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Implementation of Continual Service Improvement Concept into Service Production Environment

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Service management is a concept that is enabling organizations to maximize the value from the use of products and services. Service management practices are leaded by service management office that is a center of excellence within the organization. It is chartered to improve quality, effectiveness and efficiency of delivering the services.

The purpose of this study was to research the most suitable frameworks and develop a guideline how to implement continual service improvement concept into service production environment within the case company.

To address the challenge, the thesis started it work by forming the current state analysis of the service production and how improvement projects has been delivered within the company so far. After gathering the information of the current state and obtaining the big picture, begun the process of researching the most suitable frameworks for the case company to be used in the guideline.

This study goes through the most used best practice in the area such as ITIL, process framework Lean and improvement methodology Six Sigma and Lean Six Sigma.

The study resulted a guideline with needed key roles, tools and structure to be used in the case company to implement the continual service improvement concept and run improvement projects in the future.

Keywords	ITIL, LEAN, SIX SIGMA, Continual service improvement, service management, service production

Contents

1 Introduction

1.1 Overview

Service Management Office is a center of excellence in the case that aims to improve quality, effectiveness and efficiency of the offered services to organizations customers. Typically, service management office accomplishes this by leveraging industry specific standards and best practices by applying those to the organization's unique environment.

Service management refers to all activities that are directed by company policies, organized and structured processes and supporting actions, performed by the organization to design, plan, deliver, operate and control services produced to customers.

To understand service management and its functions in deeper level it is good to open up bit the roles within service management and the responsibilities to understand backgrounds for this thesis. *Service Owner* is representing the service across the organization managing the risks of operating the service. Service management (especially the service owner) is responsible of acting as a point of escalation for major incidents and being responsible to ensure improvements are made based on the root cause analysis of the incident. Service management is also responsible to provide input continual service improvement and to identify and prioritize the improvements.

As the service management office is relatively new in the case company and the concept of the continual service improvement is not implemented through the organization, there is a need to create general guidance how to implement continual improvement projects into the organization following good researched methodologies.

In this thesis, I was concentrating on planning the continual improvement projects and how those should be implemented into the service production environment. This thesis should be used as a guidance for continual service improvement implementation for service production within the case company. I was looking at the current implementation methodologies and combining the best practices from different frameworks. With the overall knowledge that I have gathered though out this process, I was presenting improved guidance how to implement the continual service improvement concept into case company's service production.

The output is to deliver new guidance how to implement continual service improvement concept into service production to support my work as a service owner at the case company but benefitting also other business areas when they need to have continual services improvement projects in place.

1.2 Case company

The company in this thesis is Telia Company, a large telecommunications company with global customer base, which is specialized in telecommunications, datacenters, media and ICT services. It has headquarters in Stockholm, Sweden but is operating in all Nordics and Baltics. Telia Finland's headquarter are based in Helsinki. Telia Company competes in all of its operating markets in telecommunications, datacenter, media and ICT business and globally ranked number one in the world in IP backbone solutions. Telia Company has also made acquisitions in recent years to strengthen its position in ICT, cloud and media field.

Telia Company is present in 9 countries and is employing 20,400 employees globally. Year-end net sales from 2018 were SEK 83,559 million with adjusted EBITDA SEK 26,649 million. In Finland it has around 4000 employees with net sales of € 1,5 billion.

1.3 Business challenge

Competition is very tough within the industry and it is hard to make separation with products and services against the competitors. When the battle for customers is tough and customer loyalty is rather low because it is easy and cheap to switch the service provider, you have to deliver great value for the customers money, or they will take their money to another service provider.

When the prices and the basic services provided are almost identical, one way to make separation against competitors is quality of the services provided to the customers. The quality is a term that anyone can have a different view of. Some customers might say that speed of their internet access is the quality, and some might see retainability as an aspect of quality.

We have approached the service production quality as a metric, where each incident has its own counter to increase the quality meter with target levels, more details about the quality metrics will be handled in separate chapter.
The business challenge is that we were lacking in quality metrics where the need for implementation of continual service improvement concept has been seen. The service production quality is not as good as we wanted it to be and continual service improvement was not part of everybody's routines. There was no formal way of implementing service improvement projects, so the need for guideline how to do so was needed.
Lack of guidelines for implementation process leads to variation how continual improvement projects are planned and implemented into service production environment. This leads to more time used for planning phase and is frustrating people involved in multiple projects due to different methodologies used in each project.

1.4 Objective and outcome

Objective for this thesis was to create an implementation planning guideline how to implement continual service improvement projects into service production environment in Telia.

The outcome of this thesis was the internal guideline for implementation of continual service improvement projects.

2 Method and material

In this section I have described the methods used in the Thesis research and explain the research design.

2.1 Research approach

Due to the format of the data available for further analysis I had to use both qualitative and quantitative research methods.

2.1.1 Case study

This Thesis project is made with a case study approach. Case study is an in-depth exploration to answer questions why or what a phenomenon or a case has happened. A case study as a research is a linear but iterative process where all phases are synced together as seen on Figure **1.**

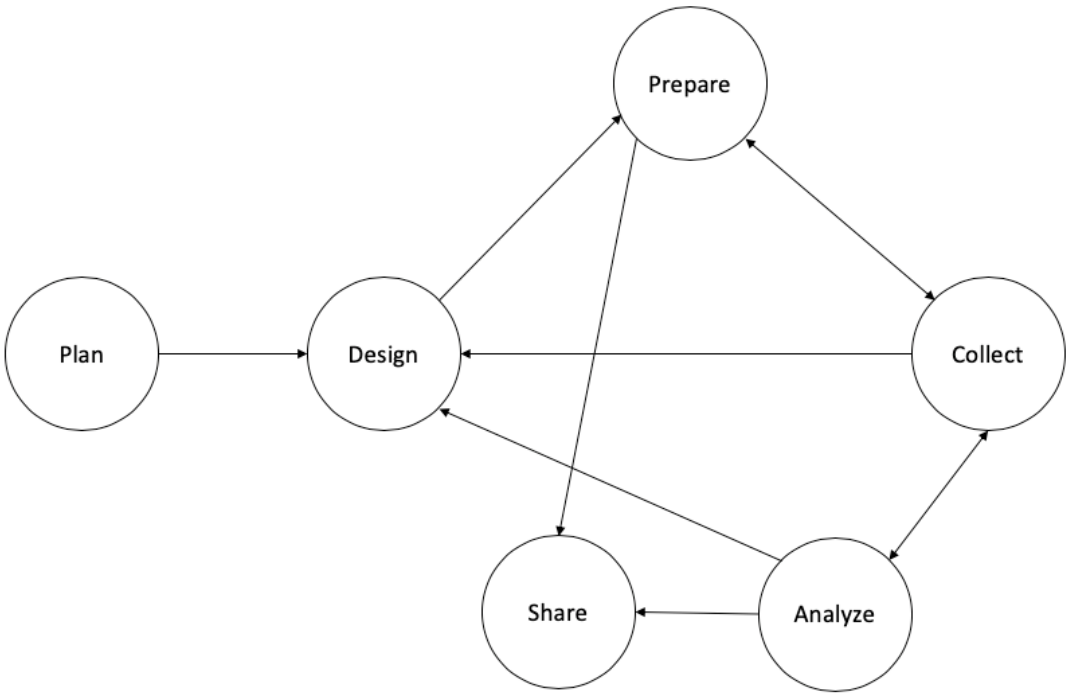

Figure 1 Logic of a Case Study Research (Yin, 2018)

Yin (2018) presents a twofold definition of case study as a research method.

1. “A case study is an empirical method that

- Investigates a contemporary phenomenon (“the case”) in depth and within its real-world context, especially when
- the boundaries between phenomenon and context may not be clearly evident” (Yin, 2018, p. 15).

As Yin states about the second part of his definition of case studies that “arises because the phenomenon and context are not sharply distinguishable in real-world situations”.

2. “A case study

- copes with the technically distinctive situation in which there will be many more variables of interest that data points, and as one result
- benefits from the prior development of theoretical propositions to guide design, data collection, and analysis, and as another result
- relies on multiple sources of evidence, with data needing to converge in a triangulating fashion” (Yin, 2018, p. 15).

2.1.2 Qualitative research

Qualitative research is term that includes wide variety of different approaches and methods for the study of natural social life. The information or the data that is collected and analyzed is mostly nonquantitative; interviews, field notes, reports/documentation etc. (Saldana, 2011, p.3-4)

> “Qualitative research uses words and sentences whereas quantitative research is based on numbers. Qualitative research does not aim for generalizations like quantitative research. The purpose is to describe and understand a phenomenon and give it a reasonable interpretation”
> (Kananen, 2013, p.31).

Qualitative research is used for this Thesis as a data collection method in current state analysis phase. Qualitative research methods are used for collecting data from interviews, incident tickets and incident reports to fully understand current state of the quality of the service production. Qualitative research provides data and feedback that cannot be found with quantitative research methods.

2.1.3 Quantitative research

Quantitative research is systematic investigation of a phenomena by collecting quantifiable data and performing statistical, mathematical or computational techniques (Bhat, n.d.). Quantitative research uses data that is typically in numbers and statistical analysis are used to analyze the data.

> “Statistics are powerful persuaders. As systematically collected numerical facts, they do much more than summarize reality in numbers” (Walter, M. & Andersen, C., 2016, p.7).

Quantitative research methods were used in this Thesis when data to be analyzed is in numbers and statistical analysis.

2.2 Research design

Thesis research design includes six phases as described in the figure 2.

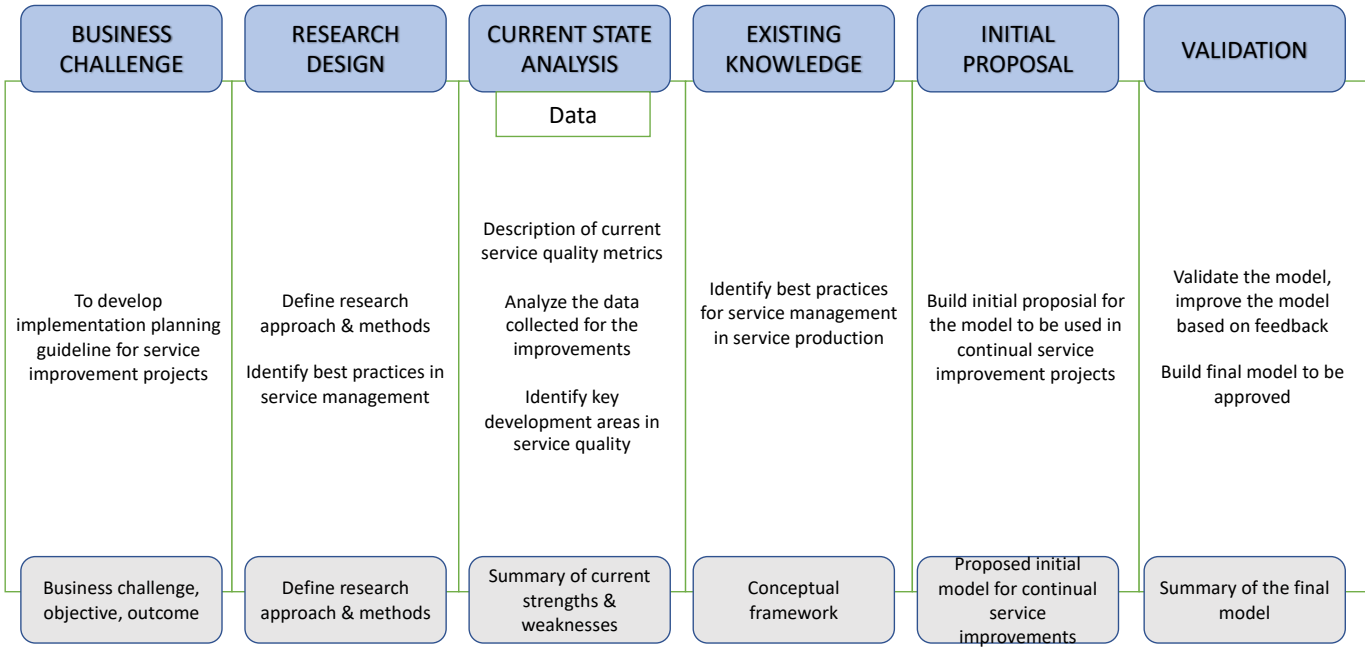

Figure 2 The Research design

1. The business challenge, objective and outcome of the Thesis.
2. Defining the research approach and methods.
3. Current state analysis for service production quality
4. Existing knowledge from literature to build conceptual framework for the guideline for service improvement projects
5. Developing initial proposal
6. Validate the guideline

2.3 Data collection

Data has been collected from multiple different sources and therefore consists different types of data. Therefore, it has also impacted on the research methods (qualitative & quantitative research).

Data has been collected from interviews with director, senior manager and team leaders, IT systems and from incident reports. Interviews has been held during the current state analysis phase and data collection from reports and IT systems has been done in that phase as well.
Data collection plan is described in table 1.

Table 1 Data collection plan

Work package	Content	Source	Outcome
Data 1 Current state analysis	• Interviews • Ticket data from different IT systems • Data from reports	• Management interviews	• Summary of current weaknesses & improvement areas
Data 2 Initial proposal	• Defining guideline for service improvement projects • Defining templates	• Stakeholder interviews	• Proposed guideline and templates for service improvement projects
Data 3 Validation	• Improve guideline & templates based on feedback	• Stakeholder interviews	• Finalized guideline and templates

2.4 Data analysis

Data collected for this Thesis has been analyzed using different software. Data from interviews has been collected in notes and analyzed after the interview highlighting the main areas risen in the interview.
Data from incident tickets has been exported to MS Excel files and managed in Excel sheets first. After the data has been cleaned and only needed information was left, further analysis has been done using Minitab software to gain more sophisticated analysis from the data. Data from incident tickets was organized based on device types, whether field force was needed or not and how many customers were affected by the incident.

Incident reports have been read and analysis has been made by reading the reports and gaining further information about the incident from the incident tickets related to the report. After reading and analyzing the incident reports notes were taken and combined to one master file to point out the root cause of the incidents and main factor that were enabling the incident.
Data from the interviews was collected into notes, the notes were collected into master file to point out the main reasons of struggling in each sector. From the master file it was easier to make assumptions and see the common pain points.

3 Current State Analysis

First it is crucial to understand what a service is. Definition of service by Case & Spalding (2007):

> *"A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs or risks" Case & Spalding, 2007.*

3.1 Why service management is needed?

In current state shown in figure 3 we can see that the index for service quality is just below the target threshold. However, the management and customer expectations are at much lower than the current state is.
This requires service management for all products and services. Overall quality for the services has to be improved to meet the management and customer expectations. There were already identified actions to take the needed steps to improve the quality of the services.

1) Clear ownership and responsibilities over each service. The service owners have to be appointed for all the services. The service owners are responsible for quality.
2) Each service owner to identify the service improvement actions for their services.

To control the improvement actions continual proceeding service management is needed daily, so the service owners are fully aware where each of the projects is going and what are the next steps towards the wanted end result.

Without service management the value from the projects would not be realized and the service quality improvements were not be reached.

3.2 Measurements for service production quality

3.3 Conclusions and actions

Quite fast after the beginning of the improvement projects it was noticed that guidelines how to implement these improvement actions were missing. The guideline should include project charts, methods and tools used in projects based on researched methodologies and best practices.

In service operations the ITIL framework is used and ITIL is pre-selected by the case company as a contributing element to be used is to proposed solution to the business challenge in this thesis. Lean and Lean Six Sigma are frameworks that delivers efficiency for processes and structure for improvement projects. Lean Six Sigma brings tools and data focused approach to improving the process and products / services.

The next chapter includes existing knowledge from ITIL framework that is the most used IT service management framework in the world, Lean and Lean Six Sigma to create base for the initial proposal for guidelines.

4 Existing Knowledge

4.1 IT Service management frameworks and methodologies

To create context to IT service management we need to understand the ways IT can be viewed.
IT is a commonly used term that has different meaning with context. There are four perspectives to view IT. “First perspective, IT systems, applications and infrastructure are components of larger product” that enables processes or services. “Second perspective, IT is an organization with its own capabilities and resources.” There are many types of IT organizations, business functions, shared service units and enterprise-level core units. Third perspective, IT is a category of services that the business is utilizing. Typically, these are IT applications and infrastructure that are packaged and offered as a service by internal IT unit or external service provider. From the fourth perspective, IT is a category of business assets that provide a stream of value for the owners, including, but not limited to, revenue, income and profit. IT costs are viewed as investments instead of expense. (Cannon & Wheeldon, 2007)

4.1.1 ITIL

“ITIL stands for Information Technology Infrastructure Library.” ITIL is currently the most widely accepted approach to IT service management. Organizations are using its best practices to run their businesses from strategy level all the way to the daily actions. The very first version of ITIL dates back to 1980s as a library of several books that were describing a process per each book. In 1980s it was mainly used and developed by British Government agencies (Joret, S., 2019). Over the years ITIL has been developed from a library of books to its latest version ITIL 4 that was launched in 2019. As the first version was describing the processes, the evolution of IT business has re-shaped ITIL to take into account wider context of customer experience, value streams and digital transformation. Also new ways of working are present in the latest version of ITIL such as Lean, Agile and DevOps.

4.1.1.1 IT Service Management

In this chapter the most common service lifecycle phases have been described.

In ITIL framework (V3) service lifecycle stages and related processes have been divided into five different sets. Starting from the beginning of service lifecycle and working towards the service retirement. The service lifecycles by Agutter (2012):

"Service strategy's purpose is to define the perspective, position, plans and patterns that a service provider needs to be able to execute to meet an organization's business" outcomes. So, the service strategy phase focuses on the strategy management for IT services. "Service strategy is responsible for service portfolio management and financial management for IT services." Also demand management and business relationship management is handled in service strategy.

"Service design designs IT services, together with the governing IT practices, processes and policies to realize the service provider's strategy and to facilitate the introduction of these services into supported environments ensuring quality service delivery, customer satisfaction and cost-effective service provision." So, service design is responsible for design coordination, handling the service catalogue and service level management. Service design is monitoring the availability and capacity of the services, as well as the "IT service continuity management, information security management and" the supplier management.

Service transition is ensuring that new, modified or retired services meet the expectations of the business as documented in the service strategy and service strategy stages of the lifecycle. So, service transition is responsible for planning and supporting the service transition from planning to production, change management of the services, service asset and configuration management. Service transition handles the release and deployment management, as well as the service validation and testing before deployment. In service transition stage also change evaluation has to be done and knowledge management to be updated.

"Service operation's purpose is to coordinate and carry out the activities and processes required to deliver and manage services at agreed levels to business users and customers. Service operation is also responsible for the ongoing management of the technology that is used to deliver and support services. Service operation is" responsible for the following processes: event management, incident management, request fulfilment, problem management and access management. Service operation processes (event management, incident management and problem management) has been described in detail in chapter 5.1.1.2.

"Continual service improvement's purpose is to align IT services with changing business needs by identifying and implementing improvements to IT services that support

business processes.” Continual service improvement has been described in detail at chapter 5.1.1.3.

4.1.1.2 Service Operations

Service operations are the daily actions that are included into service business. The aim of service operations “is tempting to focus only on managing day-to-day activities and technology as end themselves.” However, service operations have much larger impact on the whole service production context. As it is part of service management lifecycle it has responsibility for executing and performing processes (event management, incident management and problem management) that optimize the cost and the quality of the services. Service operations is also responsible for the effective functioning of components that are supporting services (Cannon, D. & Wheeldon, D. 2007). Service operations has to be in place to handle the day-to-day activities in service production and without service operation practices we can’t have continual service improvement processes.

To have better understanding about service operations and how that function is handling day-to-day activities, we need to describe the main processes in day-to-day service production.

Event Management it the process that is monitoring all events that are occurring “through the IT infrastructure to allow normal operation and also to detect and escalate” abnormal events to other processes (Cannon, D. & Wheeldon, D. 2007).

Event has been defined as following:

“Any change of state that has significance for the management of a configuration item (CI) or IT service.

The term Event is also used to mean an Alert or notification created by any IT Service, Configuration Item or Monitoring tool. Events typically require IT Operations personnel to take actions, and often lead to Incidents being logged” (Cannon, D. & Wheeldon, D. 2007, p. 232).

Purpose of Event Management is to have the ability to detect events, make sense of the events and to determine the appropriate control action to the events. Therefore, Event Management is the very basis for monitoring e.g. networks.

Often Event Management provides the entry point for other Service Operations processes. Event Management provides basis for Service Assurance and Service Improvements.
Usually the business benefits that comes from Event Management are indirect. Event Management provides information and mechanisms to detect possible incidents early on and help preventing the incidents from happening (Cannon, D. & Wheeldon, D. 2007).

In figure 3 is described a general Event Management process that helps to understand basic Event Management process flow with actions that are taken in each part of the process.

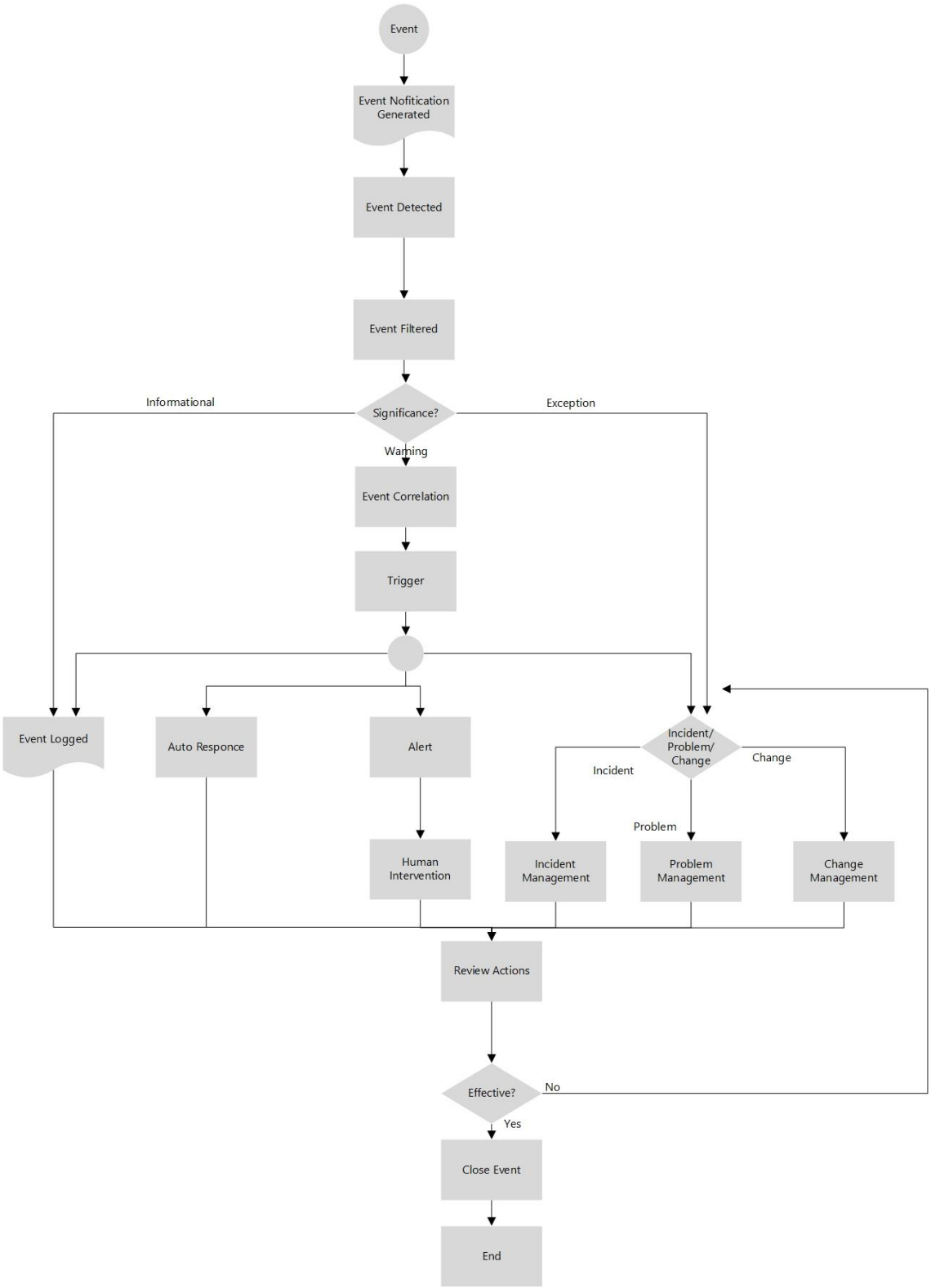

Figure 3 The Event Management process (Cannon, D. & Wheeldon, D. 2007, p. 38)

Incident management has only one purpose, restore the service as quickly as possible and minimize the business impact of the incident. Typically, incident management process is measured by how well incident restoration times are meeting the customer SLA's.

Incident has been defined in ITIL as following:
“An unplanned interruption to an IT Service or reduction in the Quality of an IT Service. Failure of a Configuration Item that has not yet affected Service is also an Incident. For example, Failure of one disk from a mirror set” (Cannon, D. & Wheeldon, D. 2007, p. 234).

Incident Management is highly visible for the business, so the value for the business is much easier to show than most of the Service Operation processes. Incident Management provides value for the business by the ability to detect and resolve incidents to reduce downtime of service/product/etc. that means higher availability of the service/product/etc. Incident Management is providing the ability for the continual service improvements, when it is understood what constitutes the incidents (Cannon, D. & Wheeldon, D. 2007).

General Incident Management process has been described in figure 4. Noticeable is the evaluation part, is the incident a major incident. Major incidents are handled in Major Incident Management process that is not described in this Thesis in detail. Major incidents are incidents with greater urgency and shorter timescale than normal incidents. What is a major incident should be defined and agreed within the organization and in ideal situation, mapped to incident prioritization matrix.

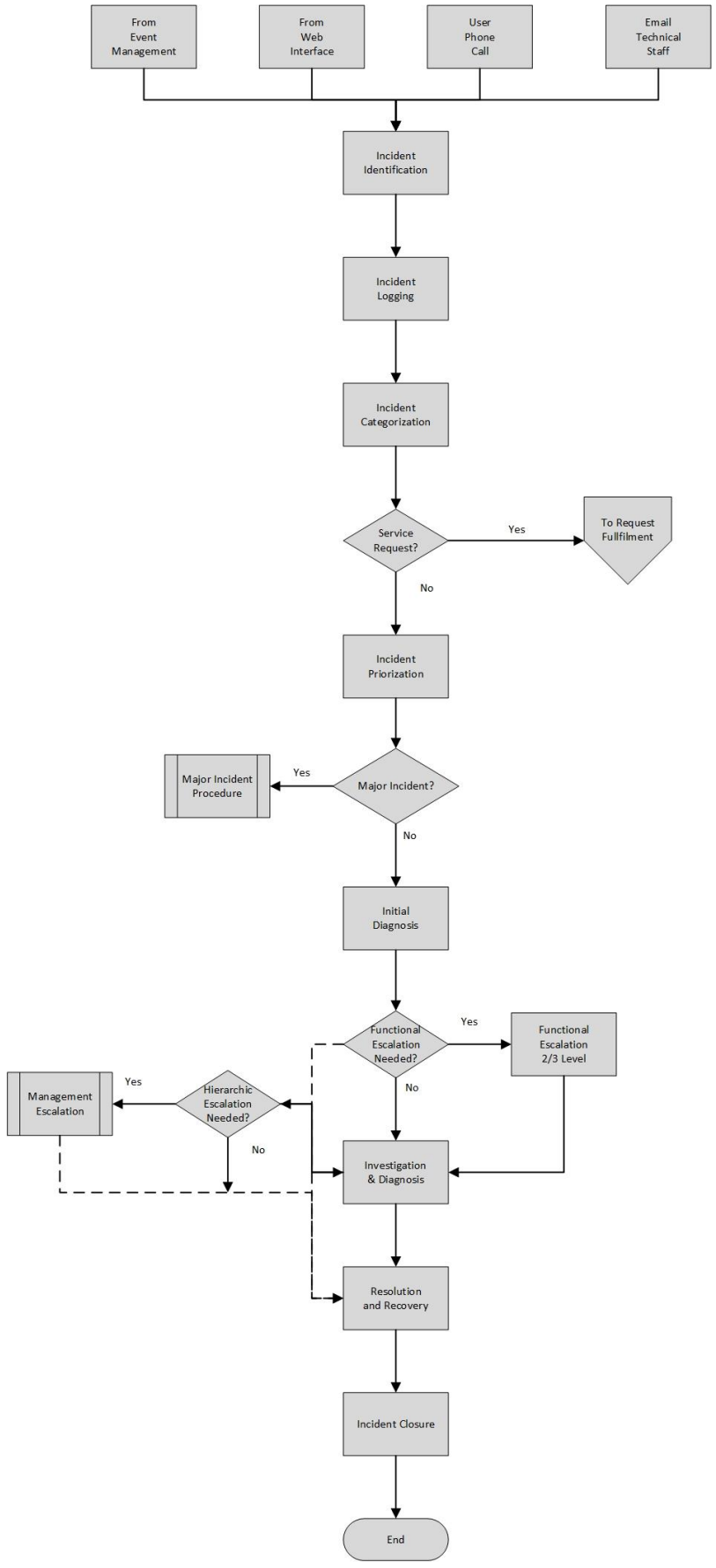

Figure 4 Incident Management process flow (Cannon, D. & Wheeldon, D. 2007, p. 48)

Problem management aims to find out the root-cause of the incident. So, the aim of problem management process is to eliminate the root of abnormal events and incidents, proactive activities to detect and prevent problems in the future is important, so the business is not affected by the incidents. Problem management is also responsible of keeping Known Error subprocess up to date to allow faster diagnosis and resolution if further incidents occur (Cannon, D. & Wheeldon, D. 2007).
Cannon & Wheeldon have defined problem:
“A cause of one or more Incidents. The cause is not usually known at the time a Problem Record is created, and the Problem Management Process is responsible for further investigation” (Cannon & Wheeldon, 2007, p.240).

Problem Management provides value to business by reducing the number of incidents, delivering higher availability of service/product/etc., reducing number of incident workaround by permanent solutions and reducing the costs for resolving repeating incidents (Cannon, D. & Wheeldon, D. 2007).

As we can see from figure 5 that there are multiple different sources to trigger Problem Management process. Problem Management can be triggered from Service Desk if they get a lot of calls, emails etc. with same topic. Event Management and Incident Management provide information about possible problems to the process. Problem managers should do proactive problem management by e.g. following statistics and trends to identify possible problems. Also, suppliers and contractors can point out possible problems.
Problem detection is the first step of problem management process and here problem managers decide it the problem proposal is accepted as a problem (moving on to problem logging phase) or rejected.

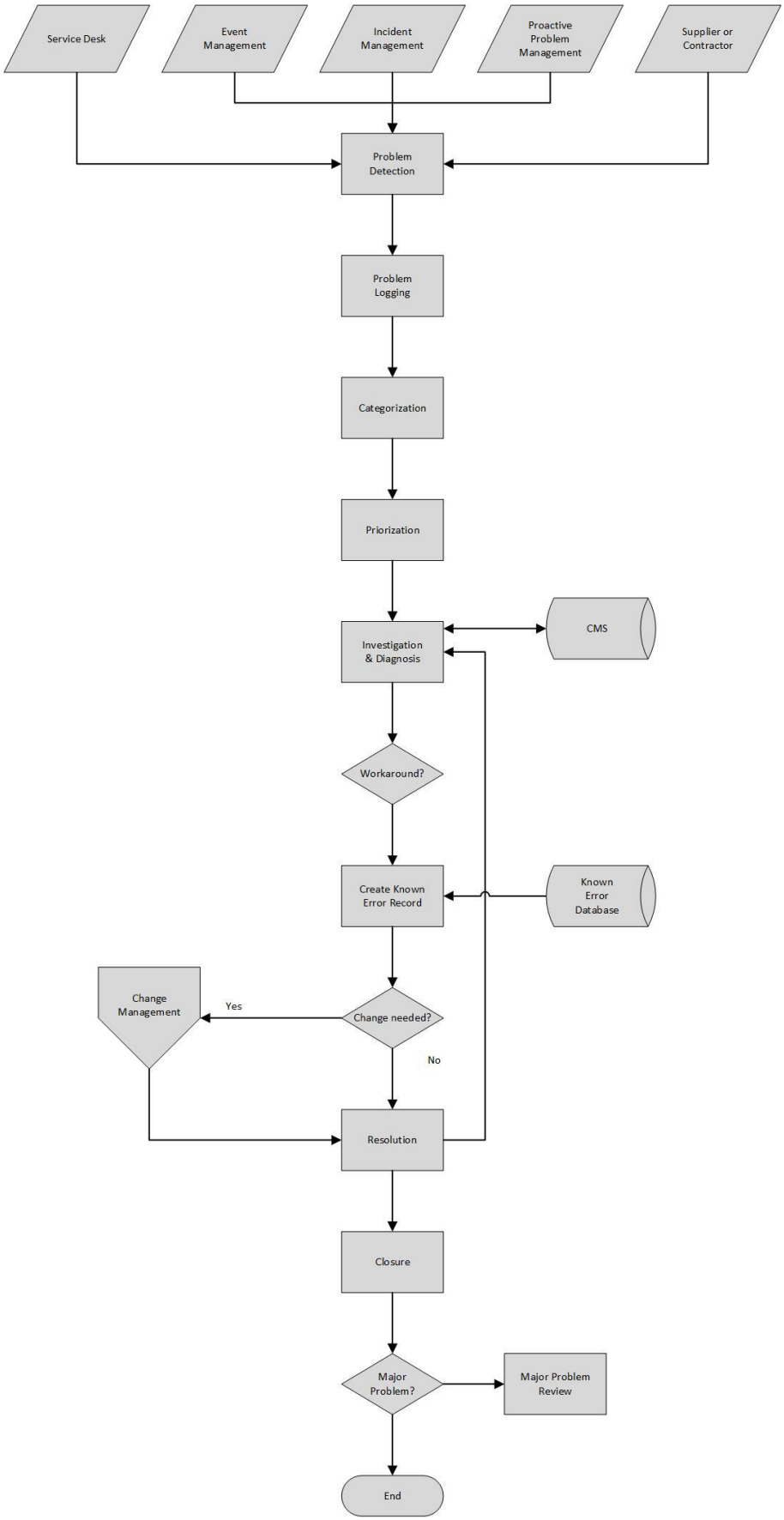

Figure 5 Problem Management process flow (Cannon, D. & Wheeldon, D. 2007, p.60)

4.1.1.3 Continual service improvement in ITIL framework

In this chapter I have focused on continual service improvement phases that are included in the ITIL framework.

4.1.1.3.1 Fundamentals of continual service improvement

The primary purpose of continual service improvement (CSI) is to continually align and re-align services to the changing business needs. This is done by identifying and implementing improvements to that specific service that is supporting the business process. The CSI activities are supporting the business though the whole service lifecycle from design phase to retirement. The aim of CSI activities is to find “ways to improve process effectiveness, efficiency as well as increase cost effectiveness.”
It is critical to businesses to implement ITSM processes, manage and support them by using clearly defined goals, objectives and measure the processes in a relevant way to generate actionable improvements.

Objects for CSI are:

1. To review, analyze and make recommendations on opportunities for improvement actions in all service lifecycle phases.
2. To review and analyze Service Level Achievement results.
3. To identify and implement individual activities to improve the quality of the service and improve the effectiveness of enabling ITSM processes.
4. To improve cost effectiveness of delivering services without at the cost of decreasing customer satisfaction.
5. To ensure that “applicable quality management methods are used to support“ continual service improvement activities. (Case, G. & Spalding, G., 2007).

4.1.1.3.2 Continual service improvement approach

As illustrated from figure 6 there is a constant cycle for improvement and CSI process can be summarized in seven steps:

1. **What is the vision:** Business values, missions, goals and objectives of the organization has to be defined and strategies aligned.

2. **Where are we now:** It is important to gather information, what is the starting point and the impact of the initiative. In this phase the baseline assessment is made for example to process, technology or service quality.
3. **Where do we want to be:** Target state is aligned, for example what is the availability rate we are aiming at or what are the service levels we are trying to reach.
4. **How do we get there:** Improvement plan is created, how do we get from the starting point to the point where we want to be.
5. **Take action:** Execute improvement actions regarding to the created improvement plan.
6. **Did we get there:** Evaluate metrics and KPIs. Measure the CSI project progress based on the initial target setting.
7. **How do we keep the momentum going:** Ensuring that the progress done so far is not lost and building the support and momentum for the next improvements. Also, from here the cycle is full and the CSI process starts again by reviewing the question what is the vision and the progress continues as it did on the first time.

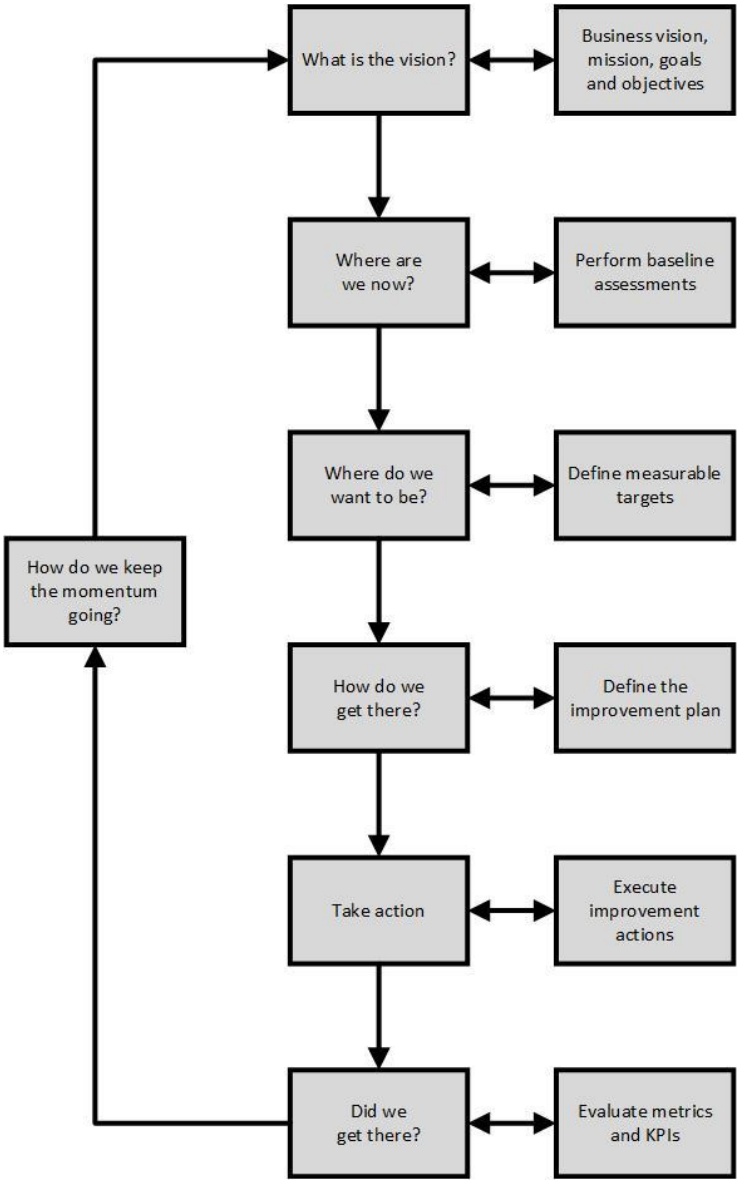

Figure 6 Continual Service Improvement model

4.1.1.3.3 The 7-Step Improvement Process

As stated in chapter 5.1.1.3.1. the concept of measurement is the fundamentals to CSI. CSI uses 7-step Improvement Process flow as shown in Figure 7. It is relatively easy to identify what takes place in the process, but it is more difficult to understand exactly how this happens. “The improvement process spans not only the management organization, but” it also spans to the entire service lifecycle. This is a cornerstone of continual service improvement (Case, G. & Spalding, G., 2007).

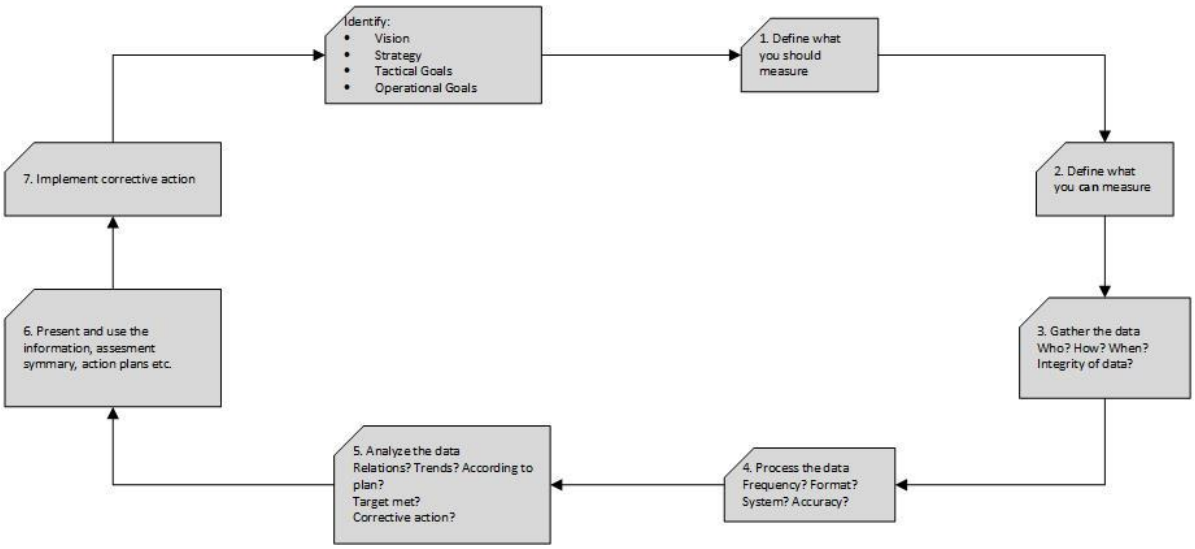

Figure 7 The 7-Step Improvement Process (Case, G. & Spalding, G., 2007, p. 32)

As Case & Spalding (2007) have defined the seven steps of improvement process are following:

1. *"Define what you should measure*
   At the onset of the service lifecycle, Service Strategy and Service Design should have identified this information. CSI can then start its ctcle all over again at "Where are we now?" This identifies the ideal situation for both the Business and IT.
2. *Define what you can measure*
   This activity related to the CSI activities of "Where do we want to be?" By identifying the new service level requirements of the business, the IT capabilities (identified through Service Design and implemented via Service Transition) and the available budgets, CSI can conduct a gap analysis to identify the opportunities for improvement as well as answering the question "How will we get there?"
3. *Gathering the data*
   In order to properly answer the "Did we get there" question, data must first be gathered (usually through Service Operations). Data is gathered based on goals and objectives identified. At this point the data is raw and no conclusions are drawn.
4. *Processing the data*
   Here the data is processed in alignment with the CSFs and KPIs specified. This means that timeframes are coordinated, unaligned data is rationalized and made

consistent, and gaps in data are identified. The simple goal of this step is to process data from multiple disparate sources into an ´apples to apples´ comparison. Once we have rationalized the data, we can then begin analysis.

5. *Analyzing the data*
   Here the data becomes information as it is analyzed to identify service gaps, trends and the impact on business. It is the analyzing step that is most often overlooked or forgotten in the rush to present data to management.
6. *Presenting and using the information*
   Here the answer to "Did we get there?" is formatted and communicated in whatever way necessary to present to the various stakeholders an accurate picture of the results of the improvement efforts. Knowledge is presented to the business in a form and manner that reflects their needs and assists them in deterring the next steps.
7. *Implementing corrective actions*
   The knowledge gained is used to optimize, improve and correct services. Managers identify issues and present solutions. The corrective actions that need to be taken to improve the service are communicated and explained to the organization. Following this step, the organization establishes a new baseline and the cycle begins anew" (*Case, G. & Spalding, G., 2007, p.31-32).*

4.1.1.3.4 Key roles & responsibilities in Continual Service Improvement

Case & Spalding (2007) defined the three key roles and responsibilities for Continual Service Improvement. Those roles are Service Manager, CSI Manager & Service Owner, each of those roles have their own important responsibilities.

"Service Manager manages development, implementation, evaluation and on-going management of new and existing products and services." Service manager is responsible to provide leadership to the development of business cases and product strategy and architecture, new service deployments and lifecycle management. Service manager is key role to develop programs to response new market opportunities, evaluate impact of new technologies and guide specialist in creation of innovative solutions for the products and services.

CSI Manager has the overall responsibility for the success of all improvement activities. CSI manager ensures that all needed CSI roles has been filled and prioritize the improvement projects. This role is responsible for all CSI activities within the organization.

“Service Owner is accountable for a specific service within the organization regardless of where technology, processes or professional capabilities are located.” Service owner is a critical role for service management function. The service owner is responsible for continual improvement and management of the changes affecting the service(s) under their care.

Conclusions

ITIL introduces us the processes of service operations, where usually the focus of the continual improvement is. It is important to understand the processes, so it is possible to improve the service chains and understand where to improve. Also, the ITIL framework includes the continual service improvement concept that is the key concept in this thesis. In this framework the important roles for successful continual service improvement are introduced.

4.1.2 LEAN

“Lean manufacturing is a generic process management philosophy” delivered mostly form Toyota Production System (TPS). Lean production was made familiar to the word from the book Machine that changed the word (1990). In that book MIT professors Womack, Jones and Roos described how Toyota managed to lower their production costs while increasing efficiency. Originally Lean was developed for manufacturing industry but the principles are very usable for service production as well (Liker, J. & Ross, K., 2017).

Lean focuses on removing the seven types of waste to increase the customer satisfaction, improve quality while lowering the costs and lead times in production. Lean aims to decrease the deviation that causes the waste. Waste has been described in chapter 5.1.2.1.

“A process that is Lean is delivering products or services that the customer wants, at a price that reflects only the value that the customer is willing to pay for.” So, to clarify what the customer wants and what are they willing to pay for (or not).

Lean process has to be fast; customers usually want things immediately. The process must be flexible because the customer wants things just the way they like them, flexible process can deliver products and services that are fitting to customer needs.
On the other hand, customers are not willing to pay for marketing the products before they are needed, recycling or fixing faulty products or services, delays or unclear communication, wasted energy during the provision of products and services (Brook, 2014).

In service production, the service excellence has to be defined. Whether its service production or manufacturing the first thing while defining service excellence is the customer. What are the customer expectations to our service? How satisfied the customer is? The customer expectation is the key and to deliver service excellence those expectations needs to be exceeded. Also, the definition of service excellence differs depending on the scale.
Mass goods distribution is for majority of the customer desire functionality, certain level of costs, reliability and convenience.
Standard experience is somewhat similar to the mass goods distribution with the touch of human interaction. Here we are talking about lower levels of costs for customers.
Personalized goods distribution is for customer who wants something special that average company cannot provide to them. Usually this experience level is for a service specific to the customers unique problem that they want to solve.
Personalized experience is for customers that wants to be wowed and feel like VIPs and are ready to pay for it (Liker, J. & Ross, K., 2017).

Brook (2014) has defined five laws of lean. Those laws encapsulate the Lean approach and provides key principles for improvements.

1. **The law of the market**: The first law defines who is the king, the answer is the customer. The customer is the only one who can define Critical to Quality characteristics (CtQ). CtQ should have the highest priority for defining the value and making improvements. All other things such as sustained market growth and returns on investments are reliant to the focus on the customer.
2. **The law of flexibility**: Tells that the speed and flexibility of the process are linked together. If the process is not flexible it will hinder the flow of a product or service and therefore the speed of delivery of it. Just to put this into manufacturing perspective, if the production line is not flexible the manufacturer will have

difficulties to change the manufactured products. This will lead into encouragement to run larger production batches and schedule each product more frequently; this will lead into increased work in progress and lead times of

3. **The law of focus**: This law points out the important thing that 80% of the delays in a process is caused by 20% of the activities. So to have a leaner process these are the time traps that should be focused on. Often these similar kinds of observations can be done via the Six Sigma methodology where 80% of the problems are caused by 20% or fewer of the key root causes.
4. **The law of velocity (Little's law)**: The more work in progress there is in the process, the longer its lead time is going to be. Little's law can be expressed as an equation, which enables the calculation the average lead time (the speed of a process) of a process by knowing how much work in progress there is and the production rate of the process.
5. **The law of complexity and cost**: Tells us that when there is more complexity in product or service, the more expensive it is to produce and deliver. So to avoid conflicts with the first law, many companies have found ways to provide mass customization to the products and services to avoid high cost.

4.1.2.1 Waste

Originally waste has been divided into three categories:

Waste has been described by TPS as activity that is not result the process closer to the final output or adding any value for the output of the process.

- **Muda –** non-value-add
- **Mura –** inconsistency; uneven flow
- **Muri –** overburdening; no value added beyond capability Kuhl, & Yankelevitch, 2015).

Wang (2010) has described TPS's seven different waste for the process as following:
1. "Overproduction— Overproduction is to manufacture an item before it is actually required. Overproduction is highly costly to a manufacturing plant because it prohibits the smooth flow of materials and actually degrades quality and productivity.

2. Excess inventory— Excess inventory tends to hide problems on the plant floor, which must be identified and resolved to improve operating performance. Excess inventory increases lead times, consumes productive floor space, delays the identification of problems, and inhibits communication.
3. Waiting— Whenever goods are not moving or being processed, the waste of waiting occurs. Much of a product's lead time is tied up in waiting for the next operation. Waiting is usually caused by poor design material flow and information flow. 4. Transportation— Transporting product between processes is a cost incursion that adds no value to the product. Excessive movement and handling cause damage and are an opportunity for quality to deteriorate.
5. Unnecessary motion— As compared to transporting materials, motion refers to the producer, worker, or equipment's movement, which could cause damage, fatigue, wear, and safety issues.
6. Over processing— Using more expensive resources than are needed for the task or adding design features that are not needed by customers. Expensive resources also encourage overproduction in order to recover the high cost of this equipment. 7. Defects— Quality defects impact to the business bottom line, resulting in rework or scrap and associated costs such as quarantining inventory, re-inspecting, rescheduling, capacity loss, and so forth" (Wang, 2010, p.1-2).

4.1.2.2 Continual improvement

In Lean the philosophy of Kaizen, "a Japanese word for continuous improvement and incremental change, is about involving everyone in the organization to focus on overall organizational improvements. As the main point in Lean is to remove waste to better respond to the needs of customer for on-time delivery, competitive cost and better quality. More importantly Kaizen emphasizes developing a process-oriented culture that is driven for improving the way the company operates" (Ortiz, 2009).
While the company removes waste, it becomes more productive, ensuring that it serves the customer needs. The end result of this is to gain financial gain to organization. However, this is not selling the philosophy of Kaizen to the people working in the organization, not only by promoting the cost savings. The way people think is not changed with reduced cost, better quality products and services and on-time delivery. The Kaizen philosophy "is about coaching and mentoring people to become better at what they do in all aspects of their work.

Kaizen teams are created to provide quick and positive impact on the organization. Each team member" based on her or his ability to provide both measurable and non-measurable improvements. Kaizen teaches people concepts of teamwork, meeting the deadlines, interacting with different kind of people and to pursue for excellence. As a non-measurable benefit that is gained from Kaizen philosophy is that it allows the organization to develop a culture of continual improvement. The other half of Kaizen is more measurable, teams are making the improvements to key metrics that are not only beneficial from organization perspective but ultimately improve the relationship with customers with benefits of cost efficiency, on-time delivery and improved product and service quality (Ortiz, 2009).

The continual improvement process in Kaizen is based on plan, do, check, act (PDCA) model. As seen from figure 8, improvement process is continual and follows the same order in every cycle.

Plan: Share the objectives though common format and process and share the vision and plan annually for the improvements.

Do: Develop and custom the standards for operations.

Check: Evaluate the operations from qualitative and quantitative point of view.

Act: Share the knowledge and know-how throughout the organization and further develop methods (Liker & Ross, 2017).

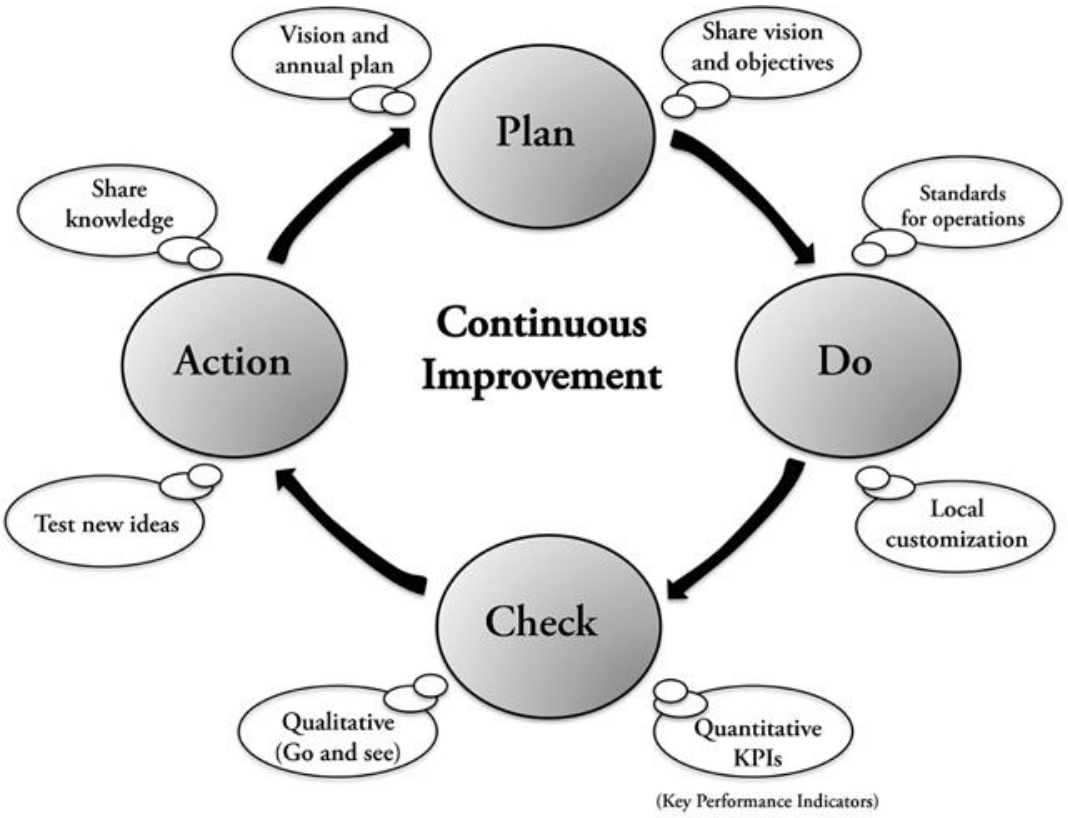

Figure 8 Plan, Do, Check, Act -model (Liker & Ross, 2017)

To summarize Kaizen philosophy, half of Kaizen is about changing the organizations mindset, coaching and mentoring the people to become better at what they do instead of using money to buy better hardware or software. The other half is about measurable targets that the teams are working towards.

Conclusions

Even thou Lean is originally focused on manufacturing industry, there are many things that can and should be taken into account in service production as well. Lean should be applied to processes to ensure that they operate efficiently and minimizing the waste in the process. Overall the key points of the Lean for service production environment are; minimize and remove the waste, the five laws of lean and the philosophy of Kaizen.

4.1.3 Six Sigma methodology

Six Sigma is a way to manage a department or a business in a smarter way. The focus is put to the customer and decisions are based on facts and data to drive better solutions. Sig Sigma efforts are targeted into three main areas:

1) Improve customer satisfaction
2) Reduce cycle time
3) Reduce deflects

While improvements are done in these areas, usually dramatic cost savings to business are seen, as well as opportunities to retain customers, take over new markets and to build reputation for top-performing products and services.

The Six Sigma involves measuring and analyzing an organization's business processes, it is "not merely a quality initiative; it is a business initiative" Pande & Holpp, 2001. When achieving goals of Six Sigma requires more than small, incremental improvements. To achieve Six Sigma goals, it requires breakthrough in all aspects of operation.

Statistically process reaching the Six Sigma means that the process or a product has nearly no deflects at all (Pande, P. & Holpp L., 2001).

Brook (2014) gives Six Sigma very practical definition: data driven problem solving. Brook also demonstrates this as explained in this chapter.

Data driven approaches in Six Sigma philosophy as Brook has defined them:

Statistical techniques: Six Sigma is applying the power of statistics in a practical way, enabling users to assess the relevance of statistical results and the risk that is involved with the decisions they are about to make.

Data quality: Despite the fact that there is more and more data available, the quality of the data is still often a key issue in data. Six Sigma is focusing on the quality of the data collection, especially to ensure that the process measures are meaningful, accurate and precise.

Graphical techniques: In Six Sigma the importance of the basic graphical tools such as histograms and run charts have been put to center in the analysis of the process performance.

Data clarity: Measurement phase of Six Sigma is ensuring that clear set of measurements are in place to measure the process performance. This has to be done before the analysis of the problem itself is started.

Data driven at every phase: Six Sigma is providing data driven approach to all phases of the problem-solving process.

Brook has split problem solving into five sections that are:

A problem-solving structure: Six Sigma is providing a structured approach to solve problems. The approach has five phases: Define, Measure, Analyze, Improve, Control (DMAIC).

Generic approach: DMAIC approach is a generic approach and is applicable to every environment. Tools used are different in different industries but the DMAIC phases are always valid.

A simple approach: DMAIC approach in problem solving flow is effective because it is simple and clear, each phase has clear objectives, actions and outcomes.

A rigorous approach: Using DMAIC flow requires discipline. Each of the steps has to be completed in order to ensure the project success in finding and controlling the root cause of the problem permanently.

Problem focused: In DMAIC approach the focus in on the problems not solutions. This meaning that projects that have pre-decided solutions are not suitable for DMAIC approach.

Conclusions

Six Sigma methodology introduces the statistical approach to problems, aiming to improve customer satisfaction (as all introduces frameworks as well), reduce cycle time and reduce the amount of deflects by statistical means. Also, the Six Sigma methodology introduces the very important way of working and the structure of DMAIC.

4.1.4 Lean Six Sigma

Lean Six Sigma for services is a business improvement methodology that aims to maximize the “value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed and invested capital” George, 2002. This fusion of Lean methodology and Six Sigma is needed for services because:

1. Lean is not capable to bring the process under statistical control
2. Six Sigma as it is cannot greatly improve the process speed or lower the invested capital
3. Both of these methodologies enable the reduction of cost of complexity (George, 2003).

As we can see from the figure 10 that lower cost levels are achievable with Lean Six Sigma methodology than either of those methodologies by themselves.

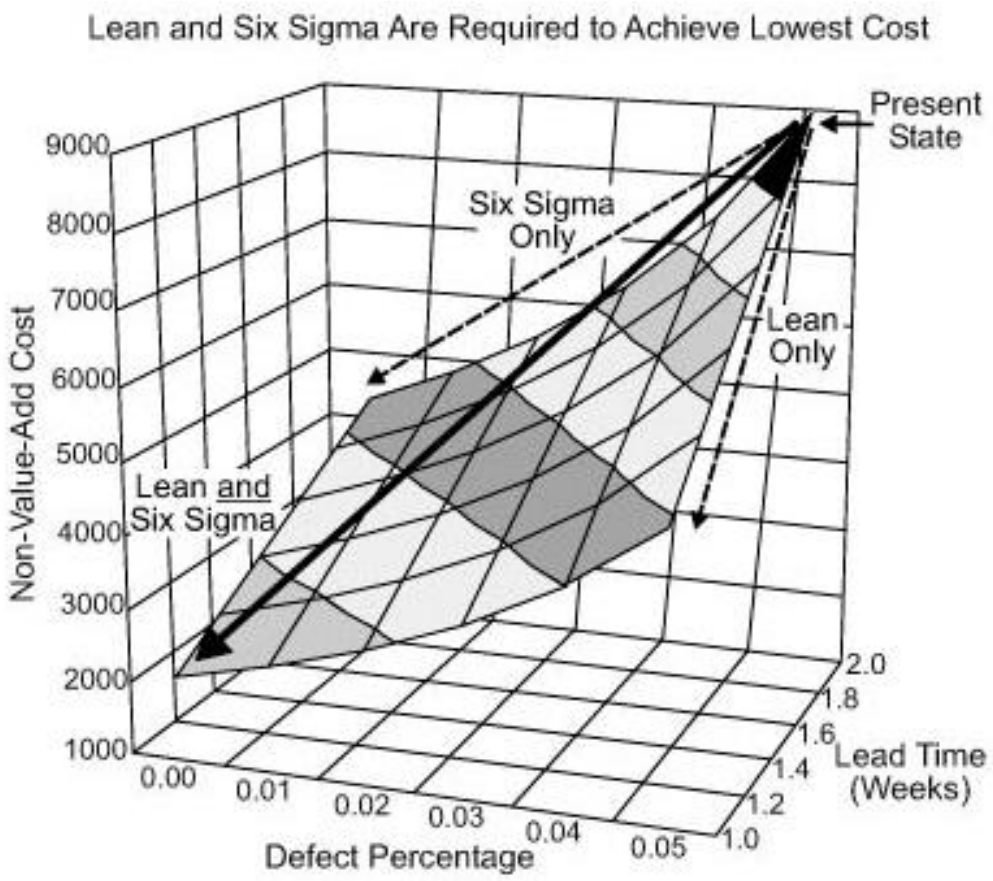

Figure 9 Lean + Six Sigma = Lowest cost (George, 2003).

George (2003) defines three “reasons why service functions need to apply Lean Six Sigma:”

1. The service processes are typically slow, expensive processes. When the process is slow, the costs are higher and ultimately it drives the customer satisfaction down and lead to revenue losses. The slow process leads to the situation where half of the costs in service applications are non-value-added waste.
2. Unnecessary complexity in the service/product offering leads to too much work-in-progress stages. It doesn’t matter if the work-in-progress is waiting on a service desk, emails etc. Of all that time almost 90% of the time is waiting, so that is a waste as described in chapter 5.1.2.2.
3. In any slow process almost 80% of the delays are caused by less than 20% of the activities. Typically, only those 20% of the activities needs to be improved to improve 80% of the overall process efficiency.

As the name Lean Six Sigma refers there is six different levels of processes with competition accuracy as seen from figure 10. The higher the sigma level the less deflects are

allowed to happen in the process. In level 6 sigma process there is only 3,4 deflects allowed in million opportunities. Often level three or four sigma process is good enough for the customers. So usually in service production sigma level four is for the core services and reaching for higher sigma level is not making sense due to costs are rising and customers are not willing to pay for the investments. There aren't many industries that operate in sigma level 6 accuracy, possibly the only industry is aviation.

Table 2 Sigma levels

Sigma Level	Deflects per million opportunities	Yeild
6	3,4	99,9997%
5	233	99,977%
4	6210	99,379%
3	66 807	93,32%
2	308 537	69,2%
1	690 000	31%

4.1.4.1 Lean Six Sigma tools

George (2002) have listed multiple tools for the DMAIC phases. Here I have presented most suitable tools for each phase for IT service projects and for service production.
To start with, it is logical to begin with tools for **Define** and work our way towards **Control** phase.
In define phase **project definitions** are made so definition form is a mandatory tool to have in place and in use. The definition form includes key information about the "project, such as problem statement, scope, assumption, resources of the project" and schedules.
SIPOC diagram (figure 10) is very close to the core of Lean Six Sigma that is that deflects can relate to anything that makes the paying customer unhappy – long lead times, variation in lead time, quality issues or high cost etc. So, to clarify end-to-end process, SIPOC tool is very valid to create high level map of the process. SIPOC stands for:

- **S**upplier: The person/process/company that is providing whatever is worked on the process (material, software, hardware, etc.). The supplier can be either outside vendor or some different unit/division within the company.
- **I**nput: The material or information provided.
- **P**rocess: The process worked with (internal), including the steps that add value and the steps that do not add value).
- **O**utput: The product or service produced to the customer.
- **C**ustomer: The last step in the process or the final customer.

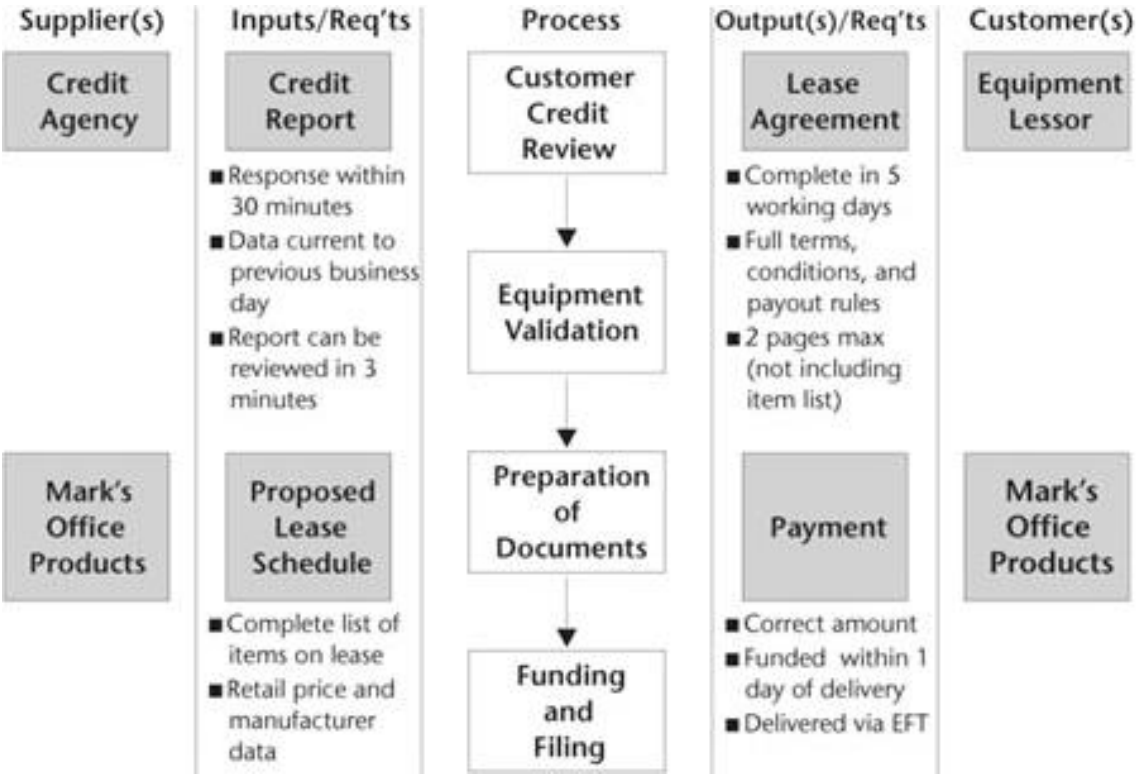

Figure 10 SIPOC process diagram (George, 2002)

"Measure phase of DMAIC is symbolic of a critical shift" of project to deliver the results as desired goals. In this phase project team can't "go from thought to action, they have to go from thought to data to action. Data" can be in all kinds of forms, shapes and sizes, with corresponding tools it can be used to collect, display and analyze it. George (2002) has spitted the tools into five types that are most commonly used in Measure phase:

A. Describing a process and its characteristics
- Process mapping
- Lead time / cycle efficiency

B. Focusing and prioritizing
- Pareto charts
- Cause-and-effect matrix
- Failure modes and effects analysis (FMEA)

C. Generic and organizing ideas
- Brainstorming
- Nominal group technique
- Multivoting
- Ishikawa diagram (fishbone)

D. Collecting data and ensuring accuracy
- Checksheets

E. Understanding and eliminating variation

- Run chats / control charts
- Process capability

George (2002) has described in more detail the tools for each type. Process characteristics tools, such as "**process mapping** is the foundation of Lean Six Sigma and virtually all modern improvement methods. Process maps are similar to SIPOC in a way that they show process steps, inputs and outputs." But process maps are different in being more detail and more localized. The importance of process map cannot be overlooked to any improvement effort, it is simply too difficult to work on a process without having the whole picture of the process. In non-manufacturing environments a process map generally doesn't exist, so the opportunities to improve speed, reduce cost and increase value are all much bigger.

Process map is clearly illustrating the steps done in the process, inputs that are necessary to proceed to next step and the outputs of each process step. Usually it is very useful to indicate critical measurements, interaction points, options, times and other key aspects of the process map.

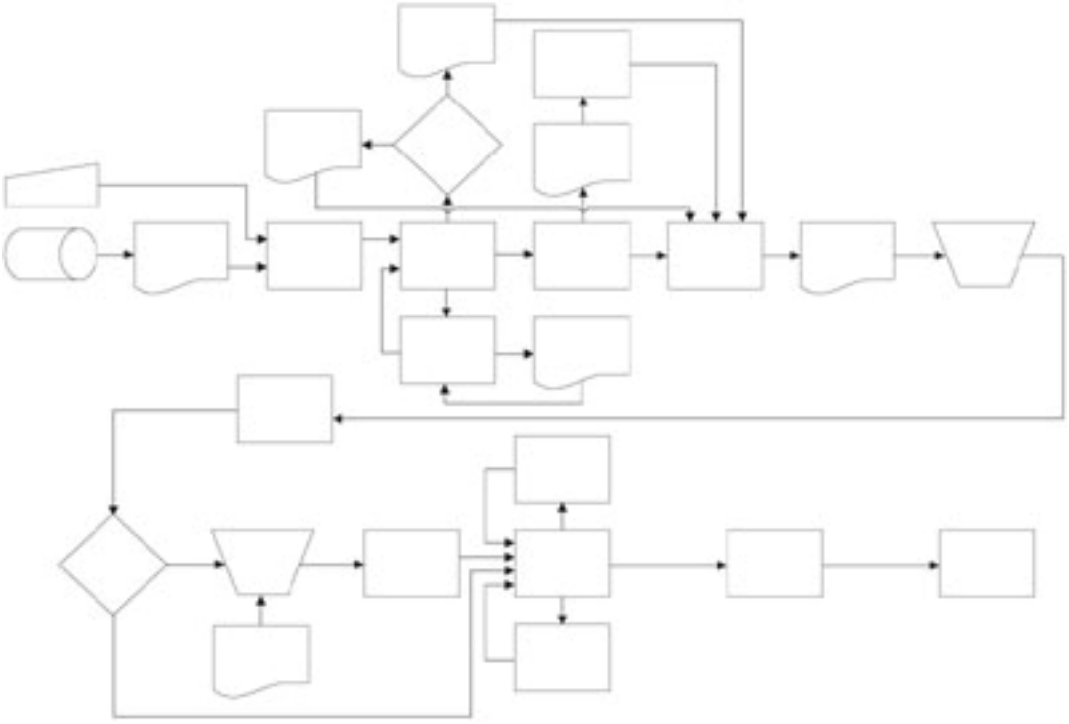

Figure 11 Process map (George, 2002)

"Process lead time and cycle efficiency. Some projects may be defined to directly" impact process cycle time, lead time or other speed related issues. Measuring total lead time of process might take a long time (some processes cycle time is multiple weeks).

Instead of measuring the full process lead time, you can get relatively accurate estimates of lead time by comparing “work in process (WIP) with the number of completions per day.”

$$Lead\ time = \frac{\text{WIP}}{\text{Completions}}$$

When the project team want to calculate cycle efficiency, some calculations may have been already may have been already been done as part of value stream mapping. But if the calculation were never done or if only preliminary data has been used the project team should have the next steps as following:

- “Confirm that the value stream map includes all non-value-added steps. These non-value-added steps will provide the foundation of estimating what cost can be driven out of a process” Georges, 2002..
- “Estimate the value-added time and WIP at each step in the process.”

When the project team has agreed how the process depicted and how the time is being allocated between the value-added steps/time and non-value-added steps/time, the cycle efficiency can be calculated.

$$Process\ cycle\ efficiency = \frac{\text{Value} - \text{added time}}{\text{Total lead time}}$$

“Measuring the process cycle efficiency is a way to benchmark the process performance against world-class standards.” As the process with 25% or more of the total lead time in process is value-added time is a Lean process. By knowing the process cycle efficiency lets you to judge how much improvement is possible to do and is it needed with reasonable costs.

As **focus and prioritization tools** are often simple and their purpose in DMAIC process is to narrow down from multiple options to the once that contribute most to key customer issues.

“Pareto chart is a simply a bar chart in which each bar” is representing the relative contribution of each cause of the total problem, the bars are arranged in descending order of importance as seen from figure 12. Pareto charts are extremely simple to constructive and interpret, so this tool is useful for almost all improvement projects.

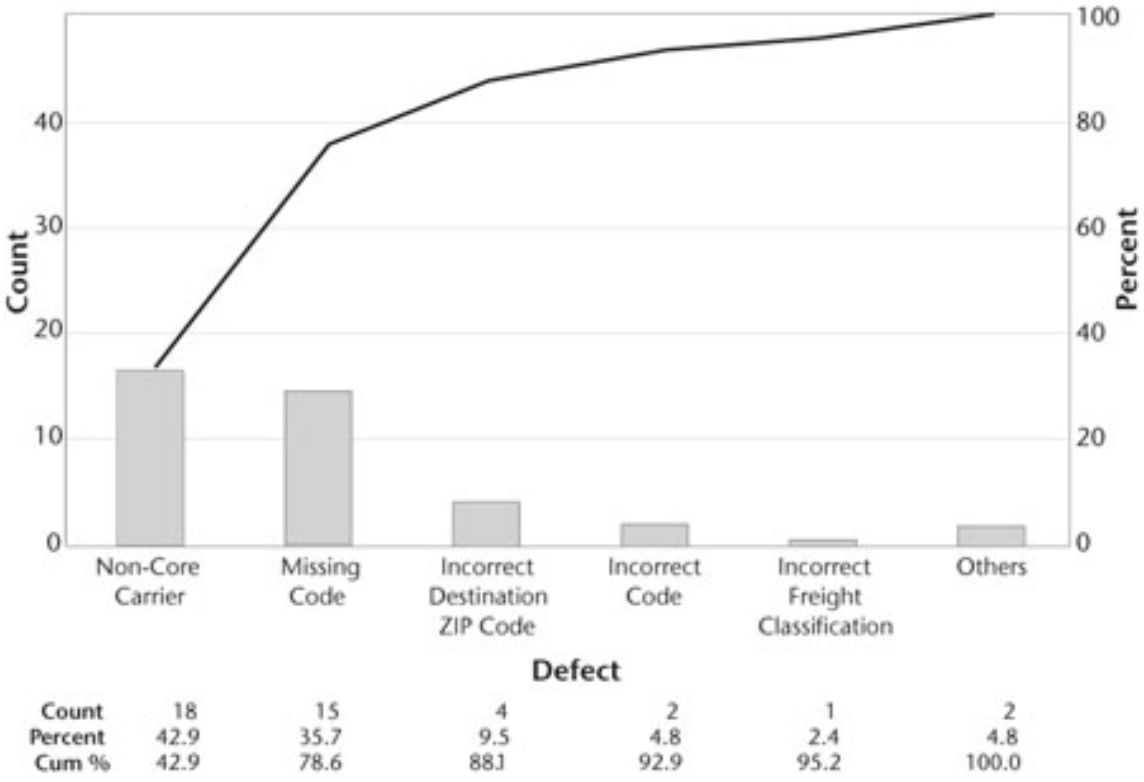

Figure 12 Pareto chart (George, 2002)

Cause-and-effect matrix is a very effective method to capture the voice of customer and relating the process input variables in the matrix as seen in figure 13. This matrix helps to filter out less important steps and inputs, so the focus can be set to the most important parts of the process.

When creating a cause-and-effect matrix, customer-related outputs are set in the top of the grid with rating 1-10 in terms of how important it is for the customer. To the left side of the matrix includes process inputs as a list, these process steps/inputs often comes form process mapping. Each process step/input rated based on the relationship with customer output, using scale 0,1,3 or 9. 0 means that the input has no correlation and 9 means heavy correlation with the output. At the end the process correlation is multiplied with the customer weighting and scores are added across the row to get the total score for each process input.

Example: Truck Stop

Process Step	Process Input	Temp of Coffee 8	Taste 10	Strength 6	Process Outputs Importance Total
		Correlation of Input to Output			
Clean Carafe		0	3	1	36
Fill Carafe with Water		0	9	9	144
Pour Water in Maker		0	1	1	16
Place Filter in Maker		0	3	1	36
Put Coffee in Filter		0	9	9	144
Turn Maker On		3	1	0	34
Select Temperature Setting		9	3	3	120
Receive Coffee Order		0	0	1	6
Pour Coffee into Cup		3	1	3	52

Process Step Correlation Scores

A higher number indicates stronger correlation

Figure 13 Cause-and-effect matrix (George, 2002)

Failure modes and effect analysis (FMEA) is like many others previously gone through in this chapter is for the focusing on right things. FMEA is used to prioritize risks on the project and to document recommended actions for the risks. “Each type of risk (failure) for the product or process is assessed relative to three criteria on a scale of 1 to 10:

- The likelihood that something will go wrong (1 = not likely” and 10 = almost certain).
- The detectability of failure (1= likely to detect and 10= very unlikely to detect).
- The severity of failure (1= little impact and 10= extreme impact).

These three scores for each potential failure are multiplied together to get combined rating (Risk Priority Number), RPN), with the highest RPN should be focused first.

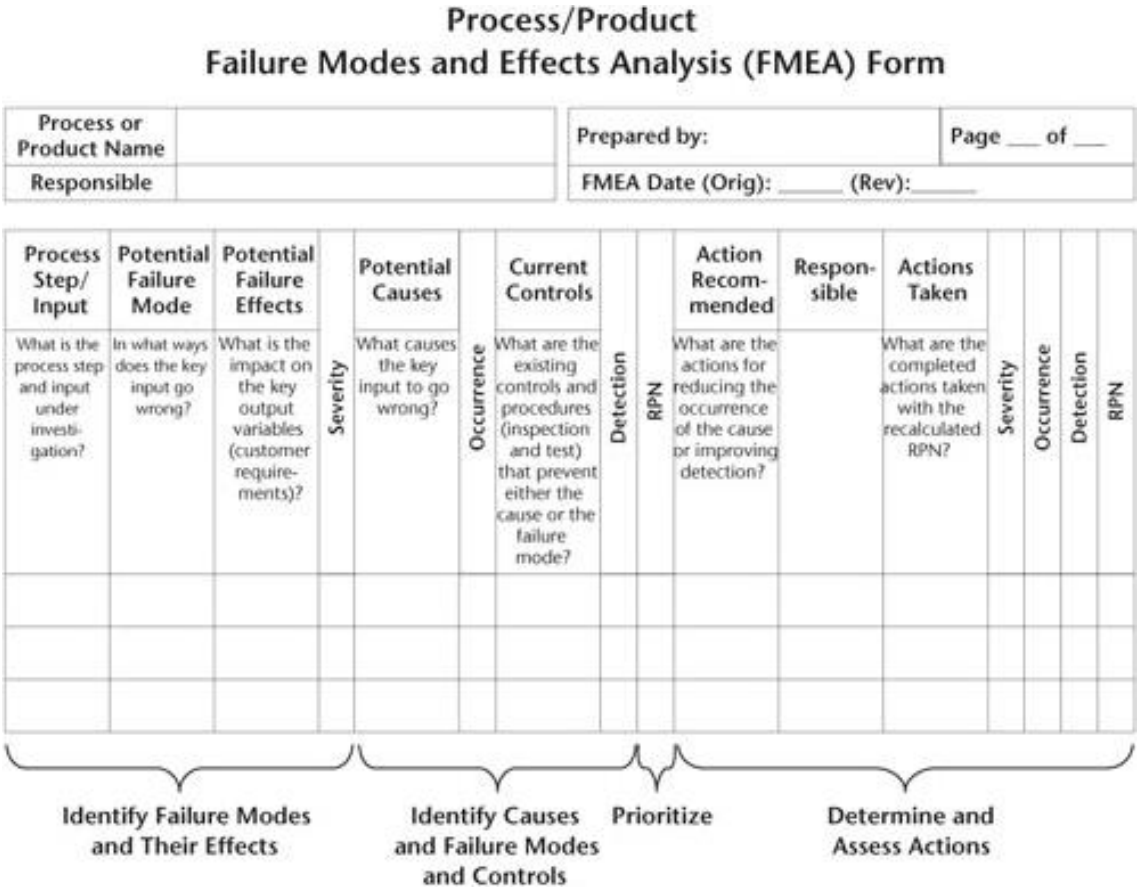

Figure 14 Failure-modes and effects analysis from (George, 2002)

Idea-generating and organizing tools. From Measure stage and onwards the project team needs high-level of involvement from all team members, so idea-generating and organizing tools are needed. **Brainstorming** techniques are used to get ideas from each team member, the way to have effective brainstorming is to record all the ideas.

Idea-selecting tools, there are some very common and simple prisonization tools that are used in conjunction with brainstorming. **Nominal group technique (NGT)** is one way to add quantitative element to decision making that often comes after brainstorming. NGT is often used when teams have contentious members or controversial issues, to uncouple ideas from the team members personalities. So, with NGT the idea gets evaluated on its merits and not according to the person who suggested it.

Multivoting is closing in on a conclusion the list result of brainstorming or from NGT. With multivoting the possible sources of problem have been narrowed down to manageable level (5-10) and each of the team member gets one third votes to cast of the total number of items on the list. Votes are collected and then put to pareto chart.

Idea-organizing tool. Cause-and-effect and **Ishikawa** (fishbone) **diagrams** special ida-organizing tools that are helping teams to identify potential causes of deflects or problems the team need to investigate, see figure 15. Typically using Ishikawa diagram

teams point out different factors that might be causing the problem. It is important to know that Cause-and-effect diagrams are just structured brainstorming tools, not the data. So as George (2002) points out even though something is listed in C&E diagram, it doesn't mean that it is actually the cause of problem. The team assigned to the project still needs to collect the data to verify the which of these potential causes are actual contributor to the problem.

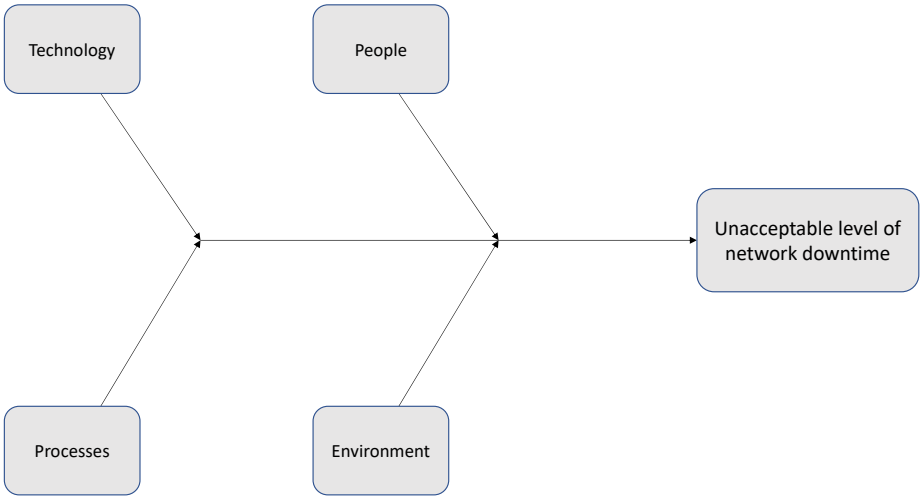

Figure 15 Ishikawa diagram

Data collection/accuracy tools. When collecting data, there should be standard procedures "for measuring and logging the data. There are many tools for establishing" a common data-collection procedure and to ensure the data collection is reliable indicator of what is going on in the process. George (2002) has highlighted one common tool for this data collection and data accuracy that is **Checksheets**

While doing Measure phase a major activity is to gather lots of data. A very simple data recording method is checksheets (see figure 16) that can detect trends and allow questions to be posed to the team. Checksheets are typically needed and used in projects early on when all the key data is not available.

Employee Benefit Issue Tracking – June

	Week				
Defect	1	2	3	4	Total
Incorrect SSN	I		I	I	3
Incorrect Address		I			1
Incorrect Work History	I			I	2
Incorrect Salary History	II	I	III	II	8

Figure 16 Data collection checksheet (George, 2002)

Understanding and eliminating variation is one of the key factors in Lean Six Sigma, where variation is evil. George (2002) has defined negative factors caused by variation as following:

- Variation in product quality is leading to scrap and rework, that are significant contributors to cost levels, total lead time and a product/service that is not meeting the customer expectations.
- Variation in time, leads to any time related deflects; arrival time, time of processing "etc. contributes to congestion and other delays that" are preventing the process to operate at the optimal speed.

So to reduce variation. the first thing is to identify it and then understand what is causing the variation. Two of the most common tools to understand variation are regarding to George:

- "Graphic tools used to plot data over time to expose patterns of huge variation."
- Statistical analytics tools that can help to point out important differences in variation.

Run charts are tools that simply displays observed data in the order that it is collected. Run charts are very simple tools to plot data in time order as seen in figure 17. Run charts are useful to display the "general range of variation in points" and to display "whether the data points are stable around some mean or is there clear trends" (upwards or downwards).

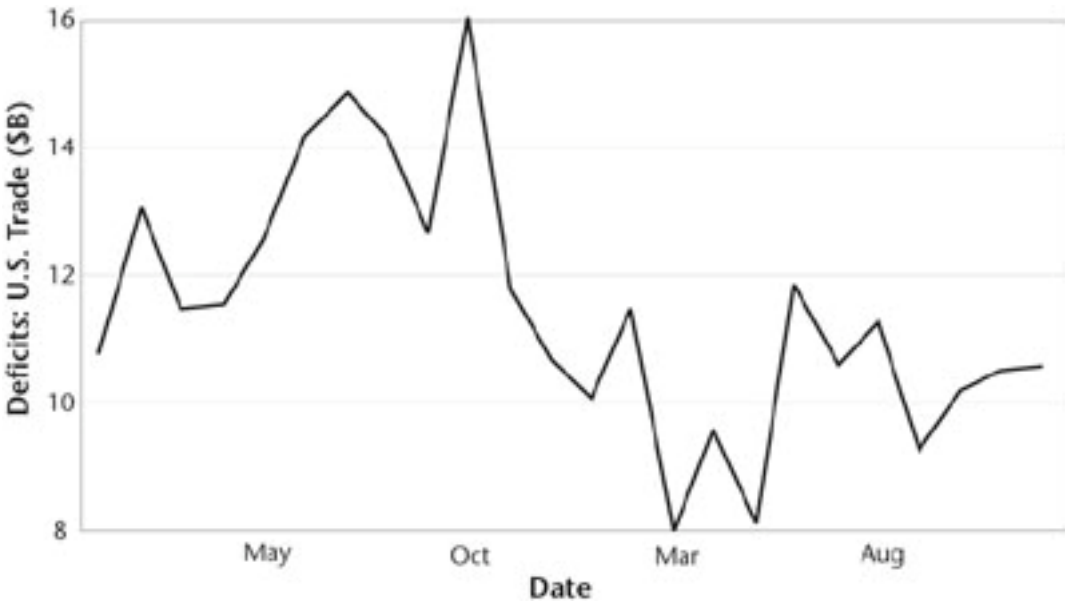

Figure 17 Run chart (George, 2002)

Typically, “detailed statistical analysis and interpretation are done with **control charts”** that are more powerful version of run charts. Control charts purpose is to help project team “to determine is the variation seen in the data normal part of the process” (common) or something special variation. There are several simple statistical rules that are used to analyze the patterns in the data and also the trends on the chart to determine is the variation common variation or special variation.

As seen from the figure 18, that the data points are plotted in time order, the centerline is indicating the average value and upper (UCL) & lower (LCL) control limits that are indicating the expected amount of variation in the process.

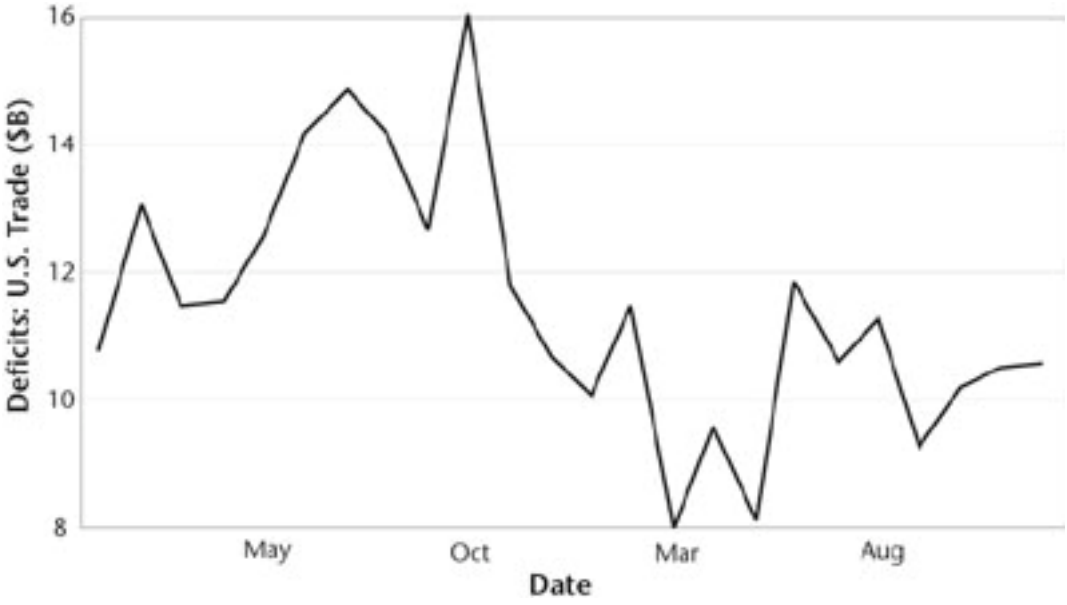

Figure 18 Control chart (George, 2002)

"Process capability analysis tells you how well the process variation is fitting to the range of customer specifications. A capable process is one, where all natural variation is fitting to the customer-defined range and in Six Sigma capable process, the natural variation is only half of the target range" (Georges, 2002). One thing to remember related to process capability analysis is that it can only be run after the process has been verified as stable (no special variation).

George (2002) defines that there are two types of tools used in **analyze** phase of DMAIC process: "**causal analysis tools** to confirm which potential causes actually" are contributing to the problem the team is trying to solve, and "**time trap analysis tools** to locate the biggest sources of delay in the process" (more suitable for manufacturing processes so not covered in this Thesis).

Scatter plot is a simple tool to help determining if there is a relationship between two sets of data. Scatter plots are providing visual image about whether the potential input variables are or are not related to targeted process outcomes, as seen in figure 19.

Figure 19 Scatter plot (George, 2002)

Applying Lean Six Sigma for services is all about getting results really fast. Lean Six Sigma applies Lean principles of speed and immediate actions to the Six Sigma's improvement process.

Improvement tools are incredibly diverse, and they fall into two main categories:

1. "Simple data collection/ analysis tools that are used to confirm improvements.

2. Specialized tools that are targeted at specific types of process problems."

Simple data collection tools are already covered in this chapter under Measure and Analyze phases. Knowing which tool should be used in all the given situations will only come with experience. George (2002) has listed five most commonly used improve tools for process and product improvements:

1. **Mistake proofing** is very applicable to any process. At the very basic level mistake proofing involves for example installation of an independent optical gauging system that is automatically measuring each part after machining and moves rejects to a bin. By doing this there is a possibility to prevent assembly related problems in manufacturing process. Mistake proofing is reflecting one key mindset of Lean Six Sigma: one important thing is to stop the deflects reaching the customer, but it is even more important to prevent those deflects ever to happen.
2. **Kaizen** has been described in more detail in chapter 4.1.2.2.
3. **"Queuing methods for reducing congestion and delay due to time variation."** Congestion is usually the biggest single source of delay and it often occurs because of the variation in timing. Earlier Identifying earlier where the congestion occurs, the better. When it has been identified there are three prime techniques to reduce congestion:
    - **Pooling**: Means having the needed capabilities in the process so, that employees can step in as needed provided an alternate path to ease the congestion.
    - **Triaging** is one way to reduce time variation where jobs are sorted "into three categories: easy and small problems, real problems and catastrophic" problems. For each of the categories different routings, strategies or resources are developed. By triaging the result is typically 15% to 20% reduction to overall wait time.
    - **Backup capacity** is a way to deal with sustained peaks, so to have cross-trained operators who can work on multiple parts of the process. So, juggling with scheduled downtimes (lunch, coffee break etc.) can be handled to increase capacity. This fits to manufacturing and it is not relevant for the topic of this Thesis.
    - **The four-step rapid setup method** is used for manufacturing industries, so it isn't relevant for this Thesis.
4. **Design of experiments (DOE)** can be used to understand which inputs affects the average and standard deviation.

Control tools have a simple purpose: to maintain any gains in the process performance. Typically, per George (2002) it is done with **statistical process control (SPC)** that has three main components:

1. Creating control charts, control charts have been described in detail previously in this chapter.
2. Isolating and removing assignable causes of variation. By using control charts the gained knowledge of control limits, special occurrences can (special deviation) can be spotted and identified. With other tools used in DMAIC process the source for the special deviation can be isolated or removed.
3. Instituting procedures for immediate detection and correction of future deflects. By this stage the process should be in control and the outputs are meeting the customer expectations. But even if the process is performing well today, it doesn't mean that something would not happen tomorrow. So, the last part of SPC is to make sure that immediate action is taken in case of process is not performing on the level that it should, or new special variation appears. These actions should take into account three things:
    1. Train the operators to use control charts.
    2. Provide clear instructions about how to respond if special causes of variation appear. The instructions should include both damage control and remedial actions.
    3. Provide clear instructions about when and how to update the process documentation including new corrective actions for new special variation cases.

Conclusions

Lean Six Sigma introduces the tools needed in the improvement projects and the tools for each of the steps along the process. Lean Six Sigma is a great way to handle improvement projects and whenever possible should be used as a framework for such projects as continual service improvement project. It fits greatly into the ITIL framework of continual service improvement and brings the statistical elements for delivering the promised improvements.

4.1.5 Summary of the existing knowledge

Looking at the theoretical framework totally from the service production point of view, it has a clear structure where all parts play different role and are equally important. ITIL framework brings to the table the framework and processes that are mandatory for fast phased service production and improvement in that environment. While Lean came first for manufacturing industries, the methodologies are very suitable for service production environment as well. Lean Six Sigma provides the tools and methodologies for continual improvement.

Different frameworks and methodologies have overlaps with each other, but they all provide important different things to the big picture where each of the strengths from different framework can be utilized and fully taken into use to provide the most suitable solution to improve business and improve the services for the customers.

Despite the fact that ITIL is a framework for IT service management and Lean is originally developed to manufacturing industry, they both deliver important insights for managing service production and how the product and service is produced to the paying customer. Both frameworks have things that are useful for improving the services and to improve cost efficiency while doing so.

Lean Six Sigma supports the other frameworks with the DMAIC approach and by delivering the tools to run improvement projects through with.

While there are many frameworks for service improvement and each of them have their own pros and cons Finding the best fit for the company in the given purpose might be difficult and therefore finding key points from each framework that fits is important. Combining the pros from each framework to give the best possible result and keeping the processes agile are the keys to success.

5 Proposal for guideline

This chapter includes the outcome of the Thesis based on frameworks introduced in chapter 4.

To create a valid guideline for company to implement and run continual service improvement projects, it is critical to understand the structure of the company and the processes how the services are handled in the company. That is classified information and out of scope from this Thesis.

The guideline has been spitted into 5 different sections based on the nature of the sections (e.g. roles, tools etc.). The sections have been introduced in the order they should be in place for continual improvement.

1 Roles

The roles as described in chapter 4.1.1.3.4 are the first thing that has to be in place to be able to have effective continual service improvement in the company. Roles ensure that the responsibilities and accountabilities are appointed for the results.

The company has to appoint CSI manager to have the overall responsibility for the success of all improvement activities that are taken place in service production environment. He/she is responsible to appoint all the roles that are needed (service owners & service managers). Also, the CSI manager has the final word to say when prioritization is needed for different improvement projects (e.g. same resources are needed for multiple projects, financial pressure, etc.) or whether or not to run the project at all. This role doesn't have to be full time job and can be run along with other responsibilities. CSI manager role should be handled by a senior manager or director to be able to handle the possible costs of the improvement projects and those effects to the budget.

The next role that is critical to have in place is service owners. As they are responsible for the continual improvement and the management of the changes affecting the service(s) under their care and are accountable for a specific service(s) within the organization. The service owner identifies and initiates the improvement projects and is leading the projects, reporting to the CSI manager about the progress of the projects.

Service manager is the last one of the three CSI roles that should be in place in the organization. As the service manager(s) is/are working closer to the expert teams in technical point of view than service owner(s), the role should be filled with person that is able to coach service owners with expertise for specified product/service. Service manager(s) can be appointed to run the improvement project(s) as well.

2 Lean mentality

As Lean has been described in chapter 4.1.2, there are some key points to be taken into account when it comes to the guideline. All appointed persons for the roles should have a Lean mentality and be always looking to find ways to remove waste from the processes related service(s) under their care.
Implementing Lean mentality is something that doesn't happen over a night and is more of an organizational change, role of the key persons is important to create the lean culture to the organization.

3 Planning improvement projects

When service owners and service managers are planning improvement projects, they should have constant dialogue with employees who are their counter parts for the product / service (product manager / business manager). It is important to remember while having the discussion with business representatives that business perspective for im-

provement model follows the same structure than CSI model but has a bit different measurement points for each step, see figure 6 vs. figure 20. It is important to understand the differences when having the discussion about improvement initiatives.

The most important thing when any projects are planned is that the decision making has to be based on data, not into a gut feeling.

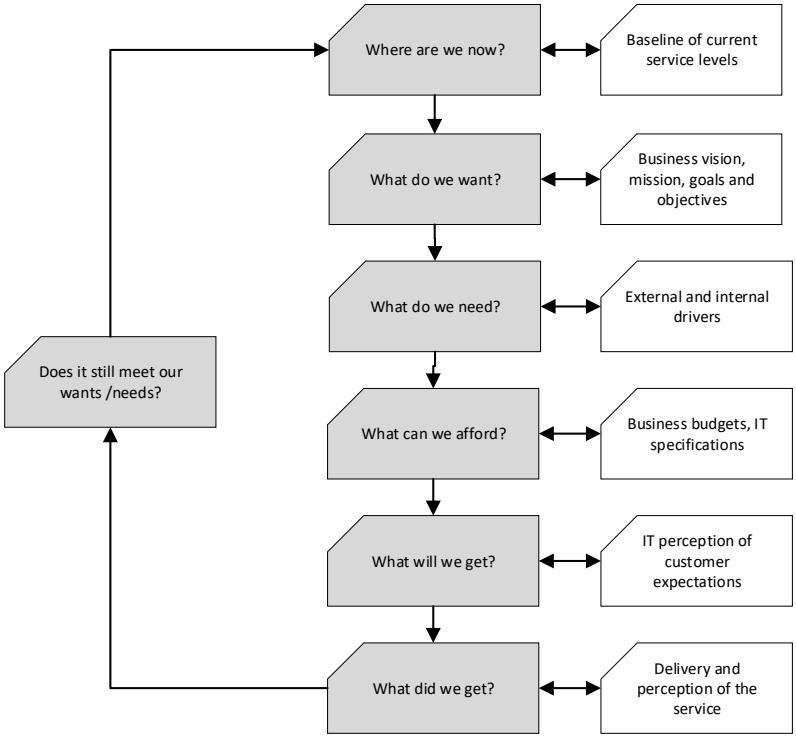

Figure 20 Business perspective improvement model (Cannon, D. & Wheeldon, D. 2007, p. 88)

The planning phase takes part in the first four steps in continual service improvement model (see figure 6). People who are taking part to the improvement initiatives should have a clear understanding of the company's/unit is/departments vision to understand what the target state is, where the company wants to be.

The first thing when thinking of any kind of improvement to the product/service is to understand the current state of the product/service and to perform the baseline assessment of the starting point. Forming the view to current state has to be based on data, so baseline has to be formed using statistics, reports or other records so the information is based on real events and risk of getting wrong information and wrong conclusions is minimized.

Tools used to form understanding the current state are the once used in Lean Six Sigma measure phase (see chapter 4.1.4.1).

The second step that comes after the understanding of the current state is to define the target state for product/service (e.g. KPI & etc.). Important thing about the target state when it comes to improvement is that it has to be measurable, so the comparison to the current state is valid. That is how the organization can clearly see the performance gaps and how far from the defined target state the current state is.

The last part of the planning phase is to figure out how to improve from current state to the target state. At this step the improvement plan is created and preparations for the improvement project are done. While creating the improvement plan it is important to involve all related people to the discussion (operations, product manager & business manager).
The end result of the planning phase is the project chart (figure 21) of the improvement project. The project chart should include clearly the problem statement about what is the problem that the project is clearing, as well as the goal statement where the expected end results of the project are described.
In the project chart, also the scope of the project should be described so it is clear what is included and excluded from the project.
Important information to support the decision making for CSI manager and other members making the decision whether or not to approve the project is the business benefits and costs of the project.
The project team and their roles in the project should be included in the project chart. Responsible person for the project outcome should be appointed here. The last thing in the project chart is the schedule when the promised project outcomes are delivered and the business benefits are being realized. The project schedule in this project chart is a

high-level schedule, the more detailed schedule of the project is handled in separate chart as shown in figure 22.

Project title		
Problem statement	Business benefits	Costs
Goal statement	Project team	
Project scope	Schedule	

Figure 21 Project chart

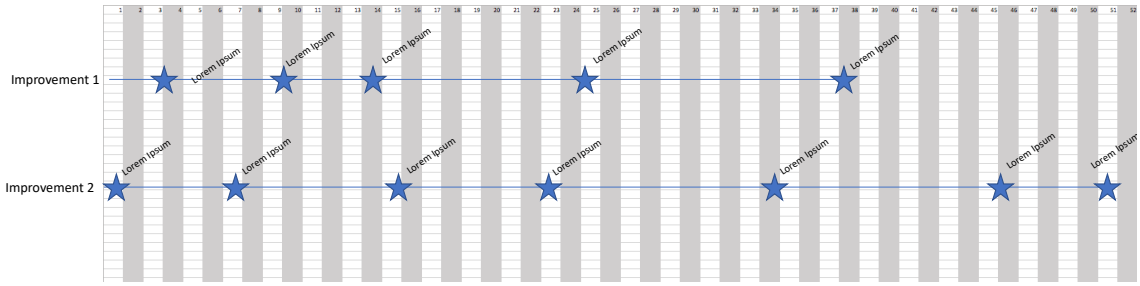

Figure 22 Improvement project schedule chart

4 Taking action

Now when the project has been planned via the project chart and scheduled with schedule chart, it is time to take action for the improvement project. The improvement projects

should follow DMAIC structure from Lean Six Sigma to have clear steps how to proceed from one step another. As the define and measure phase has already been done in planning phase, now is time to move to improve phase. Generally, tools described in chapter 4.1.4.1 are suggested, but choosing correct tools is very case sensitive. More important is to follow up the agreed steps that have been scheduled during planning phase.

To follow up the progress of the improvement projects there should be a follow up meeting biweekly. In this meeting each improvement project is gone through in simple manner. The status of the improvement project, this can be done via either traffic lights or the status reported in written. In this meeting the next steps are gone through as well, what will be achieved until the next follow up meeting. If some project is facing challenges that are preventing progress but doesn't need immediate actions between the meetings should be pointed out in this meeting. The follow up meeting should be run by CSI manager and there should be participants representing the product/service improvement project is affecting.

5 Controlling the improvement

When the improvement project has been finished, it is time to review the improvement projects end results. Evaluation of the project results should be done for both service improvement and business perspective. As the service improvement point of view represents measurable KPIs and metrics and business the delivery and perception of the service. The evaluation meeting should take place when the improvements has been done and the results are visible in e.g. measurements from the network. After the evaluation meeting the project can be officially marked as completed.

Continual evaluation and measurement of the product / service is still needed as well as possible updates of the target state. If the target state needs to be updated, it is time to evaluate how to improve the service to meet the updated target thresholds. The Lean mentality plays a big role in this phase of the service improvement. There is a continual There is a continuous need to evaluate different possibilities where and what can be improved and automatized to improve service quality and therefore customer satisfaction. Automatization should be one key focus area to improve cost efficiency and minimize the risks of manual configuration.

6 Validation and final proposal

6.1 Overview

The validation was done via Microsoft teams meeting. The thesis was sent beforehand to Telia's instructor to proceed the validation of the thesis. Validation held place after chapter 5 was finished.

Aim of the validation was to get feedback from the case company about the thesis outcomes and feedback for the thesis as a whole. After the validation and the feedback received changes to the outcome were made to get the final proposal and to generate the next steps after the thesis.

6.2 Feedback

The feedback from case company was widely positive. Problem statement was well described and met the current state and the challenges faced at the moment.

The analysis of the current state was correct, and the situation was understood correctly and was described correctly.

The feedback from the theoretical framework was very positive and the benefits for the case company were seen. The chapter for existing knowledge was seen as compact but all the key points for the context of this thesis were covered. The existing knowledge was seen as a good compact guide to the subject, so the reader is familiar with the concept.

Initial proposal received positive feedback as well. The structure of the proposal was seen good and right things for the case company were pointed out. However, there were seen room for improvement. The feedback how to improve the proposal to support the case company was to include more customer focus into the proposal. Now customer centric approach was a bit off from the proposal and the proposal was not taken into account how the customers should be noticed while planning the improvement projects and setting the targets for the product / service.

6.3 Amendments to final proposal

As received the feedback from case company's instructor customer focused approach has been included into final proposal.

To the planning phase of the proposal the amendments are focusing to take into account the customer SLA's to not to over produce the service. Also, the customer expectations are now taken into account so the improvements should be aligned with the customer expectations and the service meets the expectations that the customers are willing to pay for.

6.4 Final proposal

The guideline has been spitted into 5 different sections based on the nature of the sections (e.g. roles, tools etc.). The sections have been introduced in the order they should be in place for continual improvement.

1 Roles

The roles as described in chapter 4.1.1.3.4 are the first thing that has to be in place to be able to have effective continual service improvement in the company. Roles ensure that the responsibilities and accountabilities are appointed for the results.

The company has to appoint CSI manager to have the overall responsibility for the success of all improvement activities that are taken place in service production environment. He/she is responsible to appoint all the roles that are needed (service owners & service managers). Also, the CSI manager has the final word to say when prioritization is needed for different improvement projects (e.g. same resources are needed for multiple projects, financial pressure, etc.) or whether or not to run the project at all. This role doesn't have to be full time job and can be run along with other responsibilities. CSI manager role should be handled by a senior manager or director to be able to handle the possible costs of the improvement projects and those effects to the budget.

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provement model follows the same structure than CSI model but has a bit different measurement points for each step, see figure 6 vs. figure 20. It is important to understand the differences when having the discussion about improvement initiatives.

The most important thing when any projects are planned is that the decision making has to be based on data, not into a gut feeling. In the planning phase customer agreements should be taken into account.

The planned improvements should not over exceed the customer SLA's so the type six of waste, the over processing will not be present. While planning the improvement projects it is important to understand what the customer expectations are and also even more importantly what they are willing to pay for it.

The same principles apply for target setting for the product / service. Target setting with KPIs for product / service should be based on data as well as all the other decisions that are made. If target settings are too high the return of investment will be lower due to customers are not willing to pay more for unnecessarily over processed product / service if they are happy enough for the product / service that has e.g. 99,85% availability instead of 99,95%.

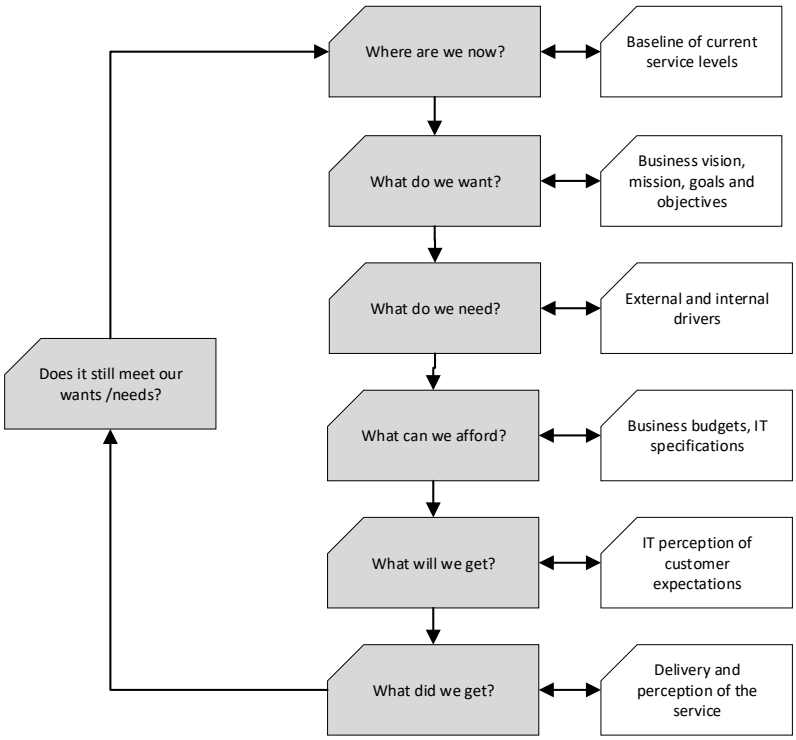

Figure 23 Business perspective improvement model (Cannon, D. & Wheeldon, D. 2007, p. 88)

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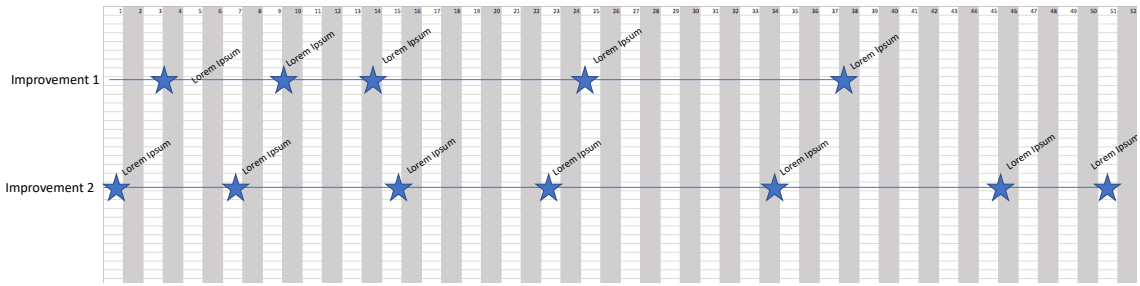
Figure 24 Project chart



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one key focus area to improve cost efficiency and minimize the risks of manual configuration.

6.5 Next steps

Next steps should take place in the near future within the case company. The guideline should be introduced to people that are working in the key roles. After the model has been introduced improvement projects should be done following the guideline.

If there are people that are not familiar with the frameworks used in the guideline, they should read through the existing knowledge chapter to be more familiar with the background of the guideline.

Also, there should be constant evaluation of the guideline that how well it suites for the case company and further develop the guideline based on the findings.

7 Conclusions

In this chapter I have written summary of the thesis, including the implications of the thesis outcome and the learning during this process of writing the thesis.

7.1 Implications of the thesis

The implications of the thesis outcomes are not immediately seen as the guideline should be implemented to the case company and would still need time to see how this guideline helps running through improvement projects and support the continual improvement of services.

Although what we can say at this point of time is, that the case company benefits for the results more or less in all of its operating markets. The guideline helps to bring structure how to run thought the projects and follow the improvements implemented. This helps the case company to efficiently implement improvement projects and deliver results in faster phase for the organization. Now the implications of this thesis remain to be seen depending how well the guideline is embraced within the case company.

The guideline is transferable to other companies working with products and services. Thesis uses widely known best practices and known processes and frameworks so, usually the practices of ITIL processes such as incident management are in use for service companies.

7.2 Objective vs Outcome

The objective for this thesis was to create a guideline how to implement continual service improvement concept into service production environment. The objective was met completely, Now the case company has a guideline how to implement the continual service improvement concept, the key roles that are needed and role descriptions pointed out.

7.3 Learnings

The last part of this thesis is my own reflections about the study and the process.

The continual service improvement has been my personal interest for a long period of time, and I have been working with service management for longer period of time in different roles.

Topic for the thesis came from different sources, mostly from the case organizations need and my personal interests. I wanted to investigate the best possible way to implement the concept of continual service improvement into the service production environment to boost up the organizations capabilities to work more efficiently.

From the very beginning I received very good support from the organization that helped me a lot to get the writing process started. The support and sparring with colleagues were valuable and they gave me ideas how to proceed forward if I seemed to be stuck. Also, what helped me during this writing process was the thing that I had a clear vision about the topics I wanted to cover in this thesis. The clear vision helped me a lot because I more or less knew what I am going to write about for different frameworks and what are the main points the I would like to cover.

Writing the existing knowledge was pretty slow due to the fact that there is so much literature about the frameworks and narrowing down correct references and finding the most relevant information for this thesis was not that easy. Also, the fact that there is so much literature from these frameworks and looking at the fact that the frameworks cover so much more than just the scope of this thesis created another challenge for me. How am I going to keep the chapter for existing knowledge compact enough that it covers all the relevant things about the object under discussion so that the chapter is not going to be overly long.

While reading a lot of literature during the writing process of existing knowledge it came clear to me how am I going to build the initial proposal for this thesis. I wanted the proposal to be based on the best practices from widely known frameworks so that it supports the case organization in the best way possible that I saw it.

As I am looking at the thesis process overall, I find that I have learned a lot during this process. I learned a lot from the frameworks discussed in this thesis and their suitability for different industries they are originally developed. I also find the whole process as a great time to learn how to apply the applied research methodologies to working environment. This thesis process has given me many new tools to use in working life in the future and helps me to personally develop myself further as a service management professional.

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Incident report

Empty FTTB devices