

Sustainable Solutions in Problem-solving Projects

A Case Study

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Abstract

The purpose of this Master's thesis is to respond to the challenge of how to implement preventive measures found and defined in problem-solving projects into the company's processes so that they become permanent practices. The topic and objectives of the thesis were obtained from the quality organization of the case company. Company is a local business unit of an international conglomerate corporation and manufactures components for the electric power industry.

This thesis was conducted in accordance with qualitative and quantitative research methodologies. This case study used two data sources, archival records, and open-ended interviews. First part of data was collected from 41 problem-solving project reports from the period January 2020 - August 2022. The second part of the data was obtained from theme-specific semi-structured interviews with persons who participated in the problem-solving processes. The interviews were conducted during November 2022.

The thesis confirmed the existence of the most common challenges found in the literature in the target company. The challenges can be divided into the "hard" side, which refers to operational guidelines, practices, and tools to improve working environment, while the "soft" side refers to cultural aspects that allows those practices to be sustained for the organization to succeed. Success in problem solving projects requires that these two aspects are applied together. The study found that, for example, the absence of a structural process or its instructions causes an individual's disbelief in the success of the project and thus in the realization of permanent solutions.

Based on the results, the case company could be asked to pay attention to improving at least the following main points: Making company guidelines for problem-solving processes, greater attention to the definition of tasks and their monitoring, transparency of projects, appropriate archiving, and the introduction of the project's final meetings.

Language: English

Key words: problem solving, sustainable solutions, preventive actions

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Tiivistelmä

Tämän opinnäytetyön tarkoituksena on vastata haasteeseen, miten ongelman-ratkaisuprojekteissa löydettyjä ja määriteltyjä ennaltaehkäiseviä toimenpiteitä viedään osaksi yrityksen prosesseja niin, että niistä tulee pysyviä käytäntöjä. Opinnäytetyön aihe ja tavoitteet saatiin tapausyrityksen laatuorganisaatiolta. Yritys on kansainvälisen monialayhtiön paikallinen liiketoimintayksikkö joka valmistaa komponentteja sähköteollisuudelle.

Opinnäytetyö tehtiin kvalitatiivisten ja kvantitatiivisten tutkimusmenetelmien mukaisesti. Tässä tapaustutkimuksessa käytettiin kahta tietolähdettä, arkistotietoja ja avoimia haastatteluja. Ensimmäinen osa tiedoista kerättiin 41 ongelmanratkaisuprojektin raportista ajalta tammikuu 2020 - elokuu 2022. Toinen osa aineistosta saatiin teemakohtaisista puolistrukturoiduista haastatteluista ongelmanratkaisuprosesseihin osallistuneiden henkilöiden kanssa. Haastattelut tehtiin marraskuun 2022 aikana.

Opinnäytetyö vahvisti yleisimpien kirjallisuudessa löydettyjen haasteiden olemassaolon kohdeyrityksessä. Haasteet voidaan jakaa "kovaan" puoleen, joka viittaa toimintaohjeisiin, käytäntöihin ja työkaluihin työympäristön parantamiseksi, kun taas "pehmeä" puoli viittaa kulttuuriin näkökohtiin, jotka mahdollistavat näiden käytäntöjen ylläpitämisen organisaation menestymiseksi. Onnistuminen ongelmanratkaisuprojekteissa edellyttää näiden kahden näkökohdan soveltamista yhdessä. Tutkimuksessa havaittiin, että esimerkiksi rakenteellisen prosessin tai sen ohjeiden puuttuminen aiheuttaa yksilössä epäuskoa projektin onnistumiseen ja sitä kautta pysyvien ratkaisujen toteutumiseen.

Tulosten perusteella yritystä voitaisiin pyytää kiinnittämään huomiota ainakin seuraavien pääkohtien parantamiseen: Yritysohjeistuksen tekeminen ongelmanratkaisuprosesseille, suurempi huomio tehtävien määrittelyyn ja niiden seurantaan, projektien läpinäkyvyyteen, asianmukaiseen arkistointiin ja projektien päätöskokouksien käyttöönottoon.

Kieli: Englanti

Avainsanat: problem solving, sustainable solutions, preventive actions

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List of abbreviations and definitions

APQP4 Wind	Advance Product Quality Planning for Wind Industry
ISO	International Organization for Standardization
DMAIC	Problem-solving method: Define, Measure, Analyze, Implement, Control
PDCA	Plan, Do, Check, Act
A3	Problem-solving methodology, from Toyota, for 1-3 days solving projects.
4Q	Problem-solving methodology, Four quadrants, from ABB
8D	Problem-solving methodology, Eight disciplines, from Ford
TOPS	Team Oriented Problem Solving, better known as 8D.
L6S	Lean Six Sigma
RCA	Root cause analysis
K8C	Kotter's 8 step of change model
PSP	Problem-solving project
BB/GB/YB/WB	Competence level in L6S. Black Belt /Green Belt /Yellow Belt /White Belt
CIL	Continuous Improvement Leader
CI	Continuous Improvement
TQM	Total Quality Management
TPS	Toyota Production System
KPI	Key performance indicator

1 Introduction

This chapter first introduces the background and topic of the thesis as well as its relevance and importance, followed by the statement of the problem and the research questions. After this, the limitations set by the nature of the case study, the research object, the sponsor, and the author of thesis are discussed. The last part focuses on the structure of the thesis.

1.1 Background

The need for continuous improvement of products and services has become necessary to overcome modern challenges and to achieve and maintain a competitive advantage. Over the last few decades, many progressive companies, especially companies operating in the field of sustainable development and renewable energy, have implemented various process improvements initiatives, such as Toyota Production System (TPS) and better-known variations from it like Lean, Six Sigma, Lean Six Sigma (L6S), APQP4Wind to name a few examples. Through these improvement initiatives, various problem-solving methods have been introduced to seek root causes and solve quality problems in products, services as well as in processes. These methodologies are, such as Team Oriented Problem Solving (TOPS) better known as Eight Disciplines (8D), DMAIC, A3 and, so on.

The topic of this thesis is the holistic utilization of problem-solving tools and its challenges in the case company. The challenges are explained later in this main paragraph. This thesis focuses on the principles, methods, culture of problem-solving methods and especially their sustainable implementation processes.

1.2 Relevance and importance

When the case company declared its desire to be the main partner of the customers, it also stated the following:

"If we want to be the primary partner of our customers, can we achieve this without a common understanding of a state-of-the-art problem-solving approach? To achieve this, everyone should take the White Belt course who has no previous knowledge of Lean Six Sigma (L6S). This way, we take the first step towards our goals." (Hitachi Energy, 2022)

Quality is quite often stated to be part of the company's DNA and license to operate. Quality goals are high when a company is aiming for operational excellence. Companies like to offer skills and tools to everyone that help find excellent solutions for the company's products, processes, and services using a standard and common approach.

One area where it is possible to advance the company's goal of operational excellence is to practice Lean culture, L6S practices with which deviations are brought to the fore. It does not matter what type of processes are practiced, Lean or others, companies will always experience problems that interrupt or threaten production. The typical behavior when facing a problem in production is to work around the case solving it often with creative, sometimes unconventional ways. The focus, of course, is on doing whatever it takes as soon as KPI's are kept and schedules are met. In a Lean culture, the typical response would be to ask why the problem occurs and what caused it. Practicing a lean culture doesn't solve any problem, it exposes them so that they are visible. After this, their causes can be analyzed, removed and/or improved. (Mann D. , 2012, p. 163)

Companies that practice the Lean Six Sigma (L6S) way of operating should know the procedures, tools, and know-how to conduct problem-solving projects (PSPs) so that the preventive and corrective solutions found from them should become part of everyday practice. Although problem-solving methods have been in use in the case company for a couple of decades, it seems that not all the benefits that could be derived from them have been implemented. It is obvious that certain features of a company's culture could prevent the full-scale utilization of L6S and its problem-solving methods. One such questionable cultural trait could be that the main thing is to find a solution to a problem as quickly as possible, and then urgently run to look for a solution to the next problem. This could lead that full-scale and sustainable implementation of the found countermeasures and their impact is given less attention.

The objectives for this thesis were to find and propose practical processes and practices that help the case company in the deployment and implementation of the sustainable corrective measures and solutions found in PSPs. Finding deficiencies and suggestions for improvement should not be limited to practices, processes, and tools, but also to corporate culture and its features. For example, taking responsibility, initiative, perseverance, listening, respect, attitude, and so on. The topic and objectives of the thesis were presented by the Quality Manager of the Case Company.

1.3 Problem statement and research questions

Using systematic problem-solving methods is one of the key operating principles and unwritten values of the case company, which concretely means that when a problem or deviation occurs, a problem-solving team is formed, the root cause or causes are found, countermeasures are solved and defined, and finally corrective measures and improvements are implemented as part of the case company's everyday operations and practice in a way that recurrence is eliminated or significantly mitigated. In the case company, it has been observed that the implementation of preventive measures found in problem-solving projects as a permanent part of daily operations is not at the desired level.

The company has found that there is room for improvement. The goal of the thesis is to find out **what** the obstacles and challenges are in the way of implementing sustainable improvement proposals and **how** these challenges could be eliminated. The goal and the objectives of the thesis can be written in two research questions.

Research questions:

RQ1: What are the challenges and obstacles when implementing the countermeasures found in the problem-solving projects so that they will become a permanent change in the processes?

RQ2: How to ensure that the solutions and benefits from problem-solving projects will be sustainable?

“What” questions generate descriptions of states, situations, and processes.

“How” questions provide an understanding of how something takes place, works, or interacts. (Eriksson & Kovalainen, *Qualitative methods in business research* (2nd edition), 2016, p. 42). Thus, research RQ2 is not a traditional qualitative research question because above mentioned as it does not provide an understanding of how something happens, acts, or reacts. The answers to the questions will explain the following:

- The answer to the first question (RQ1), "What" question will generate descriptions of occasions, situations, and processes where challenges and obstacles occur.
- The answer to the second question (RQ2), "How" question will provide suggesting a solution to remove or mitigate such occasions and situations as well as improvement suggestions for such processes.

Eriksson & Katri (2014) in their article, "Monenlainen tapaustutkimus" stated that good research questions guide the collection and analysis of data, the refinement of results, the formulation of conclusions, and the writing of a research report. Therefore, it is important to

continue defining and clarifying the research questions throughout the research process. It is usual for the research question to change and especially become more specific during the research process. Despite this, the research question, even if preliminary, is an important resource of the research process. The lack of it can be a big hindrance to the smooth progress of research. (Eriksson & Katri, Monenlainen tapaustutkimus, 2014, p. 23). During the thesis, the questions became more precise, and they were used both as an aid to the collection of data and as a guide so that the focus remained in the right direction throughout the research.

Answers to the research questions would aim to be given in chapter 5.1. Discussions and conclusions.

1.4 Delimitations

The delimitations of the thesis, which were defined between the author of the thesis and the topic provider, determined the scope of the thesis. Delimiting factors were choices of objectives, the research questions, choice of interested variables, the researchers adopted theories, and the population under research.

The first delimitation was that this study will be done to cover only the case company in question. The second delimitation was related to issues discussed in chapter 1.3. Problem statement and research questions. The third delimitation was research question no. 1, while research question no. 2 was not a delimiting factor at all. The fourth limitation was the selection of literature regarding the researched topics, regarding the literature that the researcher found and what was available, and lastly, the literature that the researcher had time to absorb in the given time. The fifth delimitation was archival data (A3 and D8-reports) found in a certain place and made in a certain time. This delimitation is explained more closely in sub-chapter 3.3.1. Internal material, secondary data.

The sixth limitation was also related to data collection, to interviews where the interviewees were selected according to a certain criterion. The criteria for the interviewees were: The population had to have representation from every personnel group, each interviewee had to have participated in a problem-solving project and work daily on continuous improvement and quality. This delimitation is explained more closely in sub-chapter 3.3.2. Interviews with thematic data analysis, primary source.

A case study should not be limited to only one data source. Research using multiple sources is better because it uses a wider range of evidence. (Yin, 2012, p. 10). This thesis was limited to using two sources of evidence. The third one, which was intended to benchmark a sister company, was left out on purpose in order to keep the scope of the thesis moderate.

The next paragraph presents the structure of the thesis.

1.5 Structure of the thesis

The thesis consists of five main chapters. Chapter one begins with a summary, followed by a table of contents and abbreviations. The first main part of the chapter, the Introduction, presented a background of the thesis and how the thesis writer came up with the topic. It also explained the relevancy and why this thesis is important to be conducted. Then the problem statement with a formulation of research questions was discussed. Last part of this chapter, structure of the thesis is presented.

Chapter two deals with getting to know the literature by first introducing the reader to a brief history of problem-solving methods. After this, the topic of the thesis focuses on the problems found in the literature through two different perspectives, which typically either help or hinder the introduction of sustainable problem-solving in the organization's process. The last part of the literature presents an integrated combination of "Kotter's 8-step change model" and "DMAIC".

Chapter three explains and discusses the data collection and analysis methods and methodology used as well as gives a short idea about the process to conduct this thesis. It also gives the possibility for readers to evaluate thesis reliability and validity thru chosen methods. In the end, it discusses the ethical aspects and provides explanations for the trustworthiness of the thesis.

Chapter four deals with analysis and results of data collected from two sources. The research data was primarily collected through interviews using semi-structured thematic questions and secondary data by collecting material from the case company's problem-solving project (PSP) reports. All analyzed PSP reports were made according to eight disciplines (8D) and A3 methodologies.

Chapter five presents the research main results, conclusions, answers to the research questions, gives improve suggestions for the case company, presents limitations for the thesis and lastly, it gives suggestions for further studies.

The last part of the thesis contains a list of literary sources, followed by a list of questions that were used as a script for the thematic semi-structured interviews.

2 Literature review

This chapter examines the theoretical part of the subjects around the problem. The main objective was to understand the theories and models of the presented problem in such a way that the author of the thesis had a sufficiently good understanding of the problematic case. Additionally, the purpose was to find what kind of challenges have been observed and what corrective and preventive measures have been suggested to mitigate the problem in similar situations. The purpose of the literature review was also to provide the author with a better readiness and understanding for researching empirical and theoretical material in the case company. This included where to focus when examining archived documents and getting a better understanding of where to concentrate when preparing and conducting a semi-structured interview.

Before jumping into the wonder world of literature and academic publications key concepts were identified and selected. The definition and selection of key concepts were an essential part of the literature review of this thesis, as they were used as keywords and phrases when exploring literary material. Another advantage of them was that they kept the thesis writer focus on the context throughout the thesis process.

Summaries of the problem statement, objectives and research questions were used to help define the key concepts.

Problem statement: Solutions and countermeasures found from problem-solving projects (PSP) are not always implemented into case company everyday processes.

Objective: To ensure better and more permanent implementation of solutions and countermeasures

Research question: What are the challenges and obstacles when implementing sustainable solutions and counter measures and how to remove them?

The found key concepts based on these summaries were "Sustainable Solutions in PSPs", "Change management in PSPs", "Problem-Solving culture" and "Failures in PSPs". These key definitions were used as guiding key concepts and keywords to help the researcher stay on the right track during whole thesis process. It cannot be denied that other related concepts and keywords were also used when researching the literature.

2.1 Introduction to the problem-solving

This chapter introduces the basic concepts of problem-solving methods, starting with a short history with examples, followed by a slightly deeper overview of the Lean Six Sigma philosophy, the practice of which strongly includes the use of different problem-solving methods.

The Encyclopedia of the Science of Learning defines “Problem” in following way:

“A problem is generally considered to be a task, a situation, or a person which is difficult to deal with or control due to complexity and non-transparency. In everyday language, a problem is a question proposed for a solution, a matter stated for examination or proof.” (Seel, 2012)

A short definition could be stated in the following way: A problem is something that is difficult to deal with and needs to be resolved.

A brief history of modern problem-solving methods is presented in a timeline. (See Figure 1: History of problem-solving methodologies in a timeline). Here only some selected milestones with tools and methodologies are presented that are familiar within the case company problem-solving projects.

Pareto. The history shown in the timeline below can be thought to begin in 1896 when the Italian Vilfredo Federico Damaso Pareto introduced the 80/20-chart, which actually was named after him, “Pareto-chart”. The principle of the diagram is still used today. The chart shows the number of pieces as bars and their accumulation percentages as a curve. The definition could be written into a form: “80% of all outcomes are derived from 20% of causes.” The Pareto chart is used, for example, in quality control to find out the causes of the most common manufacturing defects. (Wikipedia, the free encyclopedia, n.d.)

FMEA. End of 1940’s Failure mode and effect analysis (FMEA) was introduced in US Military to reduce source of variation and related failures in the production of ammunitions. As it was proven to be success, it has been used since decades until present. Nowadays in various industries and fields like in NASA and automotive industry all over the world. (Quality Training portal, n.d.).

PDCA. Plan-Do-Check-Act (PDCA) is mentioned in ISO 9001 (European Committee for Standardization, ISO 9001, 2015) where it is said that it can be utilized to all processes and the quality management system.

7QC Tools. In 1960’s in post war Japan seven quality tools (7QC Tools) was introduced. The tools are traditional tools that all are still used in nowadays PSPs. Seven tools are

Check sheet, Fishbone diagram (cause and effect diagram, Ishikawa diagram), Histogram, Pareto chart, Control chart, Scatter diagram, and Stratification (ISIXSIGMA, n.d.), (Wikipedia, the free encyclopedia, n.d.).

8D. In the 1980's Ford Motor Company's Team Oriented Problem Solving (TOPS) better known as Eight Disciplines (8D) was introduced. Already early usage of 8D it was proved so effective that documenting problem-solving projects in this way became a primary way of reporting and still today it is used in Ford and many other industries and companies around the world (Quality-One, n.d.). This is one of the other most used problem-solving practices used in case company. This is mainly used by more experienced quality professionals and in most cases due to requests of customers that have been asking more comprehensive problem-solving approach that focuses not only to eliminate the root cause but also on implementing permanent corrective and preventive actions.

A3. Before mid of 80's at Toyota, John Shook, the first hired foreign national who become a manager was given the task to teach Toyota Production Systems (TPS) to personnel of Toyota. For helping lectures, he invented a method where problem-solving reports can be fitted into A3-size paper. From that event, the A3 problem-solving method got its birth which is still used in many different industries all over the world. (Liker & Ross, 2017, p. 317) Also, this method of problem-solving practice is in use at the case company of this thesis. This is mainly used in small and medium size of problem-solving projects and with continuous improvement projects. It provides a simple and strict procedure for employees having not that comprehensive knowledge of L6S practices.

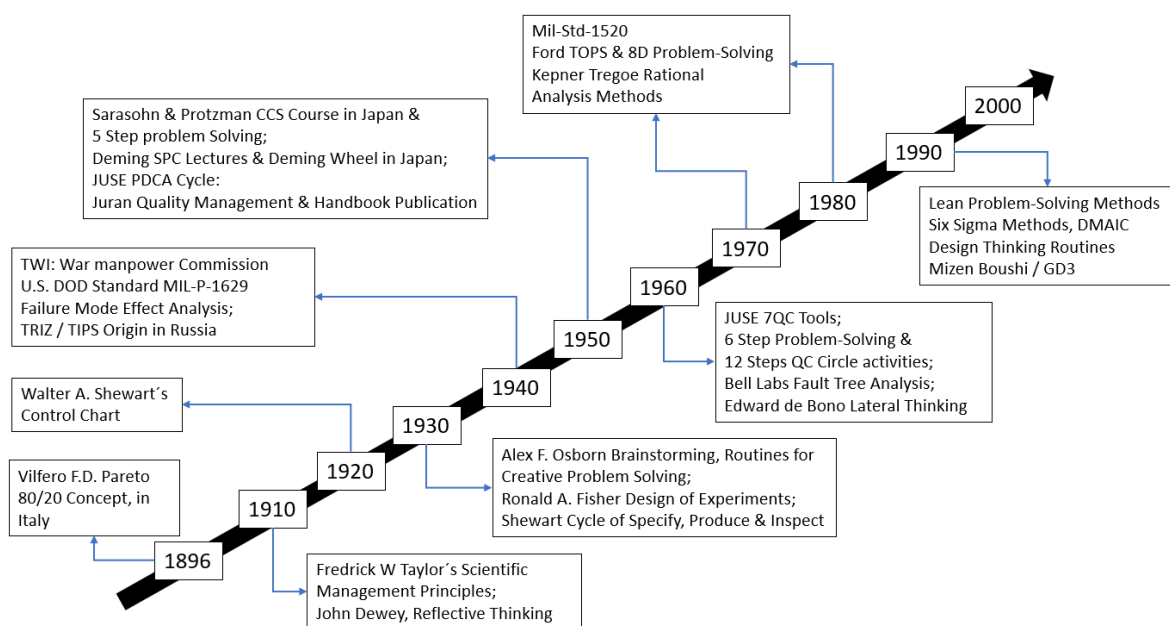


Figure 1: History of problem-solving methodologies in a timeline. Redrawn by the writer from, (Lean Enterprise Academy, n.d.)

Lean Six Sigma. In 1990's Lean, Six Sigma with Define-Measure-Analyze-Implement-Control (DMAIC), Six Sigma Problem-solving methods became more and more popular. The history of Lean goes back to the era of Henry Ford when he was successful in the production processes and when the flaws in the processes collapsed his success. The process did not allow any variables (like color, motor, nothing) while competitors was able to provide. Toyota looked at this situation in 1930's and picked good points and improved the weak points and adjusted the processes more possible to provide both continuity in process flow and a wide range of options. They revisited Ford original thinking and invented the TPS. Toyota, the leading Lean exemplar in the world is one of the biggest car manufacturers in the world in terms of overall sales. Lean today, thanks to Toyota and their success over past two decades, has encountered enormous interest towards that thinking. There are hundreds of books, papers, articles and even companies that provide courses and help for companies to make transformation towards Lean thinking. (Lean Enterprise Institute, n.d.)

What actually is Lean and Six Sigma and the combination them, Lean-Six-Sigma, L6S and how they are linked to Problem-solving projects and methodologies? On the following pages, the central parts of these philosophies will be reviewed. A wider explanation of it can be find from web site of Grey Campus, "A Brief Introduction to Lean, Six Sigma and Lean Six Sigma. (Grey Campus, n.d.)

Lean. Lean is a systematic approach and philosophy to get rid of the activities that do not gain value (Waste) to the process and emphasize the one which gain value. Lean should reduce process cycle time, improves on-time-delivery, mitigates, or removes the possibility to make defects, reduced the inventories and optimizing resources. Key principle is Continuous Improving (CI). Accordance Lean philosophy Value is customer perception from product or service which he/she is willing to pay for. Lean has evolved from Toyota Production System (TPS). While TPS was intended to be used in large-scale production environment while Lean is for all-scale industries as well as service industries. Wastes accordance of Lean concept are those that should be removed or reduced continuously. Lean lists 7 wastes that can be identified from any process, they are: Overproduction, Inventory, Waiting, Motion, Transportation, Rework and Over Processing. The five

principles of Lean refer to its continuation of seeking Added Value and reduce Waste. See Figure 2: Five principles of Lean.

1. Defining Value: Customer defines it. Key point is to understand what the Values are he/she considers to be valuable.
2. Mapping the Value Stream: This shows the process steps. This also helps to identify and eliminate non-Value activities i.e., Wastes.
3. Creating the Flow: Establishing continuous flow in accordance customer need. This is to help optimizing the process and eliminating non-value makers from the equation.
4. Establishing Pull: This is to find tact-time for the system. Tact-time is when product should be ready for customer. (Just-In-Time). This enables smooth flow and help keeping inventories low.
5. Seeking CI: Consistent effort to seek process improvements to meet customers possible changing needs he/she values and begin the process again.

(Grey Campus, n.d.) (Michigan Technological University, n.d.)



Figure 2: Five principles of Lean. Redrawn by the writer from (Michigan Technological University, n.d.)

Lean is an improvement system. Practicing Lean management system does not solve any problems, instead it exposes them so that they can be seen, eliminate their root causes, and improve them with countermeasures. (Mann D. , 2012, p. 163)

Six Sigma. Six Sigma (6S) is structured problem-solving methodology. It focuses data obtained from processes, it seeks variations from it and drives to better customer satisfaction. Problem-solving methodology uses DMAIC framework, see Figure 3: The DMAIC phases.

DMAIC: Following are short descriptions of DMAIC phases:

1. **Define:** This is overview of a L6S project and an application to top management to receive a go-ahead for PSP. *“Do we know what needs improving?”* Content should include at least: The case, problem statement, goal, scope, resources, timeline, and benefits.
2. **Measure:** Data collection for variables. *“Let’s measure and collect some facts/symptoms to know what all is about!”* Baseline obtained and metrics compared to final desired performance metrics. Capability obtained.
3. **Analyze:** RCA with tools like, histograms, Pareto charts, fishbone. Hypothesis tests done to verify and validate root causes with Viz regression, ANOVA, Chi-square, etc. *“Let’s narrow down the possibilities to find the most likely root cause!”*
4. **Improve:** Solution found from RCA will be implemented to improve the process. Simulations, Design of experiments, prototyping are some technics to improve and maximize process performance. *“Let’s rethink what would be the best cure by testing them before deployment of it!”*
5. **Control:** Measuring the implemented solution to verify the success and for further development. Process standardization with Control plan and work instructions. The main purpose is to hold the achieved gain. *“Implementing, Sustaining, Learning/Benefits, Measure new base line, Monitor in ongoing basis for any signs of new problems!”*

(Grey Campus, n.d.), (Brening-Jones & Dowdall, 2018, p. 14)

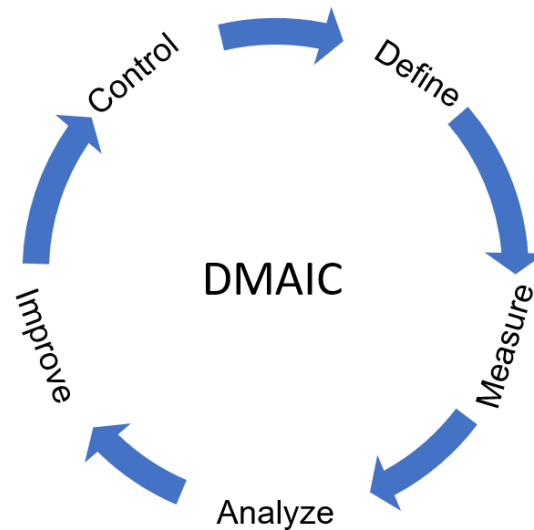


Figure 3: The DMAIC phases. Redrawn by the writer from (Brening-Jones & Dowdall, 2018, p. 14)

Lean Six Sigma: ASQ (The American Society for Quality) states,

“Lean Six Sigma is a fact-based, data-driven philosophy of improvement that values defect prevention over defect detection. It drives customer satisfaction and bottom-line results by reducing variation, waste, and cycle time while promoting the use of work standardization and flow, thereby creating a competitive advantage. It applies anywhere variation and waste exist, and every employee should be involved.”

Lean plus Six Sigma equals Lean Six Sigma in other words it is the combination of these two philosophies. While Lean is to help reducing and eliminating waste Six Sigma concentrates reducing and elimination variations in the process. So, L6S is improving the efficiency and quality in the process. Key elements of L6S are Customers, Process, and Employees.

- **Customers:** The final judges of a company's excellence are the customers when they experience the product or service they receive. They ask for more and more with the lowest level and ask for support throughout the whole product lifetime. This means that companies must approach their business processes also from an outside angle to understand the needs of customers. This is said to be the core of the L6S.
- **Processes:** This approach to look processes outside will bring need to define business process value chain. Customer is willing to pay only for the product, nor for the lack of efficiency, rework, revisions nor the wastes. L6S provides consistent

help to deliver high-quality output and improving the value chain to meet customer expectations in right timescale.

- **Employees:** L6S must be in every employee DNA, in corporate culture. All efforts toward this must be secured. Every person from grass-level employees to all stakeholders at all levels should understand the change management to secure dynamic change. Without these improvements tend to be stuck in stagnation. L6S is continuous improvement.

(Grey Campus, n.d.)

Lean Six Sigma principles are based on approach to be able to see the business processes first from outside and then inwards. The success of deployment of L6S therefore depend on organization to adapt approach outside-in. L6S and the philosophy of it listing five principles 1. Customer focus, 2. Defining roadblock to consistent quality, 3. Eliminating inefficiencies, 4. Communicate and align people, and 5. Being flexible and adaptable. (Grey Campus, n.d.)

The latter two principles "Communicate and align people" and "Being flexible and adaptable" contain several significant and important points that should be taken into consideration when thinking about sustainable solutions in PSPs.

Communicate and align people: Consistent and seamless communication, education of people, personal guidance throughout the organization to learn change management, encouraging people to fall in love with problems and get excited about solving them, fostering a problem-solving culture, groupthink technique and community, and ensuring behavioral sponsorship throughout the organization, especially at management levels. (Grey Campus, n.d.)

Being flexible and adaptable: The importance of change management, every person in the organization moves along the change curve at a different pace. The organizational structure and management philosophy have been adapted to the new solutions. Dynamic i.e., continuous improvement of business processes, fostering a culture of adaptability and agility throughout the organization is necessary if a philosophy according to L6S is to be implemented. (Grey Campus, n.d.)

Competence levels in L6S Belts. The coloring is the same as in martial arts, white-yellow-green-black. The originator of this concept was Dr. Mikel Harry, who has been widely recognized and cited in many publications as the principal architect of Six Sigma and the world's leading authority within this field (mikeljharry.com, n.d.). The following is a brief overview of the L6S belt levels and their corresponding qualifications and responsibilities.

- **White belt:** Awareness of the L6S philosophy, understands L6S jargon, mastery of basic terminology, better competence to participate in problem solving projects. WB training can last from an hour to one day, depending on the organization's requirements.
- **Yellow belt:** Proficient in DMAIC methodology, familiar with basic tools and technology, able to complete a small-scale improvement project. YB training can last up to two days.
- **Green belt:** Deeper familiarity with DMAIC, familiar with several tools and techniques, capable of wider application of L6S and project management and implementation. The green belt holder is expected to spend about 10-20% of his working time on improvement projects from his normal work duties. Training can take weeks, with some organizations a few months.
- **Black belt:** Deep familiarity with tools and techniques with a focus on statistical and analytical tools to measure and interpret process performance. Has adopted change management and its verification in successful project implementation. BB is a full-time job in many organizations. BB can be GB's coach and mentor. The training can last up to one year.
- **Master black belt:** The MBB role is seen as career-oriented BB persons with several years of practical work experience whose aspiration or passion is to become a "professional change agent". MBB can be coach for BB and carry L6S training at any level. They usually work with company senior executives as an advisor for strategic issues on the deployment of L6S.

(Purdue University, 2021)

Four quadrants, 4Q: In addition to the problem-solving philosophies presented above, the case company used its own problem-solving methodology called Four Quadrants (4Q). It was used for a couple of decades and was based on traditional problem-solving steps and traditional quality tools. The reasons leading to the abandonment of the use of 4Q are not known, but it can be assumed that it was due to better recognition of other methods. Another reason could be the availability of deeper training, which as a method is slightly different

from e.g. DMAIC belt training. The third reason can be thought to be that the customers nevertheless wanted the problem-solving projects and their reports to be done using methodologies (A3, 8D, DMAIC) and methods better known to them. A comparison of some known PSP methods and their steps can be seen in Figure 4: Comparison of PSP steps. It can be clearly seen from the table 1 that each method follows the same formula and philosophy, only the terminology, which is also almost the same in all, differs slightly.

Generalized Problem Solving Approach		Ford's Approach 8D		Toyota's Approach A3		Lean Six Sigma DMAIC		PDCA		Former approach of ABB 4Q		General Motors' Approach		Rolls-Royce Approach	
Step No.	Steps	Step No.	Steps	Step No.	Steps	Step No.	Steps	Step No.	Steps	Step No.	Steps	Step No.	Steps	Step No.	Steps
1	Identifying, breaking down, prioritizing, analyzing the root cause of a problem		1	1	Clarifying the problem	1	Define	1	Plan	Q1	Measure	1	Queue (Place problem in staging area for projects)	1	Define Problem
		D1	Form a team	2	Problem breakdown	2	Measure					2	Duplicating the green Y (Re-create experienced issue to observe and see where/what went wrong)	2	Contain Problem
		D2	Describe the problem	3	Target setting	3	Analyze			Q2	Analyze			3	Find Root Cause of Escape
		D3	Interim containment action	4	Root cause analysis	4	Improve							4	Prevent Further Escapes
		D4	Root cause analysis	5	Develop countermeasures	5	Control							5	Find Root Cause of Problem
2	Generation of countermeasures	D5	Corrective action	6	Implement countermeasure	6	Improve	2	Do	Q3	Improve	3	Clue generation (Utilize Red X training to focus on the root cause)	6	Implement corrective action
3	Selecting a countermeasure			7	Track results and processes	7	Control								
4	Implementing the best countermeasure			8	Standardize the improved process	8	Control	3	Check	Q4	Sustain				
5	Communicating countermeasure and progress	D6	Implement and validate												
6	Problem/countermeasure movement	D7	Recurrence Prevention					4	Act			4	Implementation (Apply corrective actions and completes the project)	7	Verify Fix
		D8	Closure and team celebration												

Table 1: Comparison of PSP steps. Table made by the author.

The next two pictures are used to make an introduction to the next two paragraphs.

- 2.2 PSP in the perspective of “Hard side” and
- 2.3 PSP in the perspective of “Soft side”.

Organizations having goal to be successful in implementing L6S philosophy, must have two aspects mutually and equally presented in the everyday activities. These aspects could be referred as “Hard side” and “Soft side”. The hard side is referring to operational as well as quality related tools and techniques, to organizational structure, competence and so on while soft side is referring to traits of corporate culture, to leaderships, to teamwork, to respect of individuals and to initiative, to name a few. (Fadnavis, Najarzadeh, & Badurdeen, 2020, p. 32)

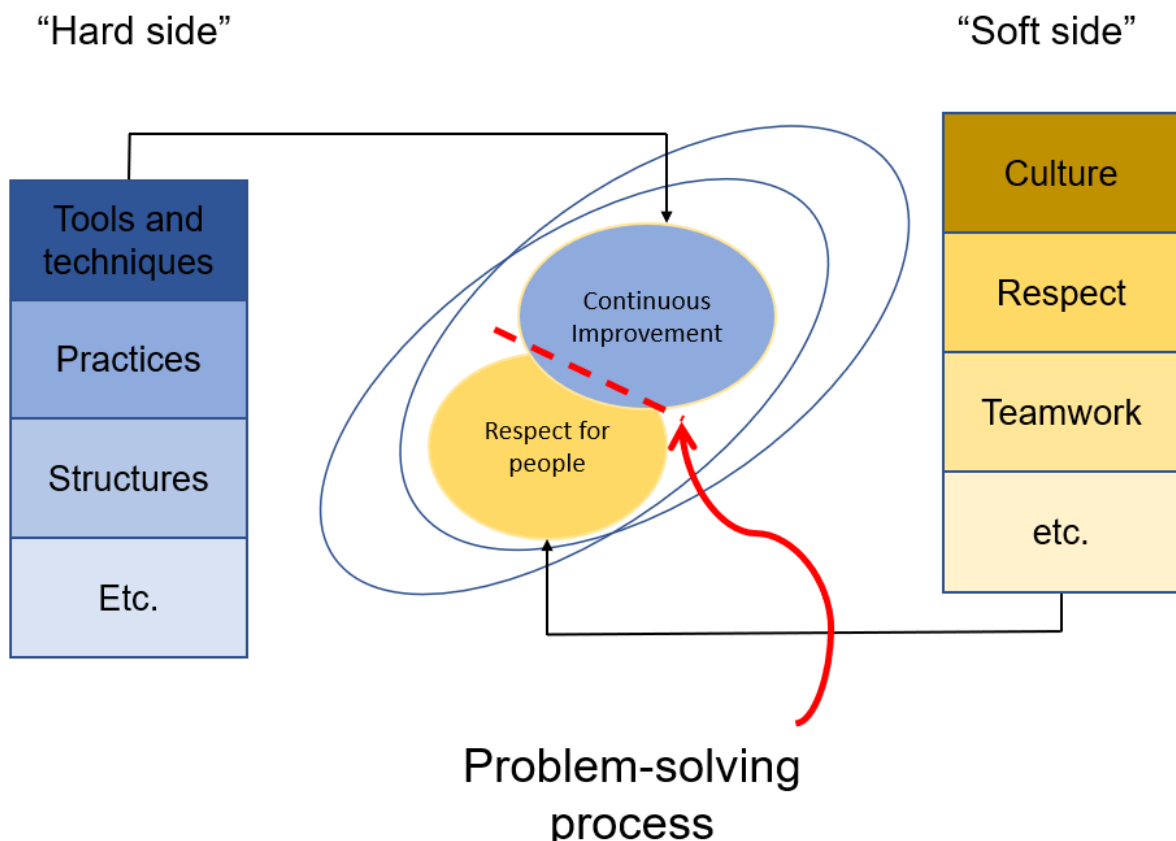


Figure 4: Two pillars of Toyota Production System. Modified and redrawn by the writer from Fadnavis et al paper. (Fadnavis, Najarzadeh, & Badurdeen, 2020)

Also another approach to these two aspects, hard and soft side can be presented. It is the Toyota Production System (TPS) which consists of two value streams. The Product Value Stream coming from "hard side" inputs like: Tools, methods, structures. etc. The People Value Stream coming from "soft side" inputs like: Traits of corporate culture, implement

teamwork, motivate people. The problem-solving process needs these two streams equally together to establishing mutual trust and from there resulting Leaner System. It can be concluded from this that if the organization does not have its value streams (hard and soft) in order, then it does not have its problem-solving processes in order either. A company like this cannot say that it practices a philosophy like Lean. (Coetzee, van Dyk, & van der Merwe, 2018).

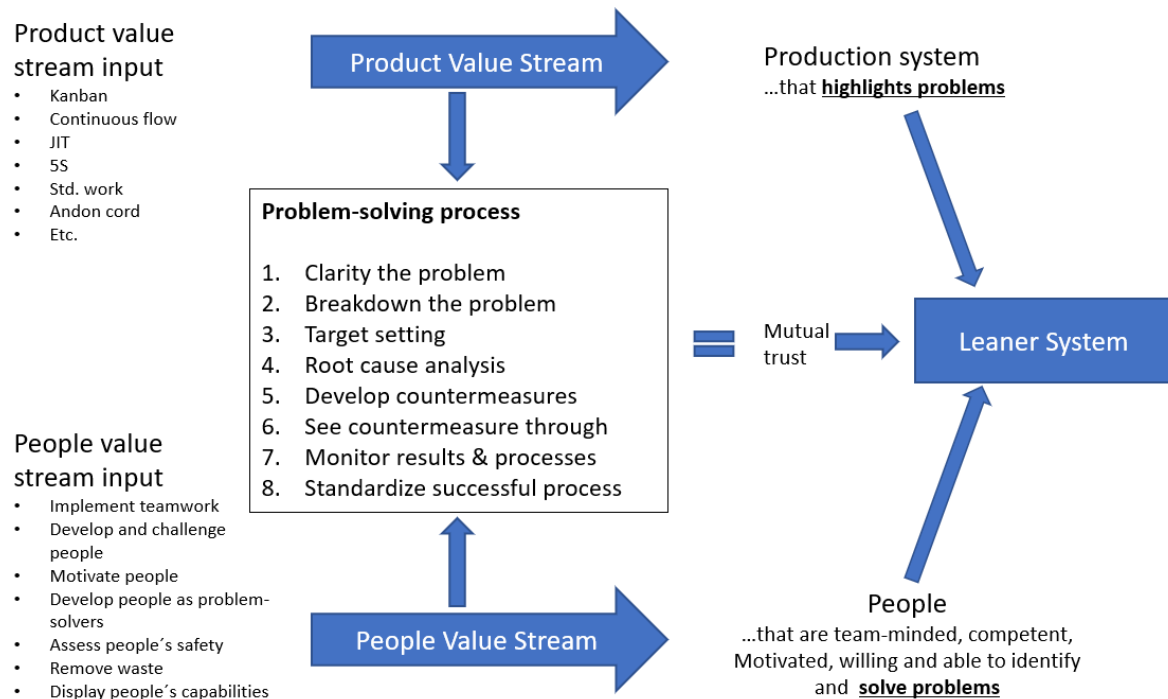


Figure 5: Value Streams of Toyota Production System. Modified and redrawn by the writer from (Coetzee, van Dyk, & van der Merwe, 2018)

Next two chapters will discuss these introduced Hard and Soft aspects of problem-solving process.

2.2 PSP in the perspective of “Hard side”

For an organization to success in L6S philosophy type of processes and in this way to success in sustainable problem-solving projects, it must manage both so called Hard and Soft sides aspects. Hard side refers to tools, techniques, practices, and structures.

In this part of the literature review, issues related to the "Hard side" of the context are discussed and deal with topics that contribute to a sustainable solution remaining in the company's process so that it becomes part of everyday practice.

The study, "Top ten reasons for process improvement project failures" states that the classical challenges in improvement projects are related to shortage of manpower, demand uncertainty and inadequate knowledge while neo-classical challenges are difficult to adapt changes and retention of customer. It has been found that many companies that have implemented various process improvement projects, such as Lean Six Sigma and related problem-solving projects, have not received the desired benefits for their processes, or the projects have even ended prematurely or failed completely. (Antony & Gupta, Top ten reasons for process improvement project failures, 2019).

The following list contains only those "reasons for failure" that best fit the "Hard Side" context, although some of them could just as easily fall under the "Soft Side" depending on the context in which it is discussed.

- **Commitment and support from top management:** Top management's commitment to problem-solving projects is essential to determine prioritization, time, resources, and goals. The management should participate in every phase of the PSP life cycle, but at least in project selection and goal setting, resource allocation, monitoring and control.
- **Communication practice:** Communication is one of the most important things in the success of problem-solving projects. It is important to identify communication obstacles already in the planning and implementation phase of the project. Communication methods/tools and at which stage of the project it takes place for different stakeholders must be clear and defined. Communication involves, among other things, the voice of the customer so that the values and needs that the customer values become clear, the voice of the employees in improving the efficiency and productivity of operations and the success of the implementation, and even the voice of the company in achieving company and business goals on a strategic and operational level.
- **Competence:** As per stated in IEC9001, the quality of work at the company is most effective when all employees understand and apply their education, skills, and experience to perform their duties and responsibilities. It is the responsibility of top management and the company to provide opportunities for people to develop these necessary skills. (European Committee for Standardization, ISO 9001, 2015). Learning at the organizational level is as important as individual learning in the sustainable implementation of process improvement projects. Like in L6S process improvement projects, learning is seen as a continuous process that must be synchronized with changing business goals and challenges.

- **Team composition:** One person, no matter how educated and no matter how capable of leading things and people he/she is, cannot alone make a big change in the organization. It needs a whole team of competent members. The ability to work in a group shows the organization's competence and is a good sign for a learning organization. The PSP team must be multifunctional in nature, which means that the skills of the team members complement each other. The project team must always be assembled and optimized according to the situation, the challenge, and the complexity. The composition of the team is based on shared cognition, knowledge sharing, performance, and innovation ability. There must be sufficient representation of the relevant functional units. Although team diversity is a desirable feature, members should be given enough time to understand each other's personalities to improve team cohesion. As the interdependence of tasks increases, it is important to consider compatibility and cohesion between team members. The team and interpersonal dynamics of project groups play a decisive role so that the team can work effectively in problem-solving projects.
- **Methodologies, tools, techniques, and practices:** Choosing wrong tools or methodologies does not always mean that PSP will fail but for sure it might affect to have right data, to make correct analysis and then at the end to choose right counter measures. For this reason, it is good to think and make sure which tool or method is best for each problem or challenge. Another important point is to minimize the overuse and underuse of tools and techniques in order to develop a primary set of core tools needed for each phase and implementation.
- **Scope:** Although process improvement projects are by nature time-bound, it is still one of the most common failure factors. It is important for the project owner to work with the project sponsor and define the scope of the project. What is inside the project and what is outside it, which activities are necessary for success versus "nice to have"? Proper documentation of the scope of the project not only explains the boundaries of the project, but also describes the responsibility of each team member and sets the methods for how the work to be performed is reviewed and approved.
- **Consistent monitoring and control (supervision):** Monitoring and control of problem-solving projects is one of the most important things, in the absence of which the chances of the project's success will decrease with a high probability. PSPs are continuous improvement, so they also need continuous expertise and continuous monitoring. Monitoring must be planned and developed so that it follows the progress of PSPs in real time. The output or report produced by the system should be disseminated consistently through visual presentation in the workplace, forums,

seminar, meeting, interim report, etc. This creates awareness among PSP members and employees, which helps to correct measures, maintain the momentum of operations, and ensure permanent change.

(Antony & Gupta, Top ten reasons for process improvement project failures, 2019)

In addition, **company-level guidelines** could be added as one important point to the previous list, which ensures that the company has general guidelines for managing PSP projects. No tool nor methodology is effective if the structures and processes are not in place. This includes documented structures and processes how PSPs should be conducted. The instruction (guideline) would include, among other things, when and why PSP should be done, responsible persons, team members, control, follow-up (monitoring), informing (transparency) and recording (archiving). These basics are the cornerstones of general quality management, which are mentioned in the ISO9000, ISO9001, and ISO9004 quality management series.

Many indirect and some direct suggestions were found in the literature to answer the research questions. One direct response suggestion was: Corrective action found from problem-solving projects should always be responsible function of function owner. The problem-solving project, no matter what method used determines action plan what, who and when. (Griffith, 2000, pp. 59-60)

In the book "Johtaminen: Keskeiset käsitteet, teorit ja trendit" of Viitala & Jylhä, 2019 is also pointing out some typical problems in decision making that in this context could be thought also be a lack of implementing sustainable corrective actions. These are: Decisions are not communicated enough in the organization, the implementation of decisions is not managed properly, effects are not monitored, personnel are not involved or listened to in decision-making. (Viitala & Jylhä, 2019, p. 130)

Schultz, 2011, in his book "Sustain Improvement: How to Make It Happen" gives the following as an example. Teams of improvement project enthused by their success and weary from the hard work often celebrate too soon. Teams don't spend sufficient time for the change management and ensuring that the new approach is secured. Improvements are implemented too lightly at this point, and therefore they are danger to slide back to old and familiar practice. Changes will be more permanent when they are reinforced and have sufficient time to become the customary way of doing things. If expectations are not being met, the team will need to tune its campaign and continue to work at locking in changes. After all, plenty of effort, time, and money went into the project. It would be an enormous

waste of resources if a new team at some time in the future had to deal with the same problem again. (Schultz, 2011, pp. 126-127)

The book "The Quality Technician's Handbook" (Griffith, 2000) generally states that in most cases corrective action plans or approaches lack one of the most significant steps in the corrective action process: monitoring/follow-up. The book states that this is usually the weakest step in corrective action. It is generally believed that simply taking action is enough. Follow-up ensures that the implemented actions were effective. In some cases, during the PSP, several probable root causes are identified, and then the team selects the most likely causes. There is no guarantee that the true root cause of the problem will be correctly identified the first time and in these cases the actions taken will not correct the problem. And same goes to if there is more than one root cause, and only one of the causes can be addressed the result is reducing the problem but not solving it. To solve this, effective follow-up should be performed after each corrective action to ensure that the actions taken have eliminated the root cause of the problem. Monitoring/follow-up can be done in several ways i.e., including reviewing corrected documents or re-inspecting a specific area, etc. (Griffith, 2000, pp. 59-60)

The next chapter discusses the "soft side" of the two elements that were originally introduced in the Toyota Production System philosophy and that Fandavis et al., 2020, in their study brought up in order for the organization to succeed in its Lean implementation.

2.3 PSP in the perspective of "Soft side"

Organization that emphasizes quality enforces corporate culture. The behavior, attitudes, actions, and processes created by this culture create value by meeting the needs and expectations of customers and other relevant stakeholders. (European Committee for Standardization, ISO 9000, 2015)

Corporate Culture. Many studies claim that corporate culture, also known as organizational culture or company culture, is an important factor that affects the success of an organization operating in a Lean environment and thus also success in problem-solving projects (Fadnavis, Najarzadeh, & Badurdeen, 2020). The definition of corporate culture can be interpreted and defined from several scientific journals, books, papers, and studies. Somewhere it is defined in one sentence and somewhere in several paragraphs. Following is one definition from the article "Corporate Culture Definition Characteristics and Importance Explained" wrote by Evan Tarver et al, 2021, in web page Investopedia: Each corporate has its own culture that refers to the believes, attitudes, and behaviors that defines how employees, management and owners interact. It can be influenced by national cultures and traditions, trends, domesticity, internationality, size, product, and the service. Culture

can be seen in dress code, business hours, decoration of office or plant, benefits, hiring decisions, treatment of clients, customer feedback, and generally all in its operations. Culture, regardless of whether it was formed organically or on purpose, affects the company's ideology and practices and thus all business areas. (Tarver, Thomas, & Pete, 2021)

“Quality means doing things right, and **culture** means doing the right things when no one is watching.”

~ Henry Ford ~

Lean related of philosophy and managements are more and more popular today, but still few companies have succeeded in it, as taught in the Toyota Production System (TPS). The reason for such failure rate could be that companies and organizations are concentrating too much for the hard side, tools, and methodologies than soft side, culture, people with right values and attitude.

The findings at the study “An Assessment of Organizational Culture Traits Impacting Problem Solving for Lean Transformation, Fadnavis et al 2020, showed that certain traits of organizational culture and project team members had positive correlation which could help corporations to identify and improve cultural traits on the way for more successful for practicing Lean related management and perform sustainable PSPs. They discovered that literature suggests that companies that succeed in a Lean environment have a different organizational culture than companies that do not. Some of the cultural traits that contribute succeeding in a Lean environment are implicit and easy to understand, while some traits could be difficult to understood and defined. (Fadnavis, Najarzadeh, & Badurdeen, 2020)

Fadnavis et al. mentioned that the cultural features found in the research can help companies identify and make the necessary changes to them. Corporate culture is very implicit and difficult to change. Change, if it happens, is organically and/or intentionally made and happens very slowly. They mentioned two easily recognizable characteristics of the company culture that would be good to strengthen:

- Initiative for continuous improvement and
- openness in communication.

These two features were found to speed up the finding and implementation of a sustainable solution.

They summarized their research in six hypotheses to examine whether there is a correlation between some traits of culture of the organization and the ability of the team members

(people, individuals) in terms of the success of problem-solving projects. Fadnavis, et al, used Paul Bate's study (1984), "The Impact of Organizational Culture on Approaches to Organizational Problem-Solving" as foundation for their study were Bate defined six undesirable corporate cultural traits that affect problem solving projects negatively.

Bates study presented six unwanted cultural traits were reviewed and their impact on the organization problem-solving projects was determined. Even though the paper was written in an era (1984) when industrial practices were quite different this work can be thought one of the first corner stone studies where the connection of unwanted cultural traits to problem-solving projects had been investigated. The study was conducted in three different industries by interviewing employees of them.

The following is a list of negative cultural traits that Bates has found to adversely affect organizational problem solving, along with the positive effects of some of the opposites of the same traits that Fandis et al. stated in their own research. In addition, the list includes two cultural characteristics defined by Anthony & Gupta 2019, in paper "Top ten reasons for process improvement project failures" which have been found to influence of the sustainable solution found from the PSP. ("pos" = positive correlation; "neg" = negative correlation)

- **Unemotionality ("neg")** is the avoidance of sharing feelings, emotions, or individual views for fear of being used against those who share them. (Bate, 1984)

Unemotionality ("pos") Problem solving is faster than individuals are not emotional. Solving problems depends greatly on the openness of individuals to share possible solutions. There is a positive correlation between unemotionality, openness and idea sharing among problem solving team members and how good and quickly problem can be solved. (Fadnavis, Najarzadeh, & Badurdeen, 2020)
- **Depersonalization ("neg")** is a fear of taking responsibility. Organizations that criticize employees more than praise them feed this negative culture. This kind of culture can lead to a situation where problems are not identified early enough, leading to the accumulation of waste at the end of the process. (Bate, 1984)

Encouraging open discussion ("pos"). Individuals should have the permission and courage to speak without being underestimated or even accused for the found deviations. The research suggests that the feature of the company culture that encourages open expression is positively correlated to the identification, processing, and prioritization of problems. (Fadnavis, Najarzadeh, & Badurdeen, 2020)

Increasing unemotionality and reducing depersonalization could be promoting and encouraging open expression and receptivity, which could improve alertness to recognize

the problem and thus speed up the whole problem-solving process. (Fadnavis, Najarzadeh, & Badurdeen, 2020)

- **Subordination (“neg”)** is a person who avoids taking initiatives. This person rather waits until supervisor or authority takes initiative. This trait could lead to situations where problem identification is weakened or not done at all. (Bate, 1984)

Taking individual initiative (“pos”) is taking initiative before supervisor’s order or approval. Empowering individuals to practice this cultural trait will ensure more effective problem solving as they are most knowledgeable about the work. This practice will ensure more effective problem solving. (Fadnavis, Najarzadeh, & Badurdeen, 2020)

- **Conservatism (“neg”)** refers to an individual's feeling where the individual thinks that his presence or contribution has no value and thus leaves out the problem-solving process. (Bate, 1984)

- **Isolation (“neg”)**. Isolationism or isolationist behavior is the practice where individuals avoid interfering with or, contributing to improve, others’ work, "it does not belong my responsibility". In such an environment, individual creative performance is reduced because there is minimal or no interaction between team members. Thus, problem solving as a team becomes an almost impossible task. This can also lead to a larger problem where team formations are biased, with certain members of the same values holding one and ignoring other opinions. Open communication, good interaction and teamwork are necessities for PSPs. (Bate, 1984)

Collectivism (“pos”) is the ability to work with different people, which in turn helps to collect different perspectives in problem-solving projects. Maintaining a group culture also offers more opportunities to criticize countermeasures and evaluate their advantages and disadvantages. (Fadnavis, Najarzadeh, & Badurdeen, 2020)

- **Receptivity (“pos”)**. The way the management responds to the voice of the employees. Receptivity is related to the organization's hierarchical communication and its importance in the organization. Responsive and healthy communication, up/down in the hierarchy, contributes to the quick resolution of problem situations. How often and quickly do individual problems or grievances reach management? Does the management consider the concerns of individuals? All of these affects how individuals perceive and receive management support and how they can influence and participate in problem identification for the overall benefit of the organization. (Fadnavis, Najarzadeh, & Badurdeen, 2020)

- **Antipathy (“neg”)** refers to the shallowness of relationships, which leads to a lack of trust and isolation. This trait can also lead to extreme group formation, where a certain group of individuals strongly believe in certain values that they stand for despite an attitude that leans more towards adversaries than allies within the organization. (Bate, 1984)
- **Forming of unions (“pos”)**. Management may consider unions an obstacle to changes in operating methods or cultural change. The study showed that unions must be allowed to form when the goals are in line with the goals of the organization. It contributes to community and a sense of belonging to an organization, which in turn contributes to problem-solving in projects. (Fadnavis, Najarzadeh, & Badurdeen, 2020)
- **Appropriate rewards and recognition system (“pos”)**. Many things support the idea of rewards and recognition to keep employees motivated and improve their morale, which in turn leads to better productivity and performance at the individual and organizational level. Due to the participation in many projects and their time constraints, the employees are constantly busy. Therefore, it is advisable to encourage their efforts with appropriate recognition and rewards. Therefore, properly timed and measured recognition and reward practices for success help inspire employees to work towards achievement. (Antony & Gupta, Top ten reasons for process improvement project failures, 2019)
- **Resistance to change (“neg”)** Changes need the acceptance of a new culture. The role of employees is crucial in the success or failure of any PSP. There is ample evidence to confirm that employee participation and involvement is key to successfully implementing change management. The employees affected by the change must be participated in each PSP phase. Even if the change is positive, employees are not always ready to accept the improvements found through "PSPs". By involving employees in to "PSPs", rather than providing right solutions to them, ensures that employees are not only buy the counter measures, but also own the counter measures. (Antony & Gupta, Top ten reasons for process improvement project failures, 2019)

Next chapter is the summary of literature review presented in a perspective John Kotter’s 8 Step Change Model.

2.4 Integration of Kotter's 8-step change model and problem-solving methodology

Since this thesis deals with the challenges of permanent change in the context of problem-solving projects, Kotter's 8-step change model cannot be left ignored or discussed.

This last chapter of the literature review discusses both Kotter's 8-stage change model and the DMAIC problem solving method in one context as if they were integrated together. The reason for this review is that one solution to the research question could be to follow Kotter's 8-step change model, while all the previously presented problem-solution models (A3, D8, DMAIC, etc.) quite consistently already follows the same process as Kotter's did in its 8 steps of change model. Only difference to Kotter ideology is that problem-solving methodologies are additionally giving tools for problem-solving. DMAIC is used as an example here because it is presented earlier in this thesis.

John Kotter described change management as a process with 8 stages or steps. Leader can get through the change with the help of his subordinates and/or team members if he/she performs the tasks included in each step well enough. The steps are built in chronological order, but in reality, the leaders manage these related challenges and tasks in parallel and move between them if necessary. (Viitala & Jylhä, 2019, p. 284)

Comparing and combining Kotter's 8-step change model (K8C) with the traditional DMAIC problem solving method or any PSP methodology, it can be found that there are surprisingly many similarities between them. Below comparison is done using three main categories of Kotter's philosophy and 5 steps of DMAIC. See Figure 6: Integration of John Kotter's 8-step change model with DMAIC. The philosophy of Kotter's 8-step change model and step/phase meanings are explained in this thesis only superficially in the comparison below, not separately and thoroughly. Here are some recommended documents for Kotter's model that can also be found in the reference list: Appelbaum, S. H., Habashy, S., Malo, J.-L., & Shafiq, H. (2012). Back to the future: revisiting Kotter's 1996 change model and Rajan, R., & Ganesan, R. (2017). A critical analysis of John P. Kotter's change management framework and Viitala, R., & Jylhä, E. (2019). Johtaminen: Keskeiset käsitteet, teoriat ja trendit

- In K8C, under umbrella "Creating climate for change" are steps: "Create urgency", "Form a powerful coalition" and "Create Vision for Change" could be referred to DMAIC's phase "Define" as both ask for urgency and need for change/resolution, team formation and involvement of right team members as well as stakeholders. In these first steps, both philosophies ask to create a vision and set goals for the changes.

- In K8C under “Engage & enable the organization” steps are: “Communicate the vision”, “Empower others”, and “Create quick wins” could be referred into DMAIC’s phases “Measure”, “Analyze” and “Improve”. The common story would go like this: With the help of a communicated vision, the right values are measured. With the help of empowered people, the analysis and found solutions can be quickly implemented into the process.
- Under last umbrella of K8C, “Implementing & sustaining for change” steps are: “Build the change” and “Embed the change”. Viitala & Jylhä (2019) are discussing following: Desired change and specially to have sustainable change will take time. The management should be able to strengthen the thinking and actions required by the change long after the change has been implemented, because just looking at the surface it may seem that the achievement has already been achieved. Even, after long time after implementation monitoring should continue for possible further improvements. To enforce sustainable change, proper recognition, and award system as well as schooling should be in place and if needed also with controlling. When the desired change is permanent, it is considered to be rooted in the company's culture. Often this requires time, repetitions, reinforcement with different management methods and positive experiences that the new business model is good. (Viitala & Jylhä, 2019, p. 286)

In DMAIC’s the corresponding step for this is “Control”. It includes measuring the implemented solution to verify the success and for further development. Process standardization with Control plan and work instructions. The main purpose is to hold the achieved gain. “Implementing, Sustaining, Learning/Benefits, measure new base line, Monitor in ongoing basis for any signs of new problems!”.

The common story would go like this: Establishing a new practice in everyday operations requires long-term monitoring and measurement to ensure success and/or new evaluation for the possible need for adjustment. This is responsibility of management and/or leader of problem-solving project. In addition to this, an appropriate evaluation of the final results should be carried out. To ensure this, project closing meeting should be organized that helps to ensure that "lessons-learned" will be done and participants will be recognized.

In the perspective and context of the thesis problem these last steps from both philosophies could be the main point of this thesis as here the changes-/corrective-/preventive actions are to be supposed to be nailed into everyday practice and embed into corporate culture.

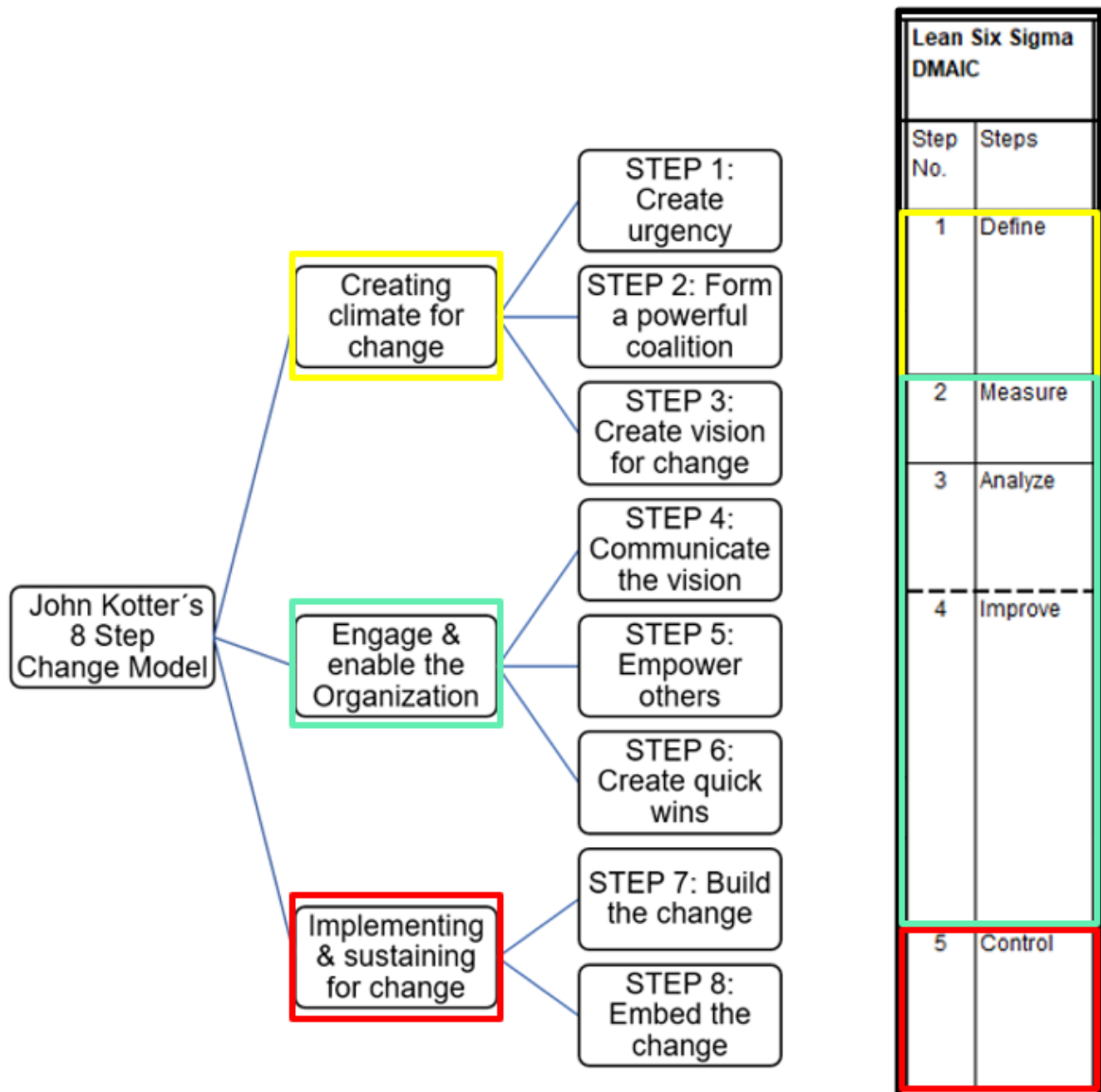


Figure 6: Integration of John Kotter's 8-step change model with DMAIC. Writer own drawing from the explained situation.

Next chapter will discuss and explain the key aspects of the chosen methods and methodologies, as well as the selection criteria, why they were chosen to conduct the research.

3 Research methods and methodologies

This chapter explains and discusses the data collection and analysis methods and methodologies used as well as gives a short idea about the process to conduct this thesis. The purpose of this chapter is also to give a possibility for readers to evaluate thesis reliability and validity through chosen methods. The first part, 3.1. introduces the research

process, the second part 3.2. presents the features of quantitative and qualitative research in respect of the case study. The third part 3.3 explains which methods were used for data collection and analysis. Part four 3.4 consist of a brief presentation of the case company and finally section five 3.5. discusses the ethical aspects and provides explanations for the trustworthiness of the thesis.

3.1 Research process

Flow chart of research process is illustrated in figure 7: Research process. The preliminary proposal for the topic of the Master's Thesis was discussed with the quality manager of the case company. The subject was a natural choice for the author of the thesis as a continuation of previous competences and due to the general interest in problem solving methods. However, the most important reason for choosing the topic was the obvious need to find and define improvement proposals how to implement preventive measures into everyday activities of case company processes. Approval for thesis was 3-way discussion with thesis supervisor, case company quality manager and writer were held. The topic, objectives and goals were found to be feasible. Shortly after, familiarization for the literature began with help of defined key concepts and key words.

Getting acquainted with the THEORY PART and conducting the EMPIRICAL PART (archival study and interviews) were two separate processes that were done partly in parallel. The theory part started earlier by getting to know the selected literature from previous studies and theories related to the presented problem. When the theory part was conducted to the point where the thesis writer had a reasonable understanding of the context the empirical part of studying PSP reports started. The theory part and investigating and analyzing reports were done to the end at the same time. Analyzes and results from PSP reports, were done intentionally before interviews, as information from there could give some additional insights when planning the manuscript of thematic interviews. As soon as both empirical data collections were done, analyzed, and results formalized started phase DISCUSSIONS AND CONCLUSIONS. During this phase answers to the research questions were written, improvement suggestions were presented and continuation for further studies was discussed. The last part of the thesis process was the final presentation, finalizing the outcome of the thesis, and handover for grading.

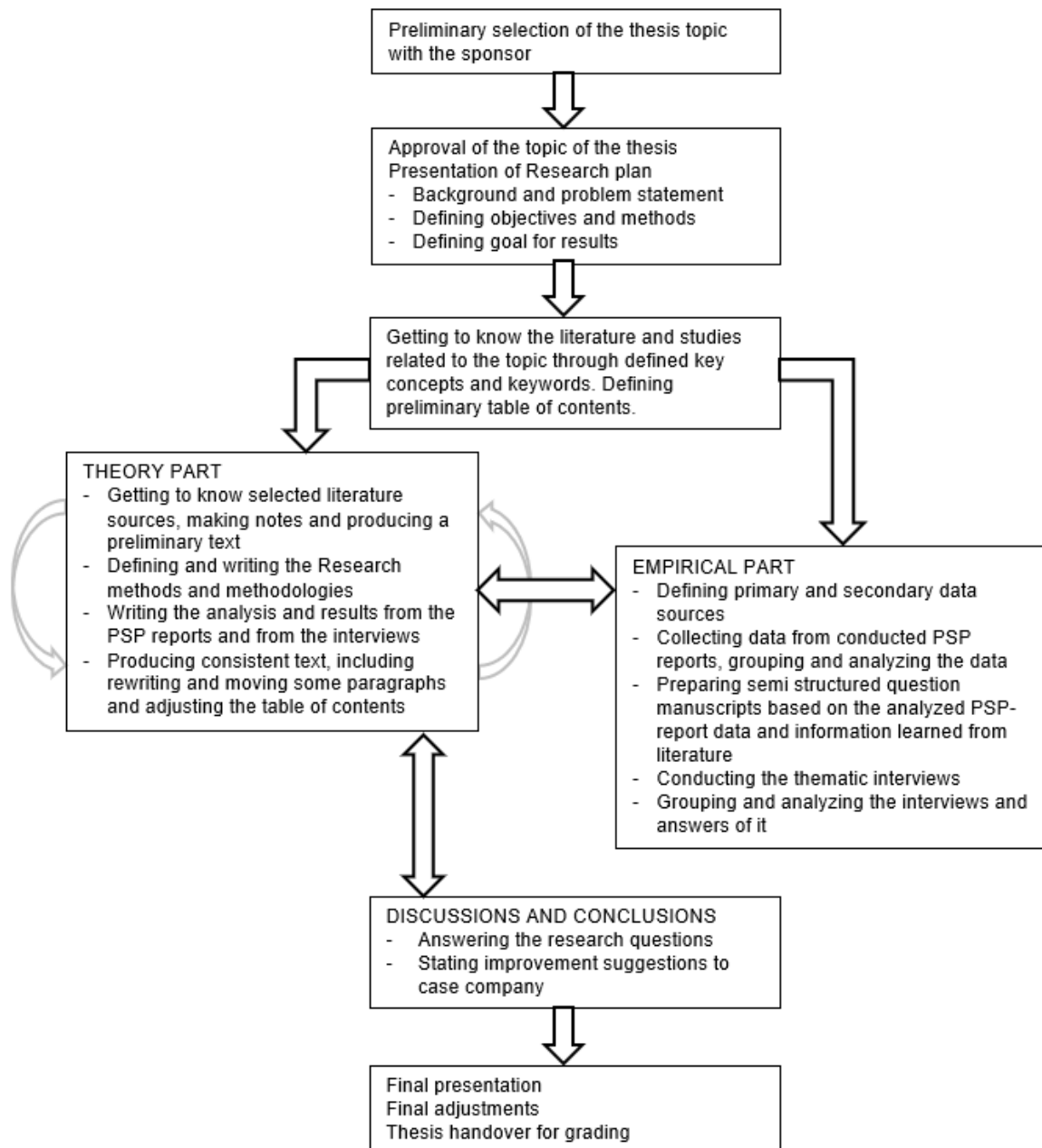


Figure 7: Research process

3.2 Quantitative and qualitative research in case study

This case study has been done according to the methods of qualitative as well as quantitative research methods. Based on the key concepts defined in the context of the theoretical framework, the literature was first examined through the basic concepts of quality followed by to get acquainted with the problem-solving history and methods. The latter part of literature review dealt of previous studies and theory concerning problem area, challenges in implementing sustainable solution in PSPs. The theoretical part provided a

clear picture and understandings of the problem area and gave insights on how to plan and construct the empirical part of the study.

Definition of case study. Eriksson & Kovalainen (2016) used two sets of examples. The first was cited from "Quantitative Inquiry and Research Design", Creswell, J.W (2012) and the second from "Case Study Research", Yin, R (2014). Combining these two definitions, a case study is:

- A bounded system which can be defined in terms of time and place (e.g., an event, an activity, individuals, or group of people).
- Conducted over certain time and through detailed, in-depth data collection.
- Empirical research that examines a contemporary within its real-life context when the boundaries between of the phenomenon and the context are not clearly evident.
- Involving multiple sources of information that are rich in context.

(Eriksson & Kovalainen, Qualitative methods in business research (2nd edition), 2016, p. 132)

In addition to the previous list, Laine et al (2007), listed a few additional features that describe the case study:

- The target is usually a small number of cases, often only one.
- Typical data is qualitative but quantitative data can be used as well.
- Main purpose is to understand the context of the case.

(Laine, Bamberg, & Pekka, 2007, p. 12)

Definitions of quantitative and qualitative research. These two different approaches of research are easier to explain making comparison to each other instead of defining them separately.

- Qualitative research can be thought as a contrast of quantitative research.
- Qualitative approaches are about interpretations and understanding, while quantitative approaches are about explanations, hypothesis testing, and statistical analysis.
- In qualitative research methods, data collection and analysis are sensitive to the social and cultural context, when the goal is a comprehensive understanding of the

researched issues, while quantitative approach concentrates phenomenon's where numbers and statistics and rarely leaves room for interpretations related to social and cultural context.

- Quantitative research is more prone to structured, standardized, and abstract models for collecting and analyzing empirical data.
- It is appropriate to use qualitative research when investigating something that is easier and more appropriate to express in words and that cannot be clearly interpreted or explained with numbers.

(Eriksson & Kovalainen, *Qualitative methods in business research* (2nd edition), 2016, pp. 4-5)

3.3 Data collection and analysis methods

Case studies should be not limited only to a single source of data, like for example as the use of plain questionnaires for carrying out a survey. In fact, good case studies benefit from having multiple sources of evidence. Six most common sources of data listed by R. Yin in his Book, "Applications of Case Study Research" are: Direct observations, Interviews, Archival records, Documents, Participant-observation, and Physical artifacts. The combination could be whatever suits best. Case study data collection, evidence could be fetched from both quantitative and qualitative data. (Yin, 2012, pp. 11-12)

This study used two sources of data. Secondary data was quantitative data from PSP-reports. The analysis of the data happened in separate Excel sheet that is not presented in this thesis because of confidentiality and anonymity.

Primary data, which was qualitative, was obtained from semi-structured thematic interviews with selected key participants involved in the problem-solving projects. Also, here the analysis of the data happened in a separate Excel sheet that is not presented in this thesis because of confidentiality and anonymity.

Following two chapters describes how the data collection for the thesis was done. Since PSP often takes place on several levels and involves the cooperation of different parties, it was deemed appropriate to collect material and data from several different perspectives, not only from the point of view of the participants in the problem-solving projects, but also by studying the respective written documents.

3.3.1 Internal archival records, secondary data source

The collection of secondary data, archival records is explained here first, as it happened chronologically during the research process before the primary source data collection, the interviews.

Data collection and analysis of PSP reports were limited only to found 8D and A3 reports that were made between January 2020 and August 2022 and those reports that were stored in mutually agreed and known locations within the case company. Therefore, the study did not receive information about reports that were possibly stored elsewhere and/or in personal places.

Secondary data collection from the PSP reports was done deliberately before planning the interviews, because the assumption that the analysis of the reports would give a better understanding of how to plan a thematic interview script and who would be appropriate to interview. The author of the thesis had a hypothetical assumption about insufficient follow-up/monitoring of the task, so more attention was paid to this in the analysis of the reports.

The data collection and analysis focused on information that was intended to reveal how preventive actions have been dealt:

- Were countermeasures to the found root causes defined as tasks?
- Was the responsible person appointed to the task?
- Was the target time defined?
- Was the task declared complete?

3.3.2 Thematic interviews, primary data source

Thematic Interview was conducted with open-ended and semi-structural conversational questions which to be successful required a pre-planned script.

The aim for such interview is to create an environment to reveal how case study participants constructs their lived experience (reality) and think about situations, not just to providing the answers to a researcher's specific questions. With this method, the purpose is to get more insightful answers than with the closed questions and questionnaire, where the answer could be more general and implicit. (Yin, 2012, p. 12)

The challenge in such interview is to ensure that all planned topics will be covered and at the same time being ready to get even more in-depth answers. Following the manuscript too closely could prevent important issues from being revealed. (Eriksson & Kovalainen, 2016, pp. 94-95)

The wording and the order of the questions changed and varied during the interview. This enabled interview to be kept as conversational and informal as possible. For this type of interview to be successful, the interviewee must have experience to conduct interviews and have certain experience in the subject. The author of the thesis had gained at least a reasonable amount of experience by writing a few essays during his studies, in which dozens of interviews were conducted.

The questions that were used in manuscript were not given to the interviewees to read in advance. The interviewees were acquainted to the topic in an invitation where the topic was explained be part of the thesis, where the purpose was to examine the challenges of implementing the countermeasures found from problem-solving projects, i.e., ensuring corrective measures, into permanent solutions and methods of operation for the different processes in the case company. Conversational interview was told to be completely anonymous interview without on-line recording. The answers to the discussed questions were said to be prepared together with the interviewee only either with keywords or using key sentences. The purpose of this was to refine the answers and to simplify them so that the analyzed phase would be easier and smoother. Additional reason was to secure conformability making sure that answers were based on participants' responses and not any potential bias or personal motivations of the thesis writer.

The interviewees were primarily chosen based on their experience of participating in problem-solving projects. The second criterion was that every personnel group was represented, and the third criterion was that the interviewee does things in his/her everyday work with problem solving issues, continuous improvement, or quality. The interviews were conducted remotely in November 2022, with 12 interviewees. The length of the interviews was from one to three hours with average duration a bit more than 1,5 hours. First few warming up questions were related to interviewee background, professional experience in case company, Lean Six Sigma belt level or other education in problem-solving methodologies, and thoughts and insights from these. Rest of the questions was semi-structured questions aiming to have open conversation that would hopefully lead discussions to more in-depth thoughts regarding context and for possible insights regarding process improvement suggestions or revealing missing parts of it. Conversational questions were divided onto two main themes. Hard side discussion was related to processes, structures, and organizational matters while soft side discussed general feelings,

leadership, behavioral, and cultural matters. Examples of discussed questions are presented in Appendix 1: Thematic interview questions: Hard side and in Appendix 2: Thematic interview questions: Soft side.

Below is a table with the basic information of the interviewees. Job titles are only reported at management and engineering level for anonymity. The best quotes exemplified to support the analysis of the thematic interviews are referred to as interviewees A, B, C, D, E, F, G, H, I, J, K and L. These randomly chosen letters do not follow the order of Table X, but still follow the way one and the same letter always corresponds to a quote from the same person.

Level	Work experience in case company [in years]	LSS Belt Level
Management	38	Black Belt
Management	10	Yellow Belt
Senior engineer	25	White Belt
Senior engineer	23	Black Belt
Senior engineer	10	Yellow Belt
Senior engineer	1	Black Belt
Supervisor	3	White Belt
Supervisor	3	White Belt
Engineer	23	Yellow Belt
Engineer	2	Green Belt
Engineer	25	White Belt
Engineer	15	White Belt
Average experience	14,8	

Table 2: Basic information about the interviewees

Manuscript for the thematic interviews was prepared into one big excel sheet for few reasons. One was that it used as note taking, easy to be handling and asking the questions in random order and easy making notes to questions in random order for those questions that was already unintentionally answered during the open discussion. The other reasons were to have data in convenient available and sorted per discussed questions and themes. This simplified the process during analysis and helped to detect extreme answers and outliers, and finally to get the main interpretation from the questions and discussed topic.

During the analysis and result phase the two main themes “Hard side” and “Soft side” questions and answers were additionally divided into sub themes. The reason for this was, rather than opening up all questions and answer separately only the sub theme with key

words and key sentences was revealed. The questions that were in subtheme was mentioned, like example below:

SQ7 and SQ8. Subtheme: Responsibility and individual initiative.

- Only two out of twelve could clearly state that people are proactive and take responsibility when it comes to PSPs. Rest says that there is room to improve. To the question who the initiators for the PSPs are, the half of the interviewee said that the request is coming from customer and from request of superiors, as well as on their own initiative, i.e., from all sides. The other half says that the requests are coming from customers and at the request of superiors, i.e., never from own initiative.
 - *I could say that it could be improved. There are things that are bad and do not go forward. The complaint is strong, but still, some don't want to do anything about it. Follow-up must be strict so that things progress. (Interviewee B)*
 - *... (continues with few other comments)*

Next chapter introduces case company.

3.4 Introduction of case company

The introduction of the company is kept as short and general as possible, for the same reason that the interviews were kept anonymous.

The case company is a local production unit in a large multinational conglomerate company that specializes in high technology. The industry of the local case company is the manufacture of electric power technology components. The main customers of the manufacturing unit are producers of renewable and sustainable energy. The unit has 70 years of tradition in manufacturing its products in Finland.

3.5 Ethical aspects and Trustworthiness

Ethics are important for science. It is said that ethics is a natural understanding of what separates right from wrong. Most research questions have some ethical aspects if they are not directly related to the research questions, they may be related to research practices, processes, or the general research area or manner that determines the relationship

between the researcher and the research. (Eriksson & Kovalainen, *Qualitative methods in business research* (2nd edition), 2016, p. 64). Research sponsorship and freedom to choose research data and methods. The author of the thesis did not receive any monetary or other compensation from the case company for doing the work, nor were there any restrictions from company side on how the research should be done and what data may be used. However, the researcher is in a professional relationship with the case company, which could be ethically questionable in terms of the results. However, at the beginning of the thesis, during the assignment, it was agreed that the results will be impartial, so that neither side, the case company, or the researcher, will benefit from them by any means. Responsibility towards others and the case company. The case study was done for the company in such a way that possible connections to its functions and processes were left as little attention as possible. The interviews were conducted anonymously. The interviewees participated of their own free will and were given the opportunity to withdraw from the interview at any time. Notes and analyzes of the interviews are not public and part of the thesis due to anonymity. However, the interviews and analyzes can be seen by the supervisor of the thesis and the client of the case company upon request.

Trustworthiness or rigor of a study refers to the degree of confidence in data, interpretation, and methods used to ensure the quality of a study. (Polit & Beck, 2014)

If research relies on that the researcher (thesis writer) and the participant (interviewee) jointly create understandings it is advised to replace the traditional notions of validity, reliability, and generalizability with the parallel concept of 'trustworthiness' containing four aspects: credibility, transferability, dependability, and confirmability. (Eriksson & Kovalainen, *Qualitative methods in business research* (2nd edition), 2016, pp. 307-308)

- **Credibility** is the how confident the qualitative researcher is in the truth of the research study's findings. How to know that findings are true and accurate? To verify this triangulation could be used. Triangulation in case study means combining both qualitative and quantitative research methods where both separately should give same or similar result. (Eriksson & Katri, *Monenlainen tapaustutkimus*, 2014, p. 46) Credibility in this thesis could be said fulfilled as both qualitative and quantitative method are used. Both directions (analyzing the reports and interviews) separately gave similar answer.
- **Transferability** means the responsibility to demonstrate the similarity between this thesis and other research, so that there is a connection between the results. A similar study was found, which dealt with the problems of the thesis. For example, scientific articles Anthony & Gupta (2018). "Top ten reasons for process improvement failures" and Fadnavis et al (2020), "An Assessment of Organizational

Culture Traits Impacting Problem Solving for Lean Transformation” are good examples of this.

- **Dependability** means that the research should be repeatable. If the thesis is to be repeated, it should provide enough information so that similar results can be achieved. Additionally, the whole process should be logical, traceable, and well documented. This thesis, it has been ensured by describing the process in as much detail as possible, such as proper citing’s, defining the criteria for data collection, and describing the data analysis methods in detail to name a few.
- **Confirmability** means that the findings are based on interviewees responses and not any potential bias or personal motivations of the thesis writer. It must be ensured that the author's bias does not distort the interpretation of what the interviewees of the study said fit a certain narrative. To establish confirmability in this thesis during note taking the answers was mutually prepared with co-operation of interviewees as described in chapter 3.3.2. Thematic interviews.

4 Results of the analyzed data

This chapter consists results of the analyzed data collected from two sources. Primary data was collected through semi-structured thematic interviews and secondary from the case company's PSP reports. All analyzed PSP reports were made accordance eight disciplines (8D) and A3 methodologies.

Data from both sources have been analyzed in separate Excel sheets that are not presented in this thesis because of confidentiality and anonymity.

4.1 Results of analyzed of A3 PSP reports.

The data collection was limited to time span January 2020 and August 2022 and only for the following points and steps of A3 methodology:

- the number of reports
- the participants divided into two groups Management level and non-Management level.
- the “Development and Plan Countermeasures”, step 6 in A3-method
- the “Check Results”, step 7 in A3-method
- the “Standardize”, step 8 in A3-method.

In below Table 3 is summary of analyzed A3-reports. Total number of analyzed A3-reports was 20 in the mentioned period. Separate analysis between management level and non-management level was done. The minimum number of participants in problem-solving projects mentioned in reports was 1 person while the maximum was 10. Average was 4,75 persons. The total number of countermeasures was 74 and from those 18 (24%) were reported to be completed with the responsible person and date. The two last steps “Check Results” and “Standardize” had no reported evidence of completion in none of the reports. There was no significant difference between management and non-management conducted of projects. Combined summary of A3 and A8 are presented in the paragraph “4.3 Summary of analyzed reports”.

prsn = person; pcs = pieces	ALL	Management level conducted	Non-Management level conducted
Total found and analyzed A3-reports	20 pcs	7 pcs	13 pcs
Min participants	1 prsn	2 prsn	1 prsn
Max participants	10 prsn	10 prsn	9 prsn
Average participants per report	4,8 prsn	5,2 prsn	4,5 prsn
6 - Develop and Plan Countermeasures			
Total number of countermeasures	74 pcs	28 pcs	46 pcs
The total number of countermeasures that have been reported as completed	18 pcs	6 pcs	12 pcs
Percentages of completed countermeasures	24 %	21 %	26 %
7 - Check results	Not reported		
8 - Standardize	Not reported		

Table 3: Summary of A3-reports

4.2 Results of analyzed 8D PSP reports.

The data collection was limited to time span January 2020 – August 2022 and only for the following points and steps.

- the number of reports
- the participants divided into two groups Management level and non-Management level.
- the “D6-Corrective actions” (reports having corrective actions)
 - Reports having responsible person nominated.
 - Reports having corrective actions completed.
 - Reports having no evidence of actions completion.
- the “D7-Recurrence prevention”

- Reports having preventive and sustainable actions.
 - Total number of preventive and sustainable actions
 - Actions having responsible person.
 - Actions having target date set.
 - Actions completed.
 - Actions having no evidence of completion.
- the "D8-Closure and lesson learned."

In below Table 4 is summary of analyzed 8D-reports. The total number of analyzed D8-reports was 21 in the mentioned period. Separate analysis between management level and non- management level was done. The minimum number of participants in PSPs mentioned in reports was 2 while the maximum was 14. Average was 6,5 persons. Corrective actions (step D6) were mentioned in all 21 reports. Reports having responsible persons nominated were 9 (29%). Reports having corrective actions completed were 19 (90%) while the rest 2 (10%) were without evidence of their completion.

Reports having preventive and sustainable actions were 18 (86%) and the total number in these was 49. The number of actions having nominated responsible persons was 34 (69% from total number of actions). Target date in these were set in 31 (63%) actions. Actions were completed in 18 (37%). The rest of the actions 31 (63%) were without evidence of their completion. The summaries and conclusions made from these analyzes are presented in the next paragraph. Combined summary of A3 and A8 are presented in the next paragraph.

	ALL	Management level conducted	Non-Management level conducted
prsn = person; pcs = pieces			
Total found and analyzed D8 reports	21 pcs	10 pcs	11 pcs
Min participants	2 prsn	2 prsn	2 prsn
Max participants	14 prsn	14 prsn	9 prsn
Average participants	6,5 prsn	7,3 prsn	5,8 prsn
D6 - corrective actions (reports having corrective actions)	21 pcs, in all reports	10 pcs, in all reports	11 pcs, in all reports
Reports having responsible persons nominated	9 pcs / 29%	4 pcs / 40%	2 pcs / 18 %
Reports having corrective action completed	19 pcs / 90%	8 pcs / 80 %	11 pcs / 100 %
Reports having no evidence of actions completion	2 pcs / 10%	2 pcs / 20%	0 %
D7 - Recurrence Prevention			
Reports having preventive and sustainable actions	18 pcs / 86%	8 pcs / 80%	10 pcs / 91%
Total number of preventive and sustainable actions	49 pcs	28 pcs	21 pcs
Actions having responsible persons	34 pcs / 69%	25 pcs / 89%	9 pcs / 43%
Actions having target date set	31 pcs / 63%	25 pcs / 89%	6 pcs / 29%
Actions completed	18 pcs / 37%	9 pcs / 32%	9 pcs / 43%
Actions having no evidence of completion	31 pcs / 63 %	19 pcs / 68 %	12 pc / 57 %
D8 - Closure and Lesson learned	Not reported		

Table 4: Summary of D8-reports

4.3 Summary of PSP-reports

The purpose of this summary is to present findings from analyzed reports that, based on literature and research, have been cited as signs in companies that have failed to implement sustainable solutions.

First, a recap regarding terminology and concepts.

- **Corrective action** is an action to eliminate the cause of a nonconformity and to prevent recurrence. Corrective action is taken after a problem happens in a process. Reactive activity - happens after the fact. Includes assessment of root cause and a plan to prevent recurrence.
- **Preventive action** is an action to eliminate the cause of a potential nonconformity or other potential undesirable situation. Proactive activity - acts when a risk is identified. Includes assessment of root cause and a plan to prevent occurrence.

(European Committee for Standardization, ISO 9000, 2015), (Advisera, n.d.)

This summary of reports does not comment about the correctness of report identification, place of archiving, nor the quantity of the reports.

- **Thorough usage of steps.** None of the analyzed A3-reports were completely filled out. This does not necessarily mean that tasks have not been completed, but nevertheless it gives the impression that something might have been left undone.
- **Corrective actions.** The term “Corrective actions” is not mentioned in-A3 reports but can be referred as “Countermeasures”. In the A3 reports, only 24% of the corrective measures were shown to have been completed. In the D8 reports, 90% of the corrective measures had been reported as completed.
- **Preventive actions.** The last two steps in A3 reports, step 7- Check Results and step 8- Standardize are totally missing from all the reports. In 8D-reports, step D7- Recurrence Prevention, was reported to be completed only in 37% from all preventive actions.
- **Conducting last steps in both methodologies are missing.** The last to steps in A3-reports, step “7- Check Results” and step “8- Standardize” are totally missing from all the reports. Same observation can be said from D8, the steps “D8 - Closure and Lessons learned” are enlightened with their absence. These final steps must be completed to secure permanent change in the organization. In the absence of these, it is very difficult to ensure it with other way if the change has been successful and/or if the change has been implemented sustainable into organization everyday practice.

Total found and analyzed A3-reports	20 pcs
Step 6 - Develop and Plan Countermeasures	
Total number of countermeasures	74 pcs
The total number of countermeasures that have been reported as completed	18 pcs
Percentages of completed countermeasures	24 %
Step 7 - Check results	Not reported
Step 8 - Standardize	Not reported

Total found and analyzed D8 reports	21 pcs
Step D6 - Corrective actions (reports having corrective actions)	21 pcs / 100%
Reports having responsible persons nominated	9 pcs / 29%
Reports having corrective action completed	19 pcs / 90%
Reports having no evidence of actions completion	2 pcs / 10%
Step D7 - Recurrence Prevention	
Reports having preventive and sustainable actions	18 pcs / 86%
Total number of preventive and sustainable actions	49 pcs
Actions having responsible persons nominated	34 pcs / 69%
Actions having target date set	31 pcs / 63%
Actions completed	18 pcs / 37%
Actions having no evidence of completion	31 pcs / 63 %
Step D8 - Closure and Lesson learned	Not reported

prsn = person, pcs = pieces

Table 5: Combined results from A3 and 8D reports

4.4 Results of the thematic interviews

In this chapter results from interviews will be presented. The interviews were conducted remotely in November 2022, with 12 interviewees. See more information about the conducted interview from chapter 3.3.2 Thematic interviews, primary source. Key findings for both of themes, “Hard” and “Soft” are presented in chapter 5.1. Discussions and conclusions of the research findings.

Case company’s policy and aim is to have all personnel to get trained for at least Lean Six Sigma (L6S) White-Belt qualification. The average belt color of the interviewees was slightly higher than the Yellow-Belt level, which can be interpreted as the group had sufficient knowledge of PSP methodologies and an understanding of the topic of the thesis. Although

there was a big difference in education levels and work experience, the views and problems of improvement proposals and improvement goals were surprisingly similar between the interviewees.

Data from interview have been analyzed in separate Excel sheets that are not presented in this thesis because of confidentiality and anonymity.

In following two sub-chapters the results of interviews are presented.

4.5 Results of Hard Side - interviews

Questions to this analysis are presented in Appendix 1. Questions will be not presented here instead they are referred as **HQ1**, **HQ2**, **HQ3** and so forth. In addition, the questions are grouped into subthemes and keywords which are to explain the context of the topic. After the analysis of each sub-theme, a few quotations from the answers are presented which, in the author's opinion, give the best insight of the discussed theme. For the sake of anonymity and ethics interviewees are referred only with capital letter. [A to L].

HQ1 and HQ2. Subtheme: Educational level, learning, importance

- All the participants had at least a White belt level education and three of them had a Black belt level. The average Belt color of interviewees was yellow.
- Vast majority (83%) of the interviewees considered the belt- and L6S-courses they participated have been necessary. The noteworthy thing was that three of the five WB level persons wanted or were in the process of updating the belt color to YB level.
- A bit more than half (58%) of the interviewees expressed to learn new issues from the courses. Rest of them didn't learn new issues as they were repetitions from previous courses. Clear indication from interviewees to be eager to learn new from problem-solving methodologies.
- Average 4,6 was the rating when the question was "How important do you consider solving problems using structured methods? 1 = no use 5 = one of the most important quality and development tools. Following few quoted answers where typical viewpoints of the matter.
 - o *Four, if we can get it on the shop floor.* (Interviewee C)

- *My opinion is 4, but it should be 5. (Interviewee J)*
- *Five, no doubt! (Interviewee A)*

HQ3, HQ4, HQ5, HQ6, HQ7 and HQ8. Subtheme: Follow-up, recordings, ending the project, transparency, lessons learned

- Two third of interviewees shares common understanding that follow-up for given tasks, especially at the final part of the project when implementation of sustainable measures should be secured are not done systematically or clear or do not even recognized that it should exists.
 - *Follow-up is unacceptably weak. We should look into mirror. (Interviewee A)*
 - *The follow-up is limping badly. You can't find or see from where you can follow the progress. (Interviewee J)*
 - *I follow my own tasks. Could be more transparent (Interviewee E)*
- To improve monitoring/follow-up, two thirds supported increasing transparency. A third of the interviewees suggested the establishment of a regular forum where all open tasks of all projects are systematically reviewed.
 - *Follow-up should be done in regularly basis. Like forum where PSP PM, task doers and sponsors are present. (Interviewee L)*
 - *It might make sense to have the tasks in one transparent application. (Interviewee H)*
 - *Separate follow-up and designated follower. Continuous Improvement Leader has been proposed. (Interviewee J)*
- Only one person claimed that the PSP-reports are archived in known locations. Rest of interviewees said that they do not know the location. Some believed that many of the reports could have been stored in personal archives.
 - *Reports and documents are not systematically named nor archived. However, we have a number booking system. All documents must have an official name otherwise they are not official. (Interviewee J)*
 - *No information. The problem is that nothing seems to be found. They are stored here and there: IMS, SharePoint, etc. (Interviewee G)*
 - *Not sure. In many places and behind many passwords. (Interviewee E)*

- When the person is responsible for managing the PSP, she/he naturally gathers information about the phases of the tasks and is thus up to date with the project situation. But when a person is only a member, she/he does not get enough information about the other tasks of the project. Even if she/he wants to, he has difficulty or even the inability to find information other than the task for which she/he is responsible. Eleven of the twelve claim that follow-up is completely missing, especially when it was the last part of the PSP, when preventive and sustainable changes are the focus.
 - *The product portfolio where I'm working for, customer does the follow-up and makes sure that given tasks are done and verified (Interviewee A)*
 - *No clue at all. I don't know even myself where to report the follow-up if I should be a PSP leader. There is no agreed follow-up actions. (Interviewee F)*
 - *From where to follow PSP, from nowhere, verifications are also missing. (Interviewee H)*
 - *From nowhere. If PSP leader informs then yes, otherwise from nowhere. (Interviewee G)*

- Closing projects so that all tasks related to PSP have been completed is only done for projects initiated by the customer where the customer is also the one who gives permission to close the project. According to the interviewees, PSPs that were started independently in the case company have never been properly closed.
 - *Never done. (Interviewee E)*
 - *Once we have found a solution, the job is considered done. If you mean about closing a project when it is implemented, then closing is never done. (Interviewee F)*
 - *Never attended (Interviewee G)*
 - *No clear project ends. For the customer we end projects. Internally they are not closed at any stage. (Interviewee L)*

- Transparency and lessons learned practices seems to be in some order at least in one out of three production lines. There information is shared in weekly production meetings and online information channel. General opinion is that cross functional transparency is lacking or at least it is weak.
 - *Only one production line has this practice in place. (Interviewee L)*
 - *There is no clear picture of what is going on in the rest of the organization. Only those things that are directly related to you, you are aware of. (Interviewee G)*

- *Lack of action. The progress of the PSP nor the agreed countermeasures are not transparently available and are not sufficiently communicated among the employees. (Interviewee J)*

HQ9, HQ10, and HQ11. Subtheme: Sustainable implementation and who should lead PSPs

- Five out of twelve interviewees mentioned that one collective follow-up forum for all open tasks for all PSPs could be a good solution to ensure sustainable implementations into the everyday practice. A need of proper company instructions was also mentioned, which clearly describes how the PSPs should be conducted.
 - *Appropriate follow-up and proper updating of instructions would be needed. As a preliminary, I have already mentioned that joint collective monitoring of PSP tasks should be in use. CIL could be one option. (Interviewee J)*
 - *Internal follow-up is totally missing. The customer who asked for the RCA follows until the end of the proof of the sustainable implementation of the countermeasures. We are currently looking into such a system to ensure proper monitoring which should help with this. (Interviewee A)*
 - *As a matter of fact, I have been thinking how this should be taken care of. One option could be to establish similar forum where to handle tasks related to customer reclamations. (Interviewee L)*
- The discussions around the subtheme “who should lead problem-solving project” had a common opinion stating that the person should, first of all, hold a decent competence i.e., knows the tools and procedures. Additionally, she/he should hold an upper belt color than yellow. Also, it was seen as beneficial if the person nominated to lead is not from the function from where the issue most likely originated from.
 - *Not given randomly to everybody (Interviewee A)*
 - *It should be given to the R&D department. A person who knows the tools and practice should be the one who leads the case. If the case is at production PM from there. Competence in the PSP procedures and tools is a must. (Interviewee C)*
 - *Quality engineer or CIL should lead. It gives more angle for the case if the outsider of the function is leading and less influence of bias. Some occasions where the problem is in the same department, the project could be led by that function. (Interviewee E)*

- The last subtheme discussed experiences about 2nd party audits when customer has returned to verify if sustainable solution has been implemented into our processes that either has removed the recurrence of possible failure or substantially reduced the occurrence of it. One production line which was earlier mentioned where customer is the major initiator of the PSPs are always returning the seek the evidence either visiting the facilities or asking completed task lists or asking to proof it via video-call. In conjunction of this it was said that the customer is driving to have PSPs completed till the end.
 - *Yes, customer has returned to ask proof are countermeasures for better quality been implemented (Interviewee F)*
 - *Yes, during second party auditing's. Customers tend to use using existing projects to verify how problem-solving projects are conducted till the end. (Interviewee L)*
 - *Yes. I have been "as an eye" (camera man) for the remote auditing for certain project where we were asked to proof those implementations where in place. (Interviewee M)*

4.6 Results of Soft Side - interviews

Questions to this analysis are presented in Appendix 2. Questions will be not presented here instead they are referred as **SQ1, SQ2, SQ3** and so forth. In addition, the questions are grouped into subthemes and keywords which are to explain the context of the topic. After the analysis of each sub-theme, a few quotations from the answers are presented which, in the author's opinion, give the best insight of the discussed theme. For the sake of anonymity and ethics interviewees are referred only with capital letter. [A to L].

SQ1, SQ2 and SQ3. Subtheme: General feeling about the PSPs carried out in the company. Feelings when you are invited to PSP. Atmosphere during PSP meetings.

- The general feeling around PSP in the company is good and even getting better. One-third of interviewees described that they have a good collaboration and a common direction to seek countermeasures. Some are a bit doubtful of success and claimed that some not properly implemented hard side issues like, proper follow-up, is missing. Some claimed that as long as the company does not have proper company instructions in place, nothing is going to change. Another thing to note was the different attitudes in meetings where the participants were only white-collar employees and in meetings where the participants were only blue-collar employees.

The white-collar employees of the design department usually had somewhat a negative attitude to meetings because they felt that meetings were set for looking for culprits, while the attitude in blue-collar employee meetings was that they were looking for a reason.

- *We have good Team Spirit in our department. Could be more people from doer side. (Interviewee A)*
- *My feeling based of "hard side"...it lowers it as I'm afraid that same problem will be faced again after half a year. If this process would be in order my feeling could be also better. (Interviewee F)*
- *General feeling always is that are we again to be blamed but calms down when things are rolling forward but still good spirit at least in the meetings of our department/office. (Interviewee G)*
- *Personnel related. Production related issues where people from quality assurance participates the meeting the vibe is good. Meetings with designers the vibe is negative, "What have we done now?" (Interviewee L)*

SQ4, SQ5 and SQ6. Subtheme: **Leading, managerial, focus, behavior, listening, possible to express oneself, equality.**

- Eleven out of twelve interviewees stated that leadership and managerial competencies seem to be driving factors to keep the focus on the topic and especially when the leader is familiar with the procedure to conduct PSPs.

The question related to whether you have experienced misbehavior such as reluctance during PSP. A third of the interviewees had noticed some reluctance in situations where people felt they were being blamed, and in some situations when they had been given a bigger task. Two-thirds claimed that they never experienced such a phenomenon.

The last question in this subtheme discussed listening, the possibility to express oneself, and equality. This topic seemed to be in order as the majority said that they are given the possibility to speak and are listened to. The vast majority felt that equality is in place. Some interviewees who are used to leading PSPs said that opinion is asked from all to make sure that all are heard. Additionally, some leaders had a one-to-one discussion after the meeting if there was a feeling for someone to have more input to give for the problem-solving. This has happened on rare occasions when the meeting had extrovert participant(s) that tend to take a room from introverted participants.

- *When the leading responsibility is with the right person, progress will gradually move forward towards a solution. The focus has rarely disappeared. (Interviewee F)*
- *The goal is always clear. The focus remains in the continuous improvement meetings. However, it is person-dependent, i.e., it depends on the meeting leader. (Interviewee M)*
- *I have noticed that some people start to search for defense positions if something is related to their own work or their own department. (Interviewee M)*
- *Surprisingly good listening, no one is shot down. (Interviewee A)*
- *The loudest ones take the space. I tend to interview everyone. (Interviewee B)*
- *People are listened. If someone is shy, the questions can be presented after the meeting. (Interviewee E)*

SQ7 and SQ8. Subtheme: Responsibility and individual initiative.

- Only two out of twelve could clearly state that people are proactive and take responsibility when it comes to PSPs. The rest of interviewees says that there is room to improve.

Regarding the question of who the initiators for the PSPs are, half said that the request is coming from customers, from superiors, and their initiative. The other half said that the requests are coming customers and from superiors, but never on their initiative.

- *I could say that - it could be improved. There are things that are bad and do not go forward. The complaint is strong, but still, some people don't want to do anything about it. Follow-up must be strict to keep things moving forward. (Interviewee B)*
- *I take responsibility. Only one out of ten is initiative. Being example gives power. At factory floor lots of people are initiative. (Interviewee M)*
- *We do PSPs by request. If i didn't see that this is not a waste of time, I could do more of them on my own initiative. (Interviewee F)*
- *By order of my superior. By myself initiatively. We have lack in our culture. (Interviewee F)*

SQ9, SQ10, SQ11, SQ12 and SQ13. Subtheme: Quantity and quality during problem-solving projects, to whom do we make PSP and reports.

- Regarding the right persons to participate in PSPs, the majority felt that the correct persons are attending. On occasions when someone is not available, or someone is by mistake left out from the invitee list can be invited for following meetings or interviewed separately. According to the interviewees, the opinion about the right number of participants in PSPs was quite clear between 5-7. It was also discussed that 1 - 2 was too few as the angle of thoughts might lacking and 9 – 10 is too many as the efficiency could suffer.

It was also mentioned that routines might lead to the same persons being more often invited. However, the general opinion about the number of participants was that each production function concerned must be represented. In addition to this, a representative(s) that a possible change will affect must be represented at the meetings.

Eight out of twelve share the opinion that the company is doing too few PSPs but in the same, they say that perhaps time to do more is limited.

For the question of whom we are doing PSPs, eight out of twelve replied to the company itself. Three replied mostly for the customer and one replied only for the customer.

- *Right persons in meetings...? Not necessarily. The routines lead to the fact that the same guys are always there. Sometimes you suddenly realize that it would have been good idea to get that person there. But eventually in some stage they will be invited. (Interviewee A)*
- *Totally we do too few problem-solving projects. Quantitatively maybe enough. Controlled and qualitatively too few. (Interviewee L)*
- *To whom we do PSPs! For our ourselves. A classic question. During the last couple of years, I have understood and internalized that these are really good tools. (Interviewee A)*
- *It seems that there are always too few people. Six is always the minimum. Each relevant function must be represented. (Interviewee M)*

SQ14 and SQ15. Subtheme: Team and community spirit. Company culture and PSPs.

- The interviewees completely agree that there is a positive correlation between community spirit and the success of problem-solving projects. Two stated that silo thinking can be observed in the company, both between individuals and

departments. One suggestion was that to reduce it, process walks aimed at adjacent functions should be arranged.

- *It is essential that we have community-spirit. The lack of it causes building up of silo-thinking and conflicts between functions, even blaming and avoidance of responsibility. (Interviewee H)*
- *Affects in a positive way. When this prevails, it is easier to bring things up. (Interviewee F)*
- In the question, which discussed what parts or characteristics the company culture should have to make problem-solving projects more successful, two things/characteristics that stood out from the others came to the fore. Half of the interviewees mentioned characteristics related to managerial issues, such as being an example, a supportive supervisor, and having a people-rewarding culture. The second half of the interviewees mentioned features related to cooperation and community, such as we-spirit, common goal, doing things for the common good, and community spirit.
 - *Management should act as an example, proof that they are interested. They could do something as an example. (Interviewee H)*
 - *The most important thing would be for everyone to understand that the common good is being sought. Courage to express an opinion, to work for common good. (Interviewee J)*
 - *To really work for one common goal to see the value of doing it together (Interviewee L)*

5 Discussions and Conclusions

This last main chapter “Discussions and Conclusions” contains four sub-chapters. In the first Sub-chapter “Discussions and conclusions of the research finding” there is a summary of key findings with their interpretations and their consequences. In addition, it aims to answer the first research question. Second sub-chapter “Improvement suggestion (Recommendations)” is aiming to give answer for the second research question. Third one discusses the Limitations of the thesis and last chapter possible continuation or recommendations for further studies.

5.1 Discussions and conclusions of the research findings

In the case company, it has been observed that the implementation of preventive measures found in problem solving projects as a permanent part of daily operations is not at the desired level.

The objectives for the thesis were to determine obstacles and challenges when implementing sustainable improvement proposals and how these challenges could be eliminated. The goal for the thesis was written into two research question.

Research questions:

RQ1: What are the challenges and obstacles when implementing the counter measures found in the problem-solving projects so that they will become a permanent change in the processes?

RQ2: How to ensure that the solutions and benefits from problem-solving projects will be sustainable?

Following is answer to the RQ1, by introducing the findings from the analyzed PSP-reports and interviews.

Key findings from the analyzed PSP reports:

- **Archiving practices were not followed or communicated properly.** The identification and archiving of PSP reports did not always follow the instructions of the case company. In particular, A3 reports are not named according to company practice. It also turned out that many reports were missing from the archival places reserved for them. These led to a situation where traceability and transparency are not at a good level.
- **Methods, steps, especially last few steps were not fully or not followed at all.** These are: Check results (A3), Standardize (A3), Lesson learned (8D) and closing the problem-solving project (8D). These are the most important parts that should secure the sustainable implementations of preventive actions.
- **Monitoring (Follow-up) and control not properly done or missing totally.** Tasks and countermeasures defined in PSP-reports should always have specific-, measurable-, reasonable-, realistic tasks with nominated responsible persons and due dates. If these are ignored or not defined, it is clear that the transfer of sustainable changes to the organization's processes is more difficult.

Key findings from interviews, Hard side: Related to tools, structures, practices etc.

- **Task monitoring (follow-up) for preventive actions.** Is weak and sometimes completely absent. When it happens, it only happens occasionally at individual level. Project managers that do follow-up are not all even report it. Without task monitoring and reporting, it is not possible to be sure that the change has reached the target even for the first time, not to mention that the change or improvement could be permanently implemented in everyday activities.
- **Archiving.** Not clear where PSP reports are stored/archived. This includes on-going project reports too. This weakens transparency and traceability, both of which have a clear weakening effect on the implementation of preventive measures.
- **Transparency.** Lack of transparency on how the results and improvements are communicated to everyone involved in the problem-solution project, including those who are affected by the project and who are not actually members of the project. Transparency is a part of openness that keeps people aware of what projects are going on and what has been decided. The lack of this can cause frustration among the employees who have noticed the problem at first place and who are then affected by the possible improvement.
- **Closing the problem-solving project.** This step is not recognized as existing at all. This is a point where defined countermeasures and tasks should be verified, such as: Are all tasks completed, implemented, additional guidance set, "lessons learned" done, etc. This is also the place to evaluate the success of the PSP and make a possible judgment for further investigation. Not properly closed problem-solving projects hinders implementing sustaining countermeasures and also leaves out a possibility to recognize team members of PSP.
- **Need for cross-functional transparent task follow-up forum.** Missing follow-up is in most cases the weakest step in corrective/preventive action in problem-solving projects. Taking only actions is not enough while follow-up ensures that actions taken were effective. (Griffith, 2000, p. 59) Cross-functional task follow-up betters the transparency at the whole organization level and gives management the possibility to offer help and support if performing tasks are hindered by the lack of resources, competence, or due to financial reasons.
- **Proper company instructions/guidelines.** No instructions existing. The instructions ensure, first of all, that how everything already described above belongs to a proper problem-solving project, it also determines which variables start the

project, determines the responsibilities, participants, etc. Clear instructions also avoid possible conflicts of responsibilities.

Key findings from interviews, Soft side: Related to feeling, initiatives, listening, behavior, team spirit, etc. in generally to traits of corporate culture.

- **Trust for sustainable results.** Trust has been weakened. Too many examples have been experienced of not implemented preventive actions/countermeasures. Especially in those preventive improvements that were supposed to become sustainable practices. Frustration to participate in PSPs is noticeable due to this.
- **There could be more proactive behavior and willingness to take responsibility.** Encouraging people to be more self-initiative behavior would be beneficial. Individual recognition and reward systems could help with this.
- **Far too few PSP projects are carried out in the company.** No time to do more due to other commitments. In other words, too little time has been allocated or given for the implementation of PSP projects.
- **Leadership.** Project management skills could be improved, especially when it involves knowledge of problem-solving projects. The better the project manager, the better the chances for PSP to succeed. Some of the PSP leaders were found to be good, but even that is not enough if the structures and systematic problem-solving methods are not strictly followed to the end. Leadership is also related to how PSP leaders are encouraged from a higher level and how upper-level representatives could be exemplary.
- **Responsibility and individual initiative.** These could be related to team and community spirit as well as proper recognition and rewarding culture. These cultural traits are difficult to foster, but they are always worth to be trying.
- **Quantity and quality.** Quantity, general opinion was that more PSPs should and could be done but time is limited or not given enough. The lack of time was also mentioned when discussing the poor quality of PSPs. Quality is also related to the leader and persons involved.
- **Team and community spirit.** These could be also better as lack of this is building silo-thinking meaning less communication between departments and individuals. In the worst case, it increases blaming others and decreases taking responsibility.

Following is the list of good cornerstones that are in order in the case company and where the direction for better PSP could lean on the way for better sustainable problem-solving practices.

- **The company's declaration** to be the customer's primary partner. This is done by ensuring that all its employees have top-notch skills to solve customers' (as well as their own) challenges and problems, by introducing them to the L6S philosophy and problem-solving methods, by training every employee to at least a white belt level.
- **Positive trust and approach for PSPs.** All interviewees shared the opinion that problem solving tools and methods are a good and logical way to solve problems. All the interviewees had a desire to learn more and new things about problem solving methods and methodologies.
- **Importance of PSP for company.** Enquiry for the PSP importance for the case company among interviewees gave result 4,6! The rating of the enquiry was to pick number between 0 to 5. Where the rating 0 meant "no use at all" and the rating 5 meant "one of the most important quality and development practice".
- **Freedom to speak, listening and equality** are good cultural features that seem to be in order. These virtues must be nurtured when wanting to foster lasting changes and good results from problem-solving projects.

Discussion around A3 methodology. This methodology is intended to be used in small to medium problem-solving projects which require only intermediate problem-solving skills and should be completed in a few days or in one week. As stated earlier, all its steps have not been completed or at least not been reported. Perhaps due to the mentality, "The quick and easy solution", these projects might have been done hastily, where the evidence of countermeasures, verification of results and standardization have been left largely undone or unreported. From this it can be concluded that too little attention has been paid to the implementation of permanent preventive measures in the case company's processes.

Discussion around 8D methodology. This methodology is for more complex problem-solving projects where, in the beginning, the focus is on a fast reaction of non-conformities where the first three steps are supposed to be completed in a few days (Steps 1-3: Form a

team, Describe the problem, Interim countermeasure). The expected duration of the whole project is from weeks to even a few months. The reports are multi-page written reports, where even more clearly (compared to the A3 methodology) it directs for preventive and permanent solutions in addition to sustainable measures. In addition, the 8D methodology suggests making clear project closing and sharing what has been learned from the project. Based on the results of the analyzed 8D reports, evidence of the completed tasks of the last two steps was partially or completely missing. In "Step D7 – Recurrence prevention" only 37% of the actions had been carried out and reported as completed. None of the reports analyzed found evidence that "Step D8 - Conclusion and Lessons Learned" had been done.

Schultz says in his book "*Making it all work: A pocket guide to sustain improvement and anchor change*" that he has noticed that some companies practicing L6S and related problem-solving methods often failed in their projects. The failures were not due to poor solutions, but to the fact that teams and their sponsors tended to lose or forget their grip during critical implementation phases. Often a lot of energy was spent on problem solving, leaving little room for the equally important implementation steps of permanent solutions. The implementation then turns into a hurried activity, where thinking about the effects of people and processes is hastily considered. When a solution to the problem has been found, the project team rushes to tackle the new problem and leaves the implementation and verification of the solution to others. (Schultz, 2011, p. 21)

Finally, a short discussion or note if the thesis had been based on only one source of information, i.e. reports. If only one and subjective opinion had been made from the analyzed reports, i.e. the interviews had been omitted completely, the interpretation of the successes of the problem solving projects would have been quite distorted. The interpretation would have been the following: "Lesson learned" type things would never have been done, confirmation that the solutions are permanent has never been done, and finally not a single project would have been completed.

The findings and results of the analyzed reports are in line with the results of the interviews, so they correlate with each other, which means that they explain each other in the same direction. Finally, it must be stated that if the research had been done using only one data source, the results, as mentioned above, could have been somewhat distorted and led to partly wrong conclusions.

The next chapter presents improvement suggestions.

5.2 Improvement suggestions (Recommendations)

In this chapter, suggestions for improvement are presented for larger detected deviations which prevent sustainable and permanent implementations of corrective solutions found in problem-solving projects into the day-to-day operations of the case company. More comprehensive list of findings, which are hindering sustainable implementation and consequences of them are presented in previous chapters. The suggestions for the improvement are not divided into hard or soft side and they are not set in any importance order. Case company can set them to order of importance and implement them as they suites best on their visions, values, and strategies.

Improvements suggestions:

- **Transparency and traceability.** PSP-reports should follow proper practices of identification, confidentiality, version handling and traceability (archiving). The availability of reports and related documents to team members must be ensured throughout the project. Ensuring handling practices of recordings mentioned in ISO 9000 series quality systems and company instructions. Records should be used to formalize traceability and to provide of verification, preventive action, and corrective action. (European Committee for Standardization, ISO 9000, 2015, 3.8.10)
- **Follow-up:** Regarding task follow-up an automated "to do" reminder using an already existing programs could be reasonable. Periodical held cross-functional follow-up forum could be beneficial to be established. The main purpose for the forum would be proper follow-up for all open tasks of all open PSPs and give possibility for task owners to ask help and for other participants to offer help and support. Forum ownership could be in hands of QA department and conducted by authorized QA representative. Permanent members for such forum could be business critical function owners and leaders, QA representatives, and naturally persons having open tasks that are business critical.
- **Project closure:** Establishment of practice for project closing and to perform final review. Activities to be included at least:
 - Finalizing the documentation.
 - Project evaluation, whether it met all the expectations that were set for it. Discussion, whether things could be taken further and deliver even bigger benefits.

- Before and After comparison of issue.
- Lessons learned and their documentation, i.e., what lessons we learned and how they were conveyed to the organization. Plan how to share the development with the rest of the organization and keep them up to date on the new way of working and problem solving.
- Defining is there need for long term verification for sustainable change.
- Celebrate successful completion, recognize the collective efforts of the team.
- **Company guideline for PSPs:** Comprehensive description of the problem-solving process as a company guideline. The instruction could include the following main points:
 - When and what triggers the problem-solving project i.e., when it is the need for establishing PSP.
 - It should define how to nominate leader and who should be members for the team.
 - It should also recommend the most common tools for root cause analysis and follow-up procedures of corrective and preventive actions, rules for archiving, verifying procedures, reporting procedures, lessons-learned plan, and minimum requirements for project closing.

The following suggestions for improvement are quite often related to things that are difficult to put into words or teach or write into company guidelines but should still somehow be mentioned in company guidelines for problem-solving projects. These things are related to the company culture, those cultural features that contribute to successful problem-solving projects.

- **Involvement and initiative:** Natural participation and initiative require an environment that respects and rewards individuals. This kind of employee feels that he/she is an important part of the company and its culture, which certainly improves the individual's natural participation and initiative. Improving collectivism with a sense of belonging together and with measures that improve community spirit creates the courage to be open and increases the sense of duty to be proactive and participate when encountering deviations and solving them.

- **Trust:** Restoring trust to everyone in such a way that when the deviation has been reacted to and a solution to its root cause has been found, it must be brought into practice and everyday activities so that the old practice is prevented from coming back. The aforementioned participation and initiative correlate very strongly with this. If perceived and forwarded deficiencies are not corrected, participation and initiative will weaken.
- **Fast reaction and more time:** This refers to the time given to the project manager (PM) to make a good problem-solving project. In this context, the respect could also be brought up, which is not good when a PM is named, and it is stated that the project has to be done with the time of a fraction of the optimal time. Early stage of reaction to the need to do a problem-solving project and appoint a PM for it, gives time to the project and better possibility to its success. Additionally, when given the core team peace to work, the project is given even more chance to succeed.
- **Too few problem-solving projects:** This, of course, does not directly help the implementation of sustainable solutions in everyday activities, but it speaks of the positive attitude that the company's employees have towards structured problem-solving methods. Paradoxically, this is about lack of time. If there was more time, more PSPs would be made.

The suggestions for improvement presented in this chapter are not all-inclusive and are not limited to any order other than the most common ones from the literature, archived reports, and the reasons that generated the most discussion and emotion among the interviewees. All found reasons that prevent and slow down the implementation of sustainable and permanent solutions are important to consider and think about measures to eliminate or reduce them for a company whose goal is to be the customer's main partner.

Last suggestion to case company would be to make to organizational problem-solving assessment to find out the level where the company currently is. Even though this thesis is pointing out the most evident strengths, weaknesses, and opportunities where the company should concentrate, still the company itself should define the minimum level where company like to be in problem-solving projects. Lean Enterprise Academy is offering usable tool to make an assessment to judge which level organization has achieved in relation to implementation of problem-solving framework. The assessment is based on five levels and supposed to be conducted as GAP-analysis. The point of the assessment is to understand company's GAP and plan what and how company will close the GAP to get to the next level of problem-solving.

(Lean Enterprise Academy, n.d., pp. <https://www.leanuk.org/quizzes/problem-solving-framework-organisational-assessment/>)

5.3 Limitations

Limitations are said to be potential weaknesses in thesis and are out of thesis writer's control. Limitations exists in almost everywhere and in everything what is done. If using a sample of convenience, as opposed to a random sample, then the results of the study cannot be generally applied to a larger population, only suggestions can be made. If looking at one aspect, say performance tests, the information is only as good as the test itself. Another limitation is time. A study conducted over a certain interval of time is a snapshot dependent on conditions occurring during that time. (Simon & Goes, 2013)

The next paragraph explains how this thesis deals with limitations that were identified and addressed so that they did not affect the outcome of the study.

This thesis is a single case study, so no generalizations can be made based on this thesis. The information obtained from the literature represents general questions related to the topic, while the empirical research, archived problem-solving reports and interviews only represent the information and perceptions obtained from the case company about its current situation at the time of data collection and about its current situation and the time period when the interviews were conducted.

It is also important to note that the interviewees' educational background, work experience, length of service and status are partly variables tied to the moment, which if done at a different time could give the interviewee a different perspective and result on the subject being discussed.

5.4 Suggestion for the future studies

This thesis has dealt research problem within boundaries mentioned in chapter "1.4 *Delimitations*" and in chapter "5.3. *Limitations*", therefore, widening the research to other similar organization could have given more elaborative viewpoint, specially to understand what kind of influence possible other tools and organizational structures, managerial and corporate culture could have offer. Additionally, it could have given other perspective and examples when defining improvement suggestions for problem-solving projects and hints fostering the culture traits that are related to PSPs. Adding a proper benchmarking to find

solutions and new practices could be a good additional suggestion to include for future research and even for a topic for further or another studies.

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Appendices, Examples of unstructured thematic questions, manuscript for interviews

Appendix 1: Thematic interview questions: Hard side

Hard side refers to questions related to instructions, processes, practices, schooling, tools and methodologies, reports, document archiving, etc.

- HQ1. [FI] Oletko osallistunut L6S tai muihin vastaaviin PSP-koulutuksiin? Oletko saavuttanut jonkin vyön värin tai muun tason? Mitä mieltä olit koulutuksesta, opitko uusia toimintatapoja ja työkaluja ja oletko käyttänyt niitä jälkepäin?
[EN] Have you been participating in L6S-belt or any other related PSP-courses? Any Belt Color or level achieved? What did you think about the course, did you learn new procedures and tools, and have you used them afterwards?
- HQ2. [FI] Kuinka tärkeänä pidät ongelmien ratkaisemista yksikössämme strukturoidun menetelmien avulla? (esim. 8D, A3, 4Q, DMAIC, jne.)
1 = ei mitään hyötyä. 5 = yksi tärkeimmistä laadun ja kehityksen työkaluista.
Perustele valintasi.
[EN] How important do you consider solving problems using structured methods in our company?
(e.g. 8D, A3, 4Q, DMAIC, etc.)
1 = no use at all 5 = one of the most important quality and development tools.
Justify your choice.
- HQ3. [FI] Tietojen mukaan olet ollut mukana PSP:ssä ja saanut hoitaa joitakin ennalta-ehkäiseviä ja korjaavia toimia. Miten toimeksiantojen seuranta on organisoitu projektin aikana, etenkin projektin loppuosassa, kun kestävien toimenpiteiden implementointi on varmistettava?
[EN] According to the records, you have been involved in PSP's and been given take care some tasks for preventive and corrective actions. How is the follow-up of the given tasks organized, especially at the final part of the project when implementation of sustainable measures should be secured?

- HQ4. [FI] Onko sinulla ehdotusta, kuinka tehtävien seurannan voisi toteuttaa tai tehdä paremmin?
[EN] Do you have a suggestion on how the task follow-up could be carried out or done better?
- HQ5. [FI] Tallenteet tässä yhteydessä, PSP-raportit, tiedätkö mistä löytää? Onko niille tietty paikka ja onko ne nimetty tietyn ohjeen tai tietyn protokollan mukaan?
[EN] Recordings in this context, PSP-reports, do you know where to find them? Is there a specific place for them and are they named after certain instruction or particular protocol?
- HQ6. [FI] Miten saat selville, onko projektissa annetut tehtävät tehty/toteutettu ja mahdollisesti todettu hyväksi/huonoiksi? Entä ne, joista et ole vastuussa?
[EN] How do you find out if the tasks given in the project have been done/implemented and possibly found to be good/bad? What about those where you are not responsible?
- HQ7. [FI] Mitä osaat sanoa PSP:n sulkemisesta, missä pitäisi käydä läpi mitä opittiin, muutettiin, lisättiin, poistettiin, mahdollisista jatkotoimenpiteistä jne.?
[EN] What can you say about the closing of the PSP, where is supposed to go through what was learned, changed, added, removed, possible follow-up measures, etc.?
- HQ8. [FI] Tiedätkö, onko tilaisuuksia tai tapoja, joissa ongelmanratkaisuprojekteja tai niiden ratkaisuja esitellään muille kuin tiimin jäsenille?
[EN] Do you know if there are any opportunities or ways in which problem-solving projects or their solutions are presented to non-team members? (e.g., quality schooling, department meetings, info TV, notice boards, production PC's etc.)

- HQ9. [FI] Kuinka varmistamme, että kestävät ratkaisut implementoidaan prosesseihimme niin kuin ne on ongelmanratkaisuprojekteissa sovittu ja määritelty?
Miten varmistamme, että muutoksista tulee uusi normaali, jokapäiväinen käytäntö, jotta vältetään virheiden toistumiselta?
[EN] How do we ensure that sustainable solutions are implemented in our processes as agreed and defined in the PSP's?
How do we ensure that changes become the new normal, everyday practice to avoid repetition of errors?
- HQ10. [FI] Onko tämä nykyinen käytäntö riittävä, jossa melkein kuka tahansa voi olla nimettynä johtamaan ongelmanratkaisuprojektia vai pitäisikö isommissa/tärkeimmissä ongelmaratkaisuprojekteissa olla vetäjänä ongelmanratkaisuprosessien paremmin osaava hlö (kuten YB/GB/BB/CIL)?
[EN] Is this current practice sufficient where almost anyone can be assigned to lead a problem-solving project, or should larger/most important problem-solving projects be led by a more knowledgeable person (such as YB/GB/BB/CIL)?
- HQ11. [FI] Onko sinulla tiedossa, jos asiakas olisi laatuauditoinnin tai yksittäisen tapauksen johdosta palanut tarkastamaan tehtyjä ratkaisuja ongelman poistamiseksi tai pienentämiseksi, jotka olemme heille ongelmanratkaisuprojektin raportissa luvanneet? Jos on, niin kerrotko kuinka siinä kävi?
[EN] Do you know if, in the context of a quality audit or an individual case, the customer had returned to review the solutions made to eliminate or mitigate the problem that we have promised them in the PSP report? If so, will you tell how it turned out?
- HQ12. [FI] Kun olemme pyytäneet toimittajalta ongelman ratkaisua jollain ongelmanratkaisumenetelmällä, niin olemmeko koskaan auditoineet sitä esimerkiksi vierailemalla toimittajan tiloissa?
[EN] When we have asked the supplier to solve a problem using some PSP method, have we ever audited it, for example, by visiting the supplier's premises?

Appendix 2: Thematic interview questions: Soft side

Soft side refers to questions related to organizational culture, management, leadership, equality, community spirit, initiative, respect, listening, etc.

- SQ1. [FI] Minkälainen yleisvaikutelma sinulla on meidän yksikkömme tavasta hoitaa ongelmanratkaisuprojekteja? Raporttien taso jne.?
[EN] What kind of overall impression do you have of our unit's handling of problem-solving projects (PSP)? The level of reports etc.?
- SQ2. [FI] Minkälaiset ajatukset sinulla on, kun sinut kutsutaan tai määrätään mukaan ongelmanratkaisuprojektiin joko vetämään sitä tai jäseneksi, eli minkälaiset odotukset sinulla on sen hyödyistä, keskusteluista, lopputuloksesta, jne.? ("Hienoa, vihdoinkin saadaan tutkittua tämä ja siihen saadaan korjaus...", positiivinen, negatiivinen, neutraali, innostunut, odottava...mitä ikinä tulee ensimmäisenä mieleen, kerro miksi ajattelet niin)
[EN] What kind of feelings do you have when you are invited or assigned to a PSP, either to lead it or become a member, i.e. what kind of expectations do you have about its benefits, discussions, outcome, etc.? ("Wonderful, let's finally get this sorted out and get a fix for it...", positive, negative, neutral, enthusiastic, expectant... whatever comes to mind first, tell me why you think so)
- SQ3. [FI] Mitä osaat kertoa ongelman ratkaisupalaverien yleisestä hengestä?
[EN] What can you say about the general spirit of the PSP meetings?
- SQ4. [FI] Johtaminen palavereissa. Onko tavoitteet aina selvillä ja päästäänkö tavoitteiden asettamisessa konsensukseen eli saadaan määriteltyä yhteinen maali? Pysyykö fokus aiheessa?
[EN] Leadership in meetings. Are the goals always clear and will a consensus be reached in setting the goals, i.e., a common goal can be defined? Does the focus stay on the topic?

- SQ5. [FI] Oletko havainnut antipatiaa/vastahakoisuutta, eli tarkoituksena on olla enemmän vastaan kuin puolesta? Oletko koskaan havainnut tahallista vastaargumentointia, joka estää tai hidastaa optimaalisen tuloksen saavuttamista?
[EN] Have you observed antipathy/reluctance, i.e. the intention is to be more against than in favor? Have you ever encountered intentional counter-argumentation that prevents or slows down the achievement of an optimal result?
- SQ6. [FI] Kuunnellaanko kaikkia, saavatko kaikki ilmaista mielipiteensä? Annetaanko kaikille mahdollisuus sanoa/todistaa kantansa? Arvostetaanko kaikkien mielipiteitä?
[EN] Is everyone being listened to, is everyone allowed to express their opinion? Is everyone given the opportunity to say/prove their position? Are everyone's opinions valued?
- SQ7. [FI] Ottavatko työntekijät/i ihmiset vastuuta? Ovatko he proaktiivisia/aloitteellisia? Osaatko antaa esimerkin näihin?
[EN] Do the employees/people take responsibility?
Are they proactive/initiative? Can you give an example of these?
- SQ8. [FI] Teemmekö ongelmanratkaisuprojekteja omasta aloitteesta, esimiehen vai asiakkaan pyynnöstä? Oletko koskaan ehdottanut, että esiin tullut ongelma voitaisiin ratkaista jollain tunnetulla ongelmanratkaisumenetelmällä?
[EN] Do we make PSP's on our own initiative, at the request of our superiors or at the request of customer? Have you ever suggested that the arisen problem could be solved using some known problem-solving methods?
- SQ9. [FI] Onko oikeat henkilöt mukana ongelmanratkaisuprojekteissa? Onko sinne kutsuttu oikeat henkilöt? Kenen siellä pitäisi olla?
[EN] Are the right people involved in PSP's? Are the right people invited? Who was supposed to be there?
- SQ10. [FI] Mitä olet mieltä osallistujien lukumäärästä, mikä on oikea määrä ihmisiä. Onko yksi riittävä, kaksi, kolme, enemmän? Voitko perustella määrää?
[EN] What do you think about the number of participants, what is the right number of people? Is one enough, two, three, more? Can you justify the amount?

- SQ11. [FI] Tehdäänkö yksikössä liian monta, oikea määrä vai liian vähän ongelmanratkaisuprojekteja? Perustelet?
- [EN] Are there too many, the right number or too few PSP's done in the unit? Justify.
- SQ12. [FI] Kenelle teemme ongelmanratkaisuprojekteja ja -raportteja?
- [EN] To whom do we make problem-solving projects and -reports for?
- SQ13. [FI] Onko ongelmanratkaisuprojektien varattu tarpeeksi aikaa? Annetaanko siihen tarpeeksi aikaa?
- [EN] Is there enough time allotted for PSP's? Will enough time be given for this?
- SQ14. [FI] Yhteisöllisyys, miten näet sen vaikutuksen ongelmanratkaisuprojektien onnistumiseen?
- [EN] Community spirit, how you see its impact on the success of PSPs?
- SQ15. [FI] Voitko ajatella, mitkä osat tai piirteet yrityskulttuurissa pitäisi olla, jotta ongelmanratkaisuprojektit onnistuisivat paremmin?
- [EN] Can you think of what parts or traits of the culture should be in better order for problem solving projects to be more successful?