANGE	UCL	LCL
Tue	2.5.2017	30	16.526316		10.88888889	45.47987	0
Wed	3.5.2017	10	16.526316	20		45.47987	0
Tho	4.5.2017	22	16.526316	12		45.47987	0
Fri	5.5.2017	20	16.526316	2		45.47987	0
Mon	8.5.2017	14	16.526316	6		45.47987	0

Table 5: Data for SPC chart

Last column is LCL = lower control limit. Used formula is "=D2-2,659*F2", If result is under zero it cannot be used because value needs to be positive or zero. Data from May is described in table 6.

WEEKDAY	DATE	UNITS	AVERAGE	MOVIN RANGE	AVERAGE OF MOVING RANGE	UCL	LCL
Tue	2.5.2017	30	16.526316		10.88888889	45.47987	0
Wed	3.5.2017	10	16.526316	20		45.47987	0
Tho	4.5.2017	22	16.526316	12		45.47987	0
Fri	5.5.2017	20	16.526316	2		45.47987	0
Mon	8.5.2017	14	16.526316	6		45.47987	0
Tue	9.5.2017	18	16.526316	4		45.47987	0
Wed	10.5.2017	16	16.526316	2		45.47987	0
Tho	11.5.2017	8	16.526316	8		45.47987	0
Fri	12.5.2017	10	16.526316	2		45.47987	0
Mon	15.5.2017	48	16.526316	38		45.47987	0
Tue	16.5.2017	18	16.526316	30		45.47987	0
Wed	17.5.2017	30	16.526316	12		45.47987	0
Tho	18.5.2017	4	16.526316	26		45.47987	0
Fri	19.5.2017	16	16.526316	12		45.47987	0
Mon	22.5.2017	18	16.526316	2		45.47987	0
Tue	23.5.2017	10	16.526316	8		45.47987	0
Wed	24.5.2017	12	16.526316	2		45.47987	0
Tho	25.5.2017	4	16.526316	8		45.47987	0
Fri	26.5.2017	6	16.526316	2		45.47987	0

Table 6: Data table for SPC

Data from May is illustrated in figure 24 where blue line is cases per day. Red line is the average of the cases. Light blue is UCL limit and yellow is LCL limit. If the blue line cross UCL limit repeatedly or is over UCL limit line, then situation is not good. In figure below, can see only one cross 15.5.2017. Average of new cases was 16,5 per day and UCL limit was 45,5 cases.

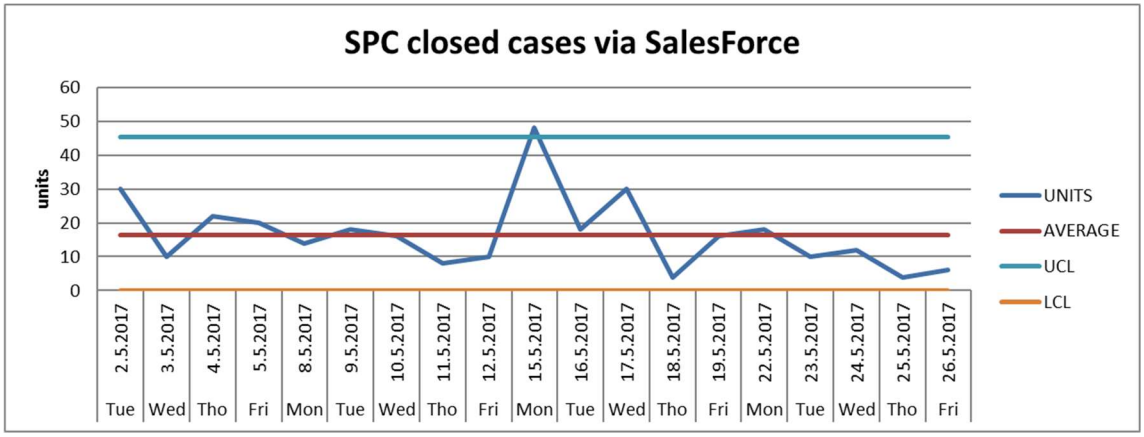

Figure 24: New cases in SalesForce

Next created a table of closed cases of May from SalesForce. The chart is illustrated in figure 25.

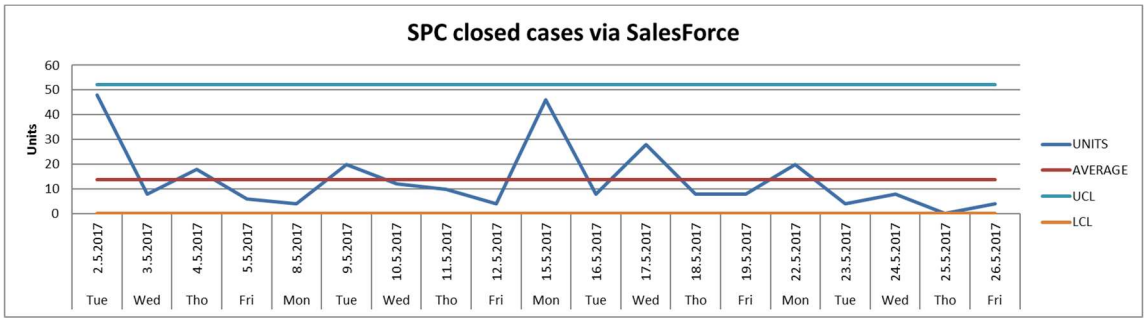

Figure 25: Closed cases in SalesForce

Average of closed cases per day was 13,9 which means that new cases that's are coming daily cannot resolve during the same day. This means 2,6 open case more every day in queue and total 49,65 open cases end of month in SalesForce. UCL limit with closed cases was 51,2. Line of closed cases was stable without crossing UCL limit.

Next chart is open cases per day from May. Chart is illustrated in figure 26. Chart shows that units of cases have been grown from zero to 68. UCL limit was 51,2 and line of units crossed UCL limit 22nd without coming back under the UCL limit. Situation with open cases was not good.

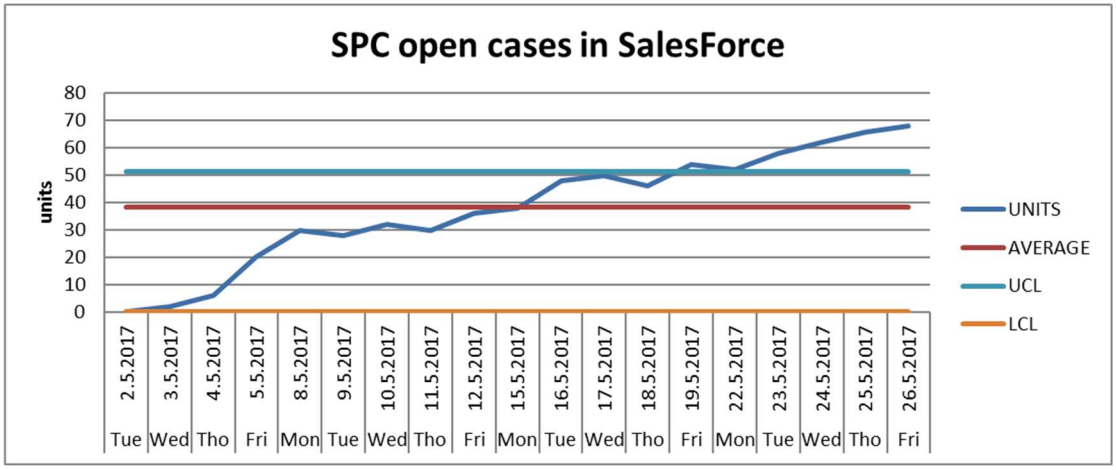

Figure 26: Open cases in SalesForce

Next channel was support email what is a group email. Data include all incoming emails per day what include a work request. Chart of new cases via support email is illustrated in figure 27. Average of emails per day was 2,5. UCL was 8,1. This channel was very stable and did not cross the UCL limit.

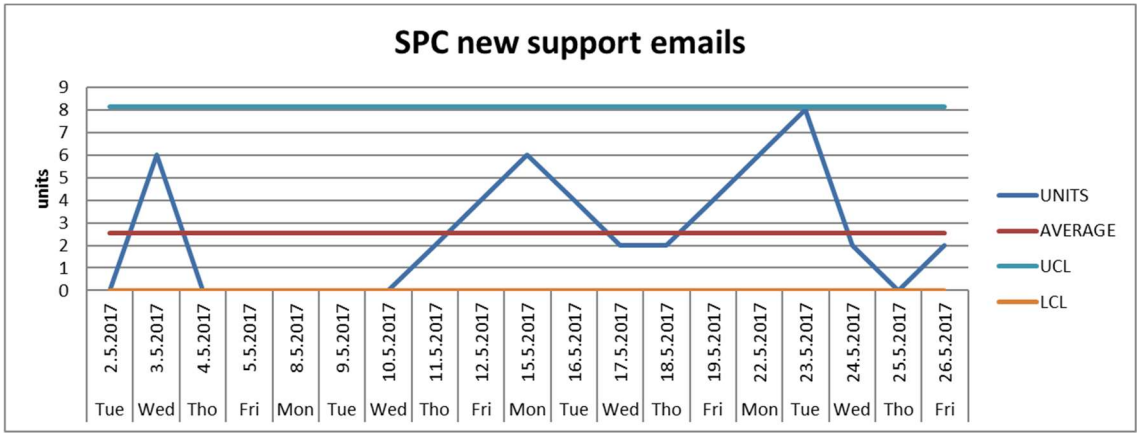

Figure 27: New support emails

Next chart was closed cases via support email. Average of closed cases via support email was 0,6 and UCL limit was 2,9 so it was not high. Chart is illustrated in figure 28.

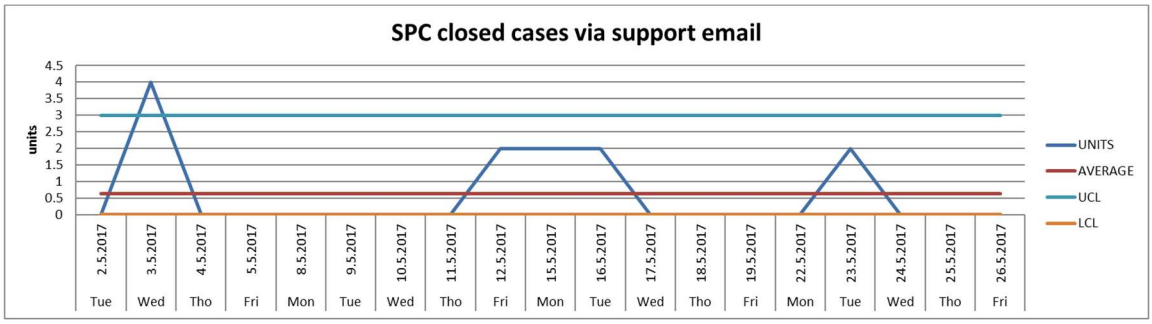

Figure 28: Closed cases via support email

Next chart is open cases via support email as illustrated in figure 29. Average was 13,5 and UCL limit was 18,8 case per day. UCL limit crossed on19th May and end of May there was total 36 open cases. Group email had same situation than SalesForce with cases. UCL limit was crossed and specialists could not resolve all coming new cases during May.

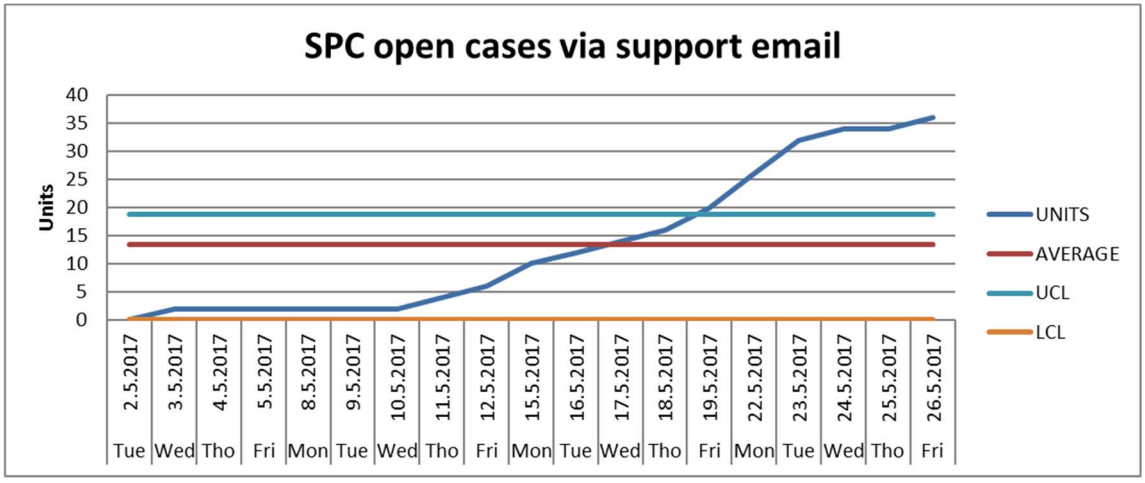

Figure 29: Open cases via support email

Next channel was personal email where data collected from specialists. Chart is illustrated in figure 30. Average was 8,5 new cases via personal email. UCL limit was 36. Situation with new cases was stable.

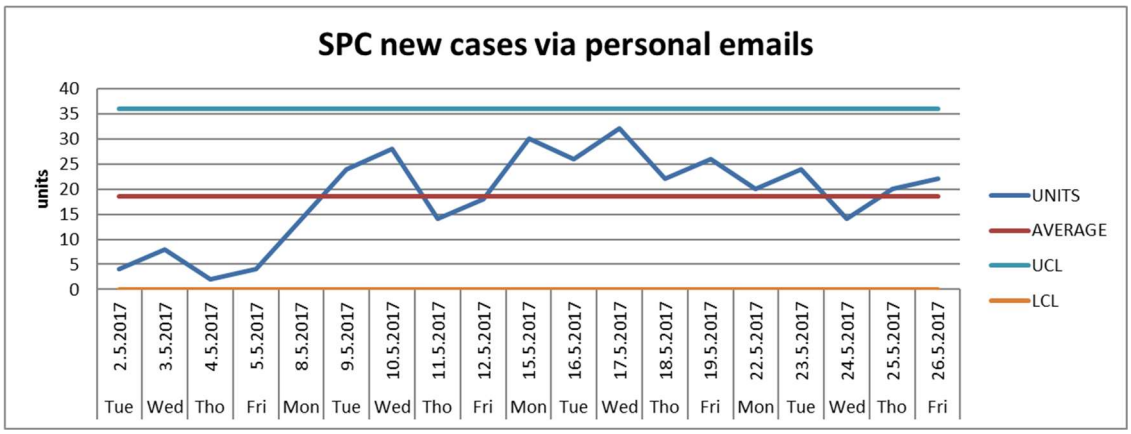

Figure 30: New cases via personal emails

Next chart was closed cases via personal email. Chart is illustrated in figure 31. Average of closed cases was only 0,6 and UCL limit was three. There were 18,5 new cases per day and specialists manage to close only 0,6 case so situation was not good.

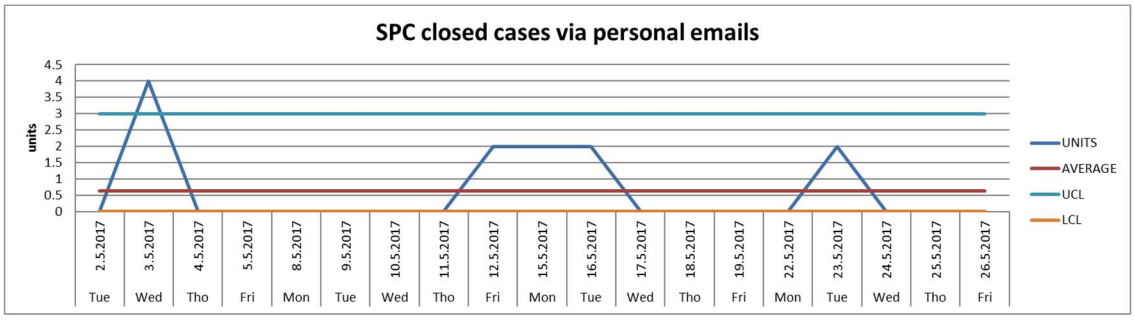

Figure 31: Closed cases via personal emails

Ratio of new and closed cases via personal email already showed non-stable situation with open cases via personal email. Chart of open cases is illustrated in figure 32. Average of open cases per day was 13,5. UCL limit was 18,8 and units per day cross that line 19th May. There was total 36 open case end of May.

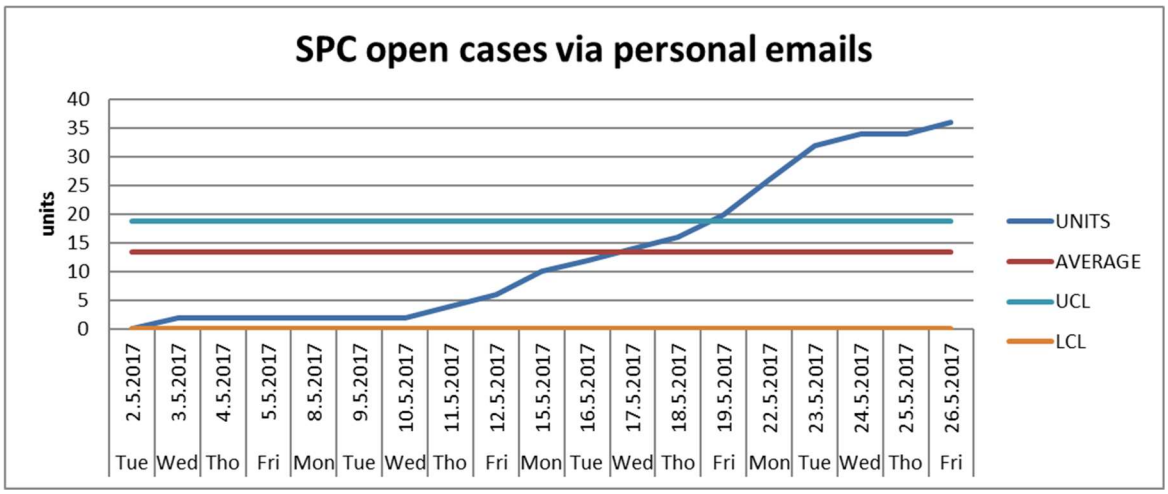

Figure 32: Open cases via personal emails

So finally, there were SPC chart from SalesForce, group and personal emails. Personal phone lines were left out of the research because there was not enough information of how many of phone calls generate a case. Also, main part of those calls has been added already to SalesForce.

Main problem with all these channels was the crosses of the UCL limits which means that specialists could not resolve all coming new cases. Totally 140 open cases end of month and average close cases is lower than new cases with every channel. Good point with this SPC research was information of how many cases came from different channels and how many can be closed every day. There was a problem that needs to be solve and find out the root cause of the crowing cases.

6.4. Results for Operational Excellence in Practice

Lean started end of September by historically first weekly meeting. Meeting was longer than one hour because participants needed to estimate time effort to all open cases by using Fibonacci numbers. Everyone was very excited, and meeting was a successfully. Participants find a guideline for estimates and cases were between one to three points depending on how much time cases takes. For showing points, participants started use method where points were added straight to SalesForce case subject. Subject field was chosen because then you can see instantly the points of case without opening it in SalesForce.

Based on work load estimates participants decided that every specialist need to take total ten points of the queue every day. It was based on calculation of how much time every specialist can use for cases. Also needed to remember that every specialist will get cases with HIGH priority during the day that are not already in the queue when ten will manage more than ten points per day. Example day is described in table 7.

FTS (8-10)	2
Case 1	1
Case 2	3
Case 3	1
Case 4	2
Cleaner	1
TOTAL	10

Table 7: Planned working day with points.

FTS means special task when specialist can do only that tasks in a certain time. Then cleaner is already explained before. Above table is planned day but after working day results are different as described in table 8 below.

FTS (8-10)	2	
Case 1	1	From queue
Case 2	3	From queue
Case 3	1	From queue
Case 4	2	From queue
Case 5	1	Case came during the work day with priority HIGH.
Case 6	2	Case came during the work day with priority HIGH.
Case 7	1	Case came during the work day with priority HIGH.
Cleaner	1	
TOTAL	14	

Table 8: Real working day with points

Case five and six came during the day straight to specialist. These cases were with HIGH priority, so these bypass on the top of the queue. In the weekly meeting, participants estimated total of points what needed to do to get continuously flow working. Maximum points per specialist was ten points and depending of specialist working day. It could be under that also. For example, if you have personal stuff and you need to leave from work and be away half of day then you add five points. Example table of resources is described table 9.

	Mon	Tue	Wed	Thu	Fri	TOTAL
Spelialist 1	10	10	10	10	10	50
Spelialist 2	0	10	10	10	10	40
Spelialist 3	10	10	10	10	0	40
Total per Day	20	30	30	30	20	130

Table 9: Example week

In this example, team had totally 130 points for the week. After the week the actual result was calculated from closed cases and it is described in table 10.

	Mon	Tue	Wed	Thu	Fri	TOTAL
Spelialist 1	12	10	8	10	14	54
Spelialist 2	0	8	16	10	10	44
Spelialist 3	10	11	10	7	0	38
Total per Day	22	29	34	27	24	136

Table 10: Actual result of week

The estimate 130 points for total of week did not realize because result was 136. Estimates did not realize on example week of each of weekday or even with each of specialist, but result was good because it was over calculated estimate. If result is over estimate, then team knows that process with continuously flow was working.

6.4.1 Kanban in use

Team had first daily meeting around the Kanban board what was designed in the white table near to team desks as illustrated in figure 33. First specialist started to choose from the queue the oldest cases from TODO section and then others followed. First meeting went very well, and everyone were waiting excited the next daily meeting where you need to tell more about what you have done and what kind of problems or comments you have. So, on next morning team had a second daily meeting where first specialist started to tell what has been done and move cards from In-Progress to Done section. Then specialist stopped with one case what was in the In-Progress section and mention that cannot resolve the case because did not know how to continue. Then team shortly discuss what could do next and it was a great success.

After first daily meetings I find out that during daily meetings team had a lot of discussion between specialist. It was very good place for changes knowledge and advices. Team members liked that also. There was a lot of discussion in the meeting, but everyone followed the agenda and meetings very rarely takes more than fifteen minutes.

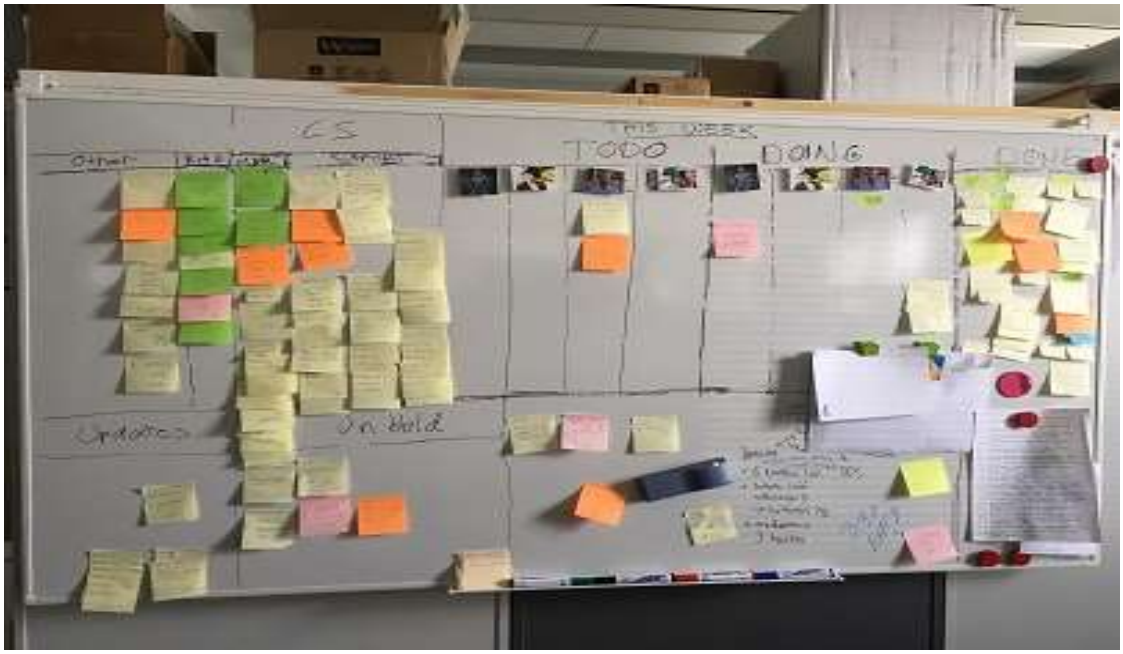

Figure 33: Kanban board

One thing what I was worried about was that how specialists starts to add these HIGH priority cases that comes during the day and are not in the Kanban board. Specialist made the cards and added those to Kanban board by themselves after they have resolved it. So, it came a routine without any problems. It was important to get these also to Kanban board because team needed to see the visual state of the process in one place and it was a Kanban board.

Specialists started to estimate cases during the special cleaner tasks and added those cases to Kanban board. Estimates were done by one specialist but estimates followed the guidelines team had in weekly meetings where they estimate cases together. Because of that change in process team did not have that much cases for estimating in weekly meeting what helped to keep meetings short. Then team also get continuously flow with cases and it helped straight to improve average case resolution time.

6.4.2 PDSA cycle and Gempa walk

PDSA cycle was in the continuously use. Team started Lean with certain planned terms what were taken in the action. Started to study results and made changes if needed. It was an ongoing process. They find out bottlenecks in the process and start to study better solution to get bottlenecks away.

Kanban board designed with only one queue for new cases. After couple weeks use team realize that there is two different products and it is simpler to separate these products to different queues. Then team find out that customers can sent also the development requests, and these are in the same queues with support cases. Team separate development request to own queue. So, they made a lot of changes in Kanban board after they started to use it and there will be more modification in future. Team used PDSA cycle to improve Kanban process.

In my mind, the Gempa walk and PDSA needs to be used together. To get needed information for PDSA study phase you need to find out the root cause and solution. Best way to find out that is to ask right questions from specialists. I used a lot gempa walk to get answer for different question.

It is important to know what specialist do and how they do it. For example, I used Gempa walk when I find out that team did not have clear process with communication between different teams. Customer created a development request and support team had many different channels in use to send request to development but then they did not follow up what will be happened to the request. I started to plan action for to get the process work between teams.

First thing was to get one channel what teams will follow. Plan was to use SalesForce and choose different type for case to get these cases in own queue. Next thing was to arrange communication with product owner. Team did not want product owner to participate to daily meeting or weekly meeting because they think that it is a waste of time for product owner. Team arrange a separate weekly meeting with product owner. One person from support and the product owner had an own weekly meeting where they checked this special queue and made a needed action.

It worked well and helped product owner to plan the sprints better and support team to get updates of cases in this special queue. This process also has been changing a lot after it started. Agenda in the meeting was same than with support weekly meetings. SalesForce was used for communication, but they added lot of communication between SalesForce and Jira. Jira was the main tool in development.

6.4.3 SPC

SPC charts has been the best tool in Lean. It helps to follow the process flow in support. It also shows instantly when needs to make changes in resources. Next four different KPI for performance measurement were used for following the state of the process.

- Open cases per day
- Closed cases per day
- Total of open cases per day
- Average of case resolution time

Only average of case resolution time is SalesForce report and other are SPC reports. Research was focused on four months period starting from October 2017 to January 2018. Four month period was long enough to see how Lean helped team in customer support.

First KPI was open cases per day. In the SPC chart average case per day was 19,4 and the UCL limit was 44,8. Line of the units followed the average per day line and did not cross the UCL limit during this reported time. Team had days when new cases were zero because these days were public holidays. For example, 6.12 Independent day, 25.12 Christmas day and 1.1. New year day. Team did not worry about the variety with units per day because it did not cross the UCL limit as illustrated in figure 34.

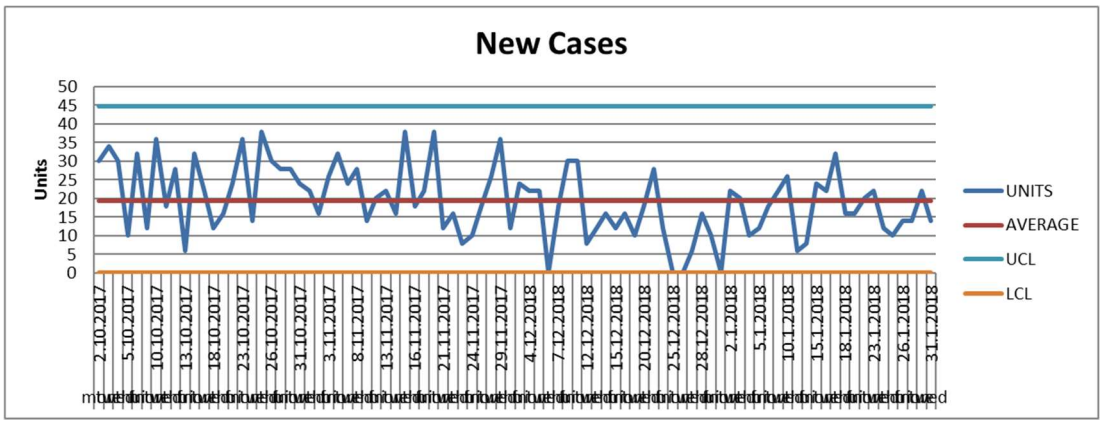

Figure 34: New cases

Next SPC chart was closed case per day. Chart is illustrated in figure 35. Average closed cases per day was 18,7. So team were closed every day same amount of case that they got. UCL limit was 46,8. Days when units were zero were public holidays. In 26th of January units was zero because of low resources in support. Team crossed UCL limit 15.11.2017 because they closed total 58 cases during that day. Team did not cross UCL limit in other days, so the limits were in right place and team had forecast the closed cases very well. If you compare new cases chart to closed cases chart you can see that they follow each other's. If team gets more cases per day we normally close more cases per day.

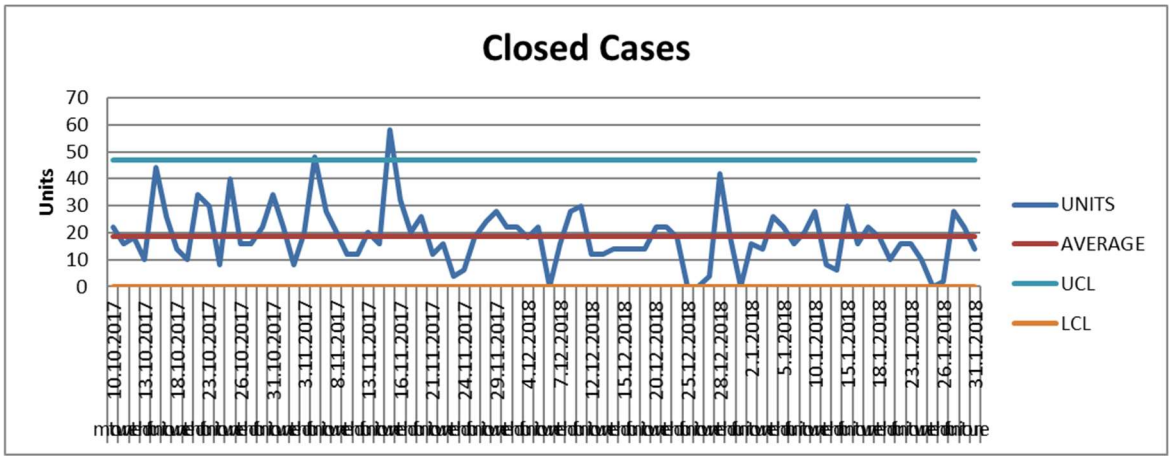

Figure 35: Closed cases

More informative SPC chart for team was open cases. It showed how support can handle coming cases as illustrated in figure 36. Average of open cases per day was total 42,7. UCL limit was 58,1. Cases crossed UCL line several times during this time. After these crosses needed to focus more possible solution like resources to get open cases under the UCL limit. Before New year was not that much coming cases, which helped to resolve open cases. Team managed to resolve all open cases. Then team members holiday season raised cases again near the UCL limit. This SPC showed straight away If there were problems with resourcing.

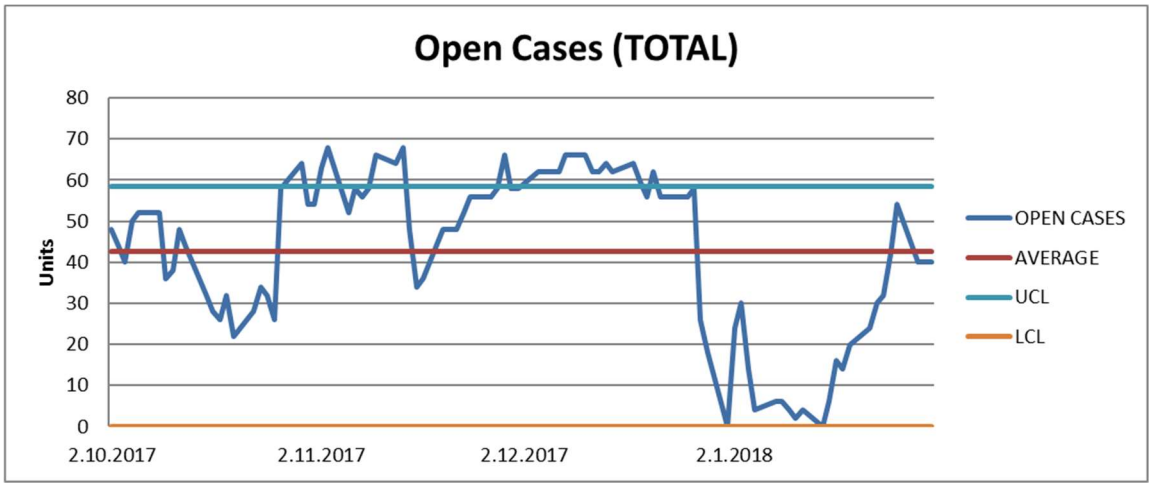

Figure 36: Open cases

Last KPI was average case resolution time. In October when team started with Lean resolution time was 5,76 days per case. In November team did not improve the resolution time. Team went even little bit backwards to 7,11 days per case. Then after improvements in process by finding root causes for negative result team got a huge improvement with case resolution time. From 7,11 to 3,42 days which is over fifty percent better. Then team get even more better result on January what was 2,53 days as illustrated in figure 37. Same time team got all open cases to zero.

So, team were in the situation where they did not have open cases in the queue. Specialist resolve case straight away when it came to queue. This motivated our specialists because then they could resolve cases faster and get very good feedback from customers.

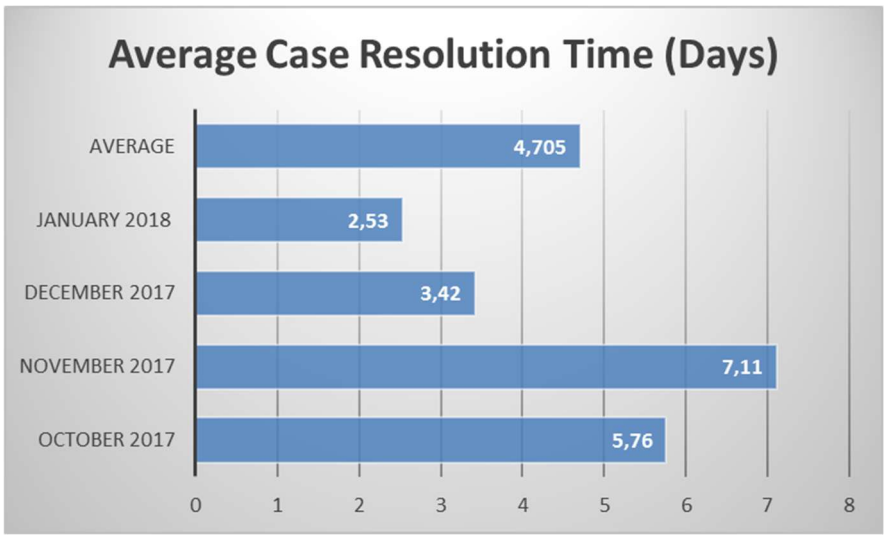

Figure 37: Average case resolution time

This case resolution time will affect straight to our customer happiness and support team happiness and motivation. This was very good chart for all to see how Lean process helped us to get better results with same resources.

7 RESEARCH VALIDITY AND RELIABILITY

This section discusses validity and reliability of the research. First, it evaluates the research methods that were used in study. Second, it describes in more detailed the reliability of the research. Third, it discusses the ethics of this research.

7.1. Evaluation of research methods

Goal of this research was taking Lean management philosophy in action in technical support. Change the technical support process by using pre-selected Lean tools and methods. Research included many changes in technical support daily basics which was one of the research questions. How this will help technical support specialist to do their work or will it make working more difficult than before Lean.

Other area in research was quantitative where empirical part was focusing of statistical methods by using action research methodology. We used AR because our research was based on actual working at the same time. I was part of the team working with the new tools and methods.

We were focusing on four main KPI's and how those change during the research. Reports of the KPI's were followed weekly during the project and how we can influence and forecast our work amounts with Lean tools and methods. This kind of analysis of KPI's helped us to see exact results of the research period. Periods followed the AR spiral model as described in figure 38.

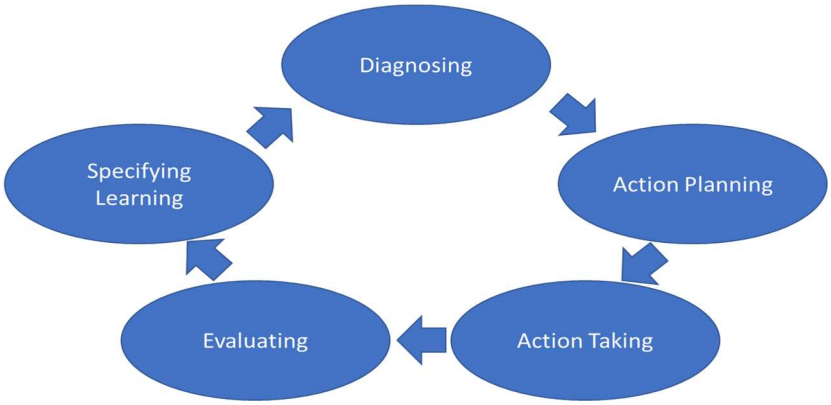

Figure 38: Statistical AR (Durcikova 258)

7.2. Reliability of the research

Research was quantitative, and the reliability of the research was based on statistical AR methods we used in empirical part. Research has been done with the same team which has been operating in May when team did not use Lean. The results of the research can be repeat, and results are verifiable again.

During research period we made some changes with operational process based on feedback from specialist. Feedback from specialist was always positive what was good. Also, positive thing was that we did not need to make big changes after we made our base figures for Lean process. So, our decisions to use May 2017 figures for planning success very well. These small changes and improvements in process also effects to KPI's and we improved our KPI's during the project. Lean has been improved KPI's in this project. This can be show by using SPC data collected and analysis during the project. Based on that we can be sure that reliability of the project is excellent.

7.3. Research ethics

In this research we have followed the ethics of good research practices. Theory of this research based on the newest sources. Sources were chosen carefully by following rules to find as trusted sources as possible.

People who participated in the research were informed before and discussion with team members and management were held before starting Lean research that will everybody want to start testing Lean in support. After discussion everyone were positive looking forward to starting this project.

8 DISCUSSIONS AND CONCLUSIONS

Main goal in this thesis was to take Lean management philosophy into action in technical support. Research period was four months. Plan was to change existing process with a process, which is based on Lean. Study new tools and methods, which Lean provides and use them in technical support. There were two research questions in this thesis.

1. Can we use Lean Philosophy in technical support?
2. Can we improve our KPI's by using Lean?

To use Lean philosophy in technical support was totally a new idea in DDS. The team has neither knowledge nor other research from our company which we could use during the research. It was challenging to find and choose the right tools and methods that are best suited for our support process. Decisions were made while selecting the right tools from large portfolio of tools but afterwards we were happy with the tools and methods we started to use. There is always possibility to choose new tools or methods to test. Especially now when the Lean philosophy determines our operational excellent works.

When I started to collect and analyze background information for this study, I found out that there is lot of sources available from Lean. It was challenging to narrow the theoretical part because there were many different researches of Lean philosophy with different tools and methods. To find out the best tools and methods for our project, I used Sari Torkkola's book as a baseline for our research and used the same tools and methods as she has used in her research with same kind of environment.

We manage to bring Lean philosophy into support team. The Lean principles and the important value of the process' map the value stream by finding the different categories of waste in overproducing and time waiting or moving cases from person to another without any good reason. Are our processes straight forward and understandable? Do we have too much information or information that we are not using? Are our people motivated and happy to work in support and is our working quality good enough for our customers?

The technical support team began to think in the new ways to support and understand the meaning of Lean philosophy. Team started to use Gemba walk and Kanban board. Team manage to forecast working day by using SPC charts. SPC chart also gives us an overview of the process. Best graphical overview of the situation of the support team got from Kanban board. When team started with Kanban board it showed the bottle necks with different products and team started to fix those straight way. Of course, we had a hunch that there are bottle necks with different areas a visual representation confirmed that there were problems that needs to be fix.

Before Lean we were struggling with basic question in support. The specialists did not know what to do next and how to prioritize the incoming cases. Kanban supported in the prioritized and the work flow. There was no need for extra communication anymore where a specialist asks from a manager about which case to do next. A specialist just picks the next task on the list and start to working on it.

We used PDSA method during the research and made changes during the weeks with different areas in the process. It was a key method to improve our operational excellent. For example, there used to be one queue for all cases, but after few weeks we change to different queues for different products. This PDSA also helped us to establish weekly meetings with product owners, which helped us with our Lean process. During the research we manage to achieve a very good process flow. Project gave us the reason to standardize our different contact channels to connect to one place, SalesForce. Like described in figure 39.

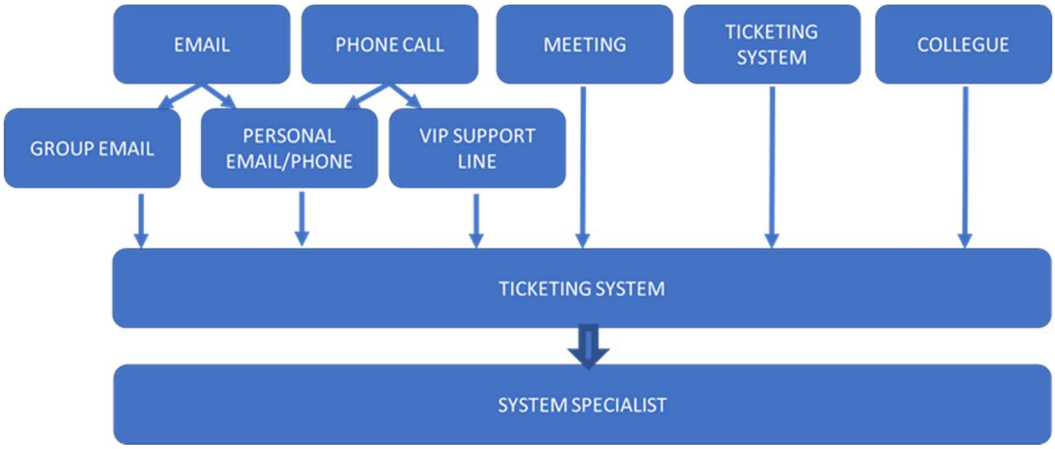

Figure 39: Channels of technical support

Standardization was the most important task to get Lean to work. The concentrate all the rules into tasks into the same system. Phone calls, meetings or emails needed to be added by specialist to SalesForce and we could all channels in the same queues.

This change helped us to monitor KPI's and how Lean effects these metrics. We reported new incoming cases and how many cases can be closed every day. It helped us to see how cases can be handled. Team got 9,7 new cases per day and they managed to close 9,5 cases per day. This means that we can handle incoming cases with resources at hand.

Total cases per day give us better understanding of the overall situation of the cases. The Chart below show us the upper limit (UCL) of cases to focus on more, to get case flow go reduced. Reason for cases to go down by the end of year was because there were not many new incoming cases so there was time to resolve open ones as illustrated in figure 40.

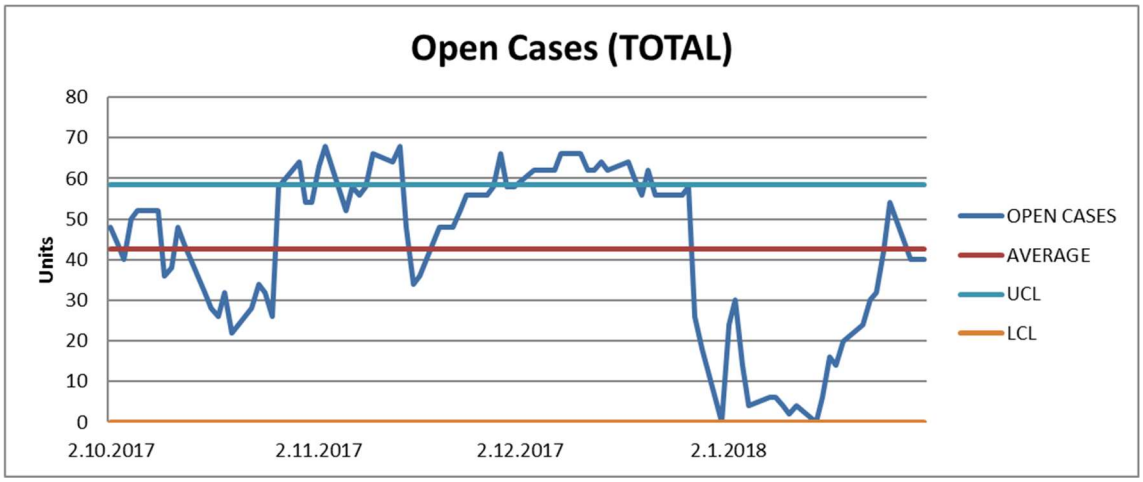

Figure 40: Open cases

Last metric we monitored was the average case resolution time. It was the most important metric because it effected directly to our customer satisfaction. Customer has its expectations for resolution time and our goal was to resolve cases within four days.

When Lean was implemented in October, we took measurement of the average case resolution time to be over five days. Then November case resolution time was over seven days. It was not expected that resolution time would grow over two days. Then we made changes to product queues, and it helped to get resolution time decrease from four days to three point forty-two days in December, then to two point five days in January as illustrated in figure 41.

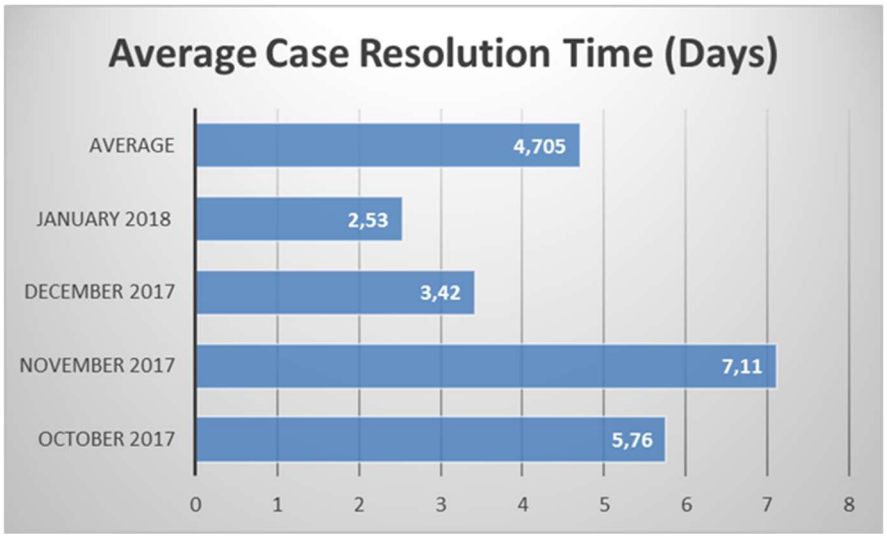

Figure 41: Case resolution times

This metric shows that the Lean philosophy can be used in technical support and it can improve KPI's. We manage to improve our four-point fifty-eight days resolution time which is a significant improvement.

Tools and methods, used during the project were important and helped to improve the support process. We find out the answer for our questions. The overall of the results of the project was excellent. We didn't stop Lean after January we are still using it now and in future. The Learning process has been rewarding for all people that were part of this Lean project. Lean helps us to see the big picture of the support process and now we have tools and technics to remove waste and improve processes.

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APPENDIX

Appendix 1. SPC new cases via SalesForce

WEEKDAY	DATE	UNITS	AVERAGE	MOVIN RANGE	AVERAGE OF MOVING RANGE	UCL	LCL
Tue	2.5.2017	30	16.526316		10.8888889	45.47987	0
Wed	3.5.2017	10	16.526316	20		45.47987	0
Tho	4.5.2017	22	16.526316	12		45.47987	0
Fri	5.5.2017	20	16.526316	2		45.47987	0
Mon	8.5.2017	14	16.526316	6		45.47987	0
Tue	9.5.2017	18	16.526316	4		45.47987	0
Wed	10.5.2017	16	16.526316	2		45.47987	0
Tho	11.5.2017	8	16.526316	8		45.47987	0
Fri	12.5.2017	10	16.526316	2		45.47987	0
Mon	15.5.2017	48	16.526316	38		45.47987	0
Tue	16.5.2017	18	16.526316	30		45.47987	0
Wed	17.5.2017	30	16.526316	12		45.47987	0
Tho	18.5.2017	4	16.526316	26		45.47987	0
Fri	19.5.2017	16	16.526316	12		45.47987	0
Mon	22.5.2017	18	16.526316	2		45.47987	0
Tue	23.5.2017	10	16.526316	8		45.47987	0
Wed	24.5.2017	12	16.526316	2		45.47987	0
Tho	25.5.2017	4	16.526316	8		45.47987	0
Fri	26.5.2017	6	16.526316	2		45.47987	0

Appendix 2. SPC closed cases via SalesForce

WEEKDAY	DATE	UNITS	AVERAGE	MOVIN RANGE	AVERAGE OF MOVING RANGE	UCL	LCL
Tue	2.5.2017	48	13.894737		14.44444444	52.30251	0
Wed	3.5.2017	8	13.894737	40		52.30251	0
Tho	4.5.2017	18	13.894737	10		52.30251	0
Fri	5.5.2017	6	13.894737	12		52.30251	0
Mon	8.5.2017	4	13.894737	2		52.30251	0
Tue	9.5.2017	20	13.894737	16		52.30251	0
Wed	10.5.2017	12	13.894737	8		52.30251	0
Tho	11.5.2017	10	13.894737	2		52.30251	0
Fri	12.5.2017	4	13.894737	6		52.30251	0
Mon	15.5.2017	46	13.894737	42		52.30251	0
Tue	16.5.2017	8	13.894737	38		52.30251	0
Wed	17.5.2017	28	13.894737	20		52.30251	0
Tho	18.5.2017	8	13.894737	20		52.30251	0
Fri	19.5.2017	8	13.894737	0		52.30251	0
Mon	22.5.2017	20	13.894737	12		52.30251	0
Tue	23.5.2017	4	13.894737	16		52.30251	0
Wed	24.5.2017	8	13.894737	4		52.30251	0
Tho	25.5.2017	0	13.894737	8		52.30251	0
Fri	26.5.2017	4	13.894737	4		52.30251	0

Appendix 3. SPC open cases via SalesForce

WEEKDAY	DATE	UNITS	AVERAGE	MOVIN RANGE	AVERAGE OF MOVING RANGE	UCL	LCL
Tue	2.5.2017	0	38.210526		4.888888889	51.21008	0
Wed	3.5.2017	2	38.210526	2		51.21008	0
Tho	4.5.2017	6	38.210526	4		51.21008	0
Fri	5.5.2017	20	38.210526	14		51.21008	0
Mon	8.5.2017	30	38.210526	10		51.21008	0
Tue	9.5.2017	28	38.210526	2		51.21008	0
Wed	10.5.2017	32	38.210526	4		51.21008	0
Tho	11.5.2017	30	38.210526	2		51.21008	0
Fri	12.5.2017	36	38.210526	6		51.21008	0
Mon	15.5.2017	38	38.210526	2		51.21008	0
Tue	16.5.2017	48	38.210526	10		51.21008	0
Wed	17.5.2017	50	38.210526	2		51.21008	0
Tho	18.5.2017	46	38.210526	4		51.21008	0
Fri	19.5.2017	54	38.210526	8		51.21008	0
Mon	22.5.2017	52	38.210526	2		51.21008	0
Tue	23.5.2017	58	38.210526	6		51.21008	0
Wed	24.5.2017	62	38.210526	4		51.21008	0
Tho	25.5.2017	66	38.210526	4		51.21008	0
Fri	26.5.2017	68	38.210526	2		51.21008	0

Appendix 4. SPC new cases via support emails

WEEKDAY	DATE	UNITS	AVERAGE	MOVIN RANGE	AVERAGE OF MOVING RANGE	UCL	LCL
Tue	2.5.2017	0	2.5263158		2.111111111	8.13976	0
Wed	3.5.2017	6	2.5263158	6		8.13976	0
Tho	4.5.2017	0	2.5263158	6		8.13976	0
Fri	5.5.2017	0	2.5263158	0		8.13976	0
Mon	8.5.2017	0	2.5263158	0		8.13976	0
Tue	9.5.2017	0	2.5263158	0		8.13976	0
Wed	10.5.2017	0	2.5263158	0		8.13976	0
Tho	11.5.2017	2	2.5263158	2		8.13976	0
Fri	12.5.2017	4	2.5263158	2		8.13976	0
Mon	15.5.2017	6	2.5263158	2		8.13976	0
Tue	16.5.2017	4	2.5263158	2		8.13976	0
Wed	17.5.2017	2	2.5263158	2		8.13976	0
Tho	18.5.2017	2	2.5263158	0		8.13976	0
Fri	19.5.2017	4	2.5263158	2		8.13976	0
Mon	22.5.2017	6	2.5263158	2		8.13976	0
Tue	23.5.2017	8	2.5263158	2		8.13976	0
Wed	24.5.2017	2	2.5263158	6		8.13976	0
Tho	25.5.2017	0	2.5263158	2		8.13976	0
Fri	26.5.2017	2	2.5263158	2		8.13976	0

Appendix 5. SPC closed cases via support emails

WEEKDAY	DATE	UNITS	AVERAGE	MOVIN RANGE	AVERAGE OF MOVING RANGE	UCL	LCL
Tue	2.5.2017	0	0.6315789		0.888888889	2.995135	0
Wed	3.5.2017	4	0.6315789	4		2.995135	0
Tho	4.5.2017	0	0.6315789	4		2.995135	0
Fri	5.5.2017	0	0.6315789	0		2.995135	0
Mon	8.5.2017	0	0.6315789	0		2.995135	0
Tue	9.5.2017	0	0.6315789	0		2.995135	0
Wed	10.5.2017	0	0.6315789	0		2.995135	0
Tho	11.5.2017	0	0.6315789	0		2.995135	0
Fri	12.5.2017	2	0.6315789	2		2.995135	0
Mon	15.5.2017	2	0.6315789	0		2.995135	0
Tue	16.5.2017	2	0.6315789	0		2.995135	0
Wed	17.5.2017	0	0.6315789	2		2.995135	0
Tho	18.5.2017	0	0.6315789	0		2.995135	0
Fri	19.5.2017	0	0.6315789	0		2.995135	0
Mon	22.5.2017	0	0.6315789	0		2.995135	0
Tue	23.5.2017	2	0.6315789	2		2.995135	0
Wed	24.5.2017	0	0.6315789	2		2.995135	0
Tho	25.5.2017	0	0.6315789	0		2.995135	0
Fri	26.5.2017	0	0.6315789	0		2.995135	0

Appendix 6. SPC open cases via support emails

WEEKDAY	DATE	UNITS	AVERAGE	MOVIN RANGE	AVERAGE OF MOVING RANG	UCL	LCL
Tue	2.5.2017	0	13.473684		2	18.79168	0
Wed	3.5.2017	2	13.473684	2		18.79168	0
Tho	4.5.2017	2	13.473684	0		18.79168	0
Fri	5.5.2017	2	13.473684	0		18.79168	0
Mon	8.5.2017	2	13.473684	0		18.79168	0
Tue	9.5.2017	2	13.473684	0		18.79168	0
Wed	10.5.2017	2	13.473684	0		18.79168	0
Tho	11.5.2017	4	13.473684	2		18.79168	0
Fri	12.5.2017	6	13.473684	2		18.79168	0
Mon	15.5.2017	10	13.473684	4		18.79168	0
Tue	16.5.2017	12	13.473684	2		18.79168	0
Wed	17.5.2017	14	13.473684	2		18.79168	0
Tho	18.5.2017	16	13.473684	2		18.79168	0
Fri	19.5.2017	20	13.473684	4		18.79168	0
Mon	22.5.2017	26	13.473684	6		18.79168	0
Tue	23.5.2017	32	13.473684	6		18.79168	0
Wed	24.5.2017	34	13.473684	2		18.79168	0
Tho	25.5.2017	34	13.473684	0		18.79168	0
Fri	26.5.2017	36	13.473684	2		18.79168	0

Appendix 7. SPC new cases via personal emails

WEEKDAY	DATE	UNITS	AVERAGE	MOVIN RANGE	AVERAGE OF MOVING RANGE	UCL	LCL
Tue	2.5.2017	4	18.526316		6.555555556	35.95754	0
Wed	3.5.2017	8	18.526316	4		35.95754	0
Tho	4.5.2017	2	18.526316	6		35.95754	0
Fri	5.5.2017	4	18.526316	2		35.95754	0
Mon	8.5.2017	14	18.526316	10		35.95754	0
Tue	9.5.2017	24	18.526316	10		35.95754	0
Wed	10.5.2017	28	18.526316	4		35.95754	0
Tho	11.5.2017	14	18.526316	14		35.95754	0
Fri	12.5.2017	18	18.526316	4		35.95754	0
Mon	15.5.2017	30	18.526316	12		35.95754	0
Tue	16.5.2017	26	18.526316	4		35.95754	0
Wed	17.5.2017	32	18.526316	6		35.95754	0
Tho	18.5.2017	22	18.526316	10		35.95754	0
Fri	19.5.2017	26	18.526316	4		35.95754	0
Mon	22.5.2017	20	18.526316	6		35.95754	0
Tue	23.5.2017	24	18.526316	4		35.95754	0
Wed	24.5.2017	14	18.526316	10		35.95754	0
Tho	25.5.2017	20	18.526316	6		35.95754	0
Fri	26.5.2017	22	18.526316	2		35.95754	0

Appendix 8. SPC closed cases via personal emails

WEEKDAY	DATE	UNITS	AVERAGE	MOVIN RANGE	AVERAGE OF MOVING RANG	UCL	LCL
Tue	2.5.2017	0	0.6315789		0.888888889	2.995135	0
Wed	3.5.2017	4	0.6315789	4		2.995135	0
Tho	4.5.2017	0	0.6315789	4		2.995135	0
Fri	5.5.2017	0	0.6315789	0		2.995135	0
Mon	8.5.2017	0	0.6315789	0		2.995135	0
Tue	9.5.2017	0	0.6315789	0		2.995135	0
Wed	10.5.2017	0	0.6315789	0		2.995135	0
Tho	11.5.2017	0	0.6315789	0		2.995135	0
Fri	12.5.2017	2	0.6315789	2		2.995135	0
Mon	15.5.2017	2	0.6315789	0		2.995135	0
Tue	16.5.2017	2	0.6315789	0		2.995135	0
Wed	17.5.2017	0	0.6315789	2		2.995135	0
Tho	18.5.2017	0	0.6315789	0		2.995135	0
Fri	19.5.2017	0	0.6315789	0		2.995135	0
Mon	22.5.2017	0	0.6315789	0		2.995135	0
Tue	23.5.2017	2	0.6315789	2		2.995135	0
Wed	24.5.2017	0	0.6315789	2		2.995135	0
Tho	25.5.2017	0	0.6315789	0		2.995135	0
Fri	26.5.2017	0	0.6315789	0		2.995135	0

Appendix 9. SPC open cases via personal emails

WEEKDAY	DATE	UNITS	AVERAGE	MOVIN RANGE	AVERAGE OF MOVING RANG	UCL	LCL
Tue	2.5.2017	0	13.473684		2	18.79168	0
Wed	3.5.2017	2	13.473684	2		18.79168	0
Tho	4.5.2017	2	13.473684	0		18.79168	0
Fri	5.5.2017	2	13.473684	0		18.79168	0
Mon	8.5.2017	2	13.473684	0		18.79168	0
Tue	9.5.2017	2	13.473684	0		18.79168	0
Wed	10.5.2017	2	13.473684	0		18.79168	0
Tho	11.5.2017	4	13.473684	2		18.79168	0
Fri	12.5.2017	6	13.473684	2		18.79168	0
Mon	15.5.2017	10	13.473684	4		18.79168	0
Tue	16.5.2017	12	13.473684	2		18.79168	0
Wed	17.5.2017	14	13.473684	2		18.79168	0
Tho	18.5.2017	16	13.473684	2		18.79168	0
Fri	19.5.2017	20	13.473684	4		18.79168	0
Mon	22.5.2017	26	13.473684	6		18.79168	0
Tue	23.5.2017	32	13.473684	6		18.79168	0
Wed	24.5.2017	34	13.473684	2		18.79168	0
Tho	25.5.2017	34	13.473684	0		18.79168	0
Fri	26.5.2017	36	13.473684	2		18.79168	0