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Challenges of COPQ Improvement Projects in Company X

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Challenges of COPQ Improvement Projects in Company X

The case company of this thesis faced issues in running sufficient number of continuous improvement projects throughout the year. The purpose of the research is to examine the potential gaps in the process and focus on the challenges in initiation and execution of the improvement projects. Based on the research further development recommendations are provided.

The theory of the thesis revolves around quality management and focus on continuous improvement process, Cost of Quality methodology, and problem-solving tools. Theory provides base for the study, and for understanding the COPQ improvement process in the company.

As a result of the thesis, challenges are identified, and improvement ideas are provided to support the internal organizations to execute sufficient number of improvement projects. Besides the author’s review and initiatives, the recommendations are based on the challenges and recommendations gathered from the informants.

Keywords:

Quality management, Cost of Poor-Quality, Continuous improvement, Problem solving, Corrective actions, Preventive actions, Lean

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COPQ parannushankkeiden haasteet yrityksessä X

Opinnäytetyön tapausyrityksellä oli ongelmia toteuttaa riittävä määrä jatkuvan parantamisen kehityshankkeita ympäri vuoden. Tutkimuksen tarkoituksen on tutkia prosessin mahdollisia puutteita ja keskittyä parannushankkeiden käynnistämiseen ja toteteuttamiseen liittyviin haasteisiin. Tutkimuksen tavoitteena oli muodostaa jatkokehittämissuosituksia.

Opinnäytetyön teoria koostuu laaduhallinnan ympärille ja keskittyy erityisesti jatkuvan parantamisen prosessiin, Cost of quality – menetelmään, ja ongelmanratkaisu metodeihin. Teoria tarjoaa kattavan pohjan tutkimukselle ja yrityksen COPQ-parannushankkeiden ymmärtämiselle.

Opinnäytetyön tuloksena määritetään haasteita ja esitetään parannusideoita joiden avulla tuetaan sisäisiä organisatioita toteuttamaan riittävä määrä parannushankkeita. Kirjoittajan tarkastelun ja havaintojen lisäksi kehitys-suositukset perustuvat informanteilta kerättyihin havaintoihin ja suosituksiin.

Asiasanat:

Laadunhallinta, Jatkuva parantaminen, Ongelmanratkaisu, Korjaavat toimenpiteet, Ehkäisevät toimenpiteet, Lean

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List of abbreviations

BU	Business Unit
FMEA	Failure Mode and Effect Analysis
CIP	Continuous Improvement Project
COGQ	Cost of Good-Quality
COPQ	Cost of Poor-Quality
COQ	Cost of Quality
PDCA	Plan-Do-Check-Act
Q-Head	Head of Quality
RCA	Root Cause Analysis
TPS	Toyota Production Systems

1 Introduction

The introduction of the thesis provides base for the research topic and study. It presents the target, purpose and context of the research.

The research focuses on how Business Units (BU) and plants could further develop their Cost of Poor Quality (COPQ) improvement initiatives in the company. The research is conducted as an qualitative study and executed with semi-structured questionnaire. The final results of the research are analysed using inductive content analysis methodology.

The thesis targets to detect the challenges and issues in developing sufficient number of improvement initiatives to reduce COPQ in the plants and BU's of the company. Informants of the thesis are Heads of Quality of the company, and their team members. Thesis questionnaire seeks to gather valuable data to answer the thesis question: *: "What are the underlying factors that hinder the initiation and execution of new improvement projects targeted to reduce the COPQ within BU's and plants?"*. The results of the thesis can be utilized in the case company to improve the quality processes and practices to reduce the COPQ in the units.

The structure of the thesis is divided into four phases. The first phase of the study focuses on providing the background and target to the research. The second phase provides the theoretical background linked to the practical part of the study. The third phase reviews the methodology of the thesis and the research questionnaire. In the final phase the results are reviewed, and the further development recommendations are provided.

2 Background

Company X is a multinational company operating in the construction industry. It provides software, hardware, and services worldwide. The company's turnover is over 6 billion, and it operates a direct sales model. More than 35,000 employees work for the organization, supporting customers in all phases of the highly developed customer journey. Company X's culture and values are the base for a well-established brand that is well-known all over the industry and appreciated by its customers. This thesis is conducted in the global quality department of the company.

The reason to join the Company X and focus on quality costs is a high interest in developing processes and increasing the quality of those processes and furthermore the products. The company is well known for its quality of products, and high level of customer service. Joining a multinational company gives a good opportunity to learn about advanced quality practices and how those practices could be developed even further. It’s a great opportunity to join the leading company in the construction industry and learn from the educated and competent colleagues. The key source of motivation is the chance to improve the quality processes in the company with this research.

To carry out this research, some pre-requisites are needed. It is necessary to have a good overview of the quality management system and COPQ processes in the company. It is important to understand where the costs are incurred and how they are tracked. It is also important to identify which incidents have a major impact on customers and the company itself. The company has advanced quality management system in place, which includes variety of processes, tools and methods. These processes, tools and methods are introduced in theoretical framework of this research. The thesis aims to have a comprehensive review of these processes and methods to understand the benefits of using them. It is important as well to have knowledge of LEAN manufacturing and process optimization, as it’s the base for the whole Quality management in the company.

3 Quality management

Quality is a topic that delves into service and product excellence. The main objective of quality management is to increase product and service quality, and meet customer expectations. Enhanced quality leads to increased value, increased market share, and increased revenue and profitability. Although quality can be defined from various perspectives, the final judge of the product is always the customer. Therefore, designing the product to meet the customer's expectations is vital. (Sahay 2015.)

Quality, market share, and profitability always have a close relationship. Therefore, companies need to understand customer expectations to reach and even exceed them. Customer needs can be achieved through implementation of continuous improvement measures. In today's global and competitive economy, it is vital that a company can provide high-quality services and products. The following figure shows how improved quality can help companies reach a larger market share and improve profitability. (Sahay 2015.)

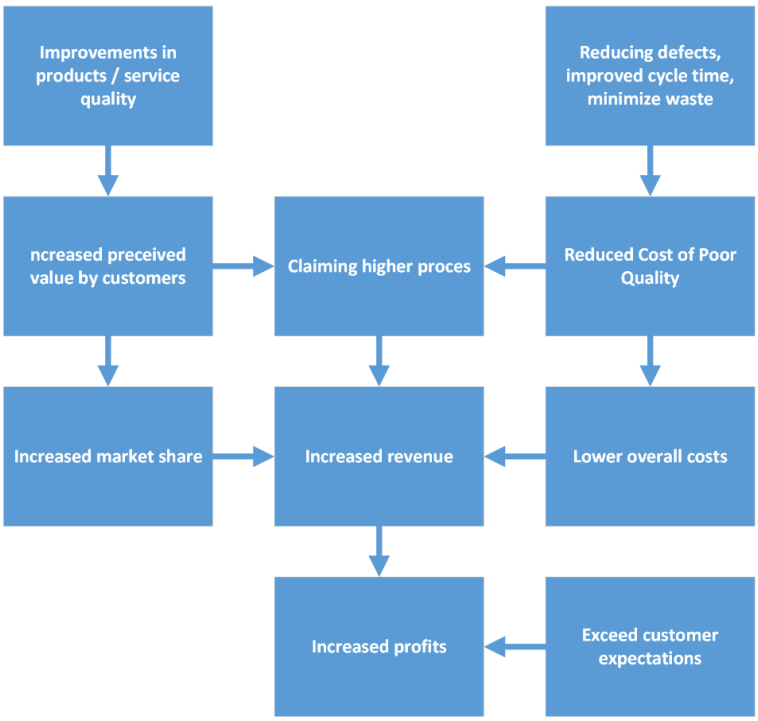

Figure 1 Benefits of increased quality (Sahay 2015)

In different situations quality can mean different things to different people. Some descriptions of quality are intoduced in the following statements. (Burke & Silvestrini 2017)

- Quality is not a program. Instead, it is a way to execute business.
- Customers and their satisfaction define quality.
- Quality includes breakthrough events and continuous improvement.
- Quality tools apply to various phases and functions of business.
- Quality's target is perfection. This means that anything less is an opportunity to improve.
- Quality focuses deeply on customer satisfaction. It reduces cycle time, costs, rework, and errors.

Quality management and improvement is always an ongoing process. Top management is responsible for articulating company quality targets, and their active commitment and knowledge are critical for success. However, all the employees of the organization must be active participants. A common language and strong communication are the keys to reaching this goal. (Burke & Silvestrini 2017.)

3.1 Lean management

Lean management can be called by many names, such as Lean thinking, Lean manufacturing, and Lean production. The main target of Lean is to eliminate waste. By eliminating the waste the target is to obtain more resources to increase customer satisfaction. Lean is strongly linked to the automotive industry which means it has succesful background. (Pažek 2021.) Lean was introduced and implemented at Toyota Production System(TPS) to reduce waste and inefficient practices in manufacturing processes. Lean is well developed approach to reduce different kind of wastes. (Bacoup et al. 2017) TPS Lean system was built around two main ideas: Waste elimination and respect towards people. (Pažek 2021).

There are many proven cases where implementing Lean thinking for continuous improvement has been successful. However, Lean is not a strict concept that gives specific tools or rules for success. It is rather a ideology that guides efforts to reach its main goal, which is waste elimination. (Pažek 2021.) Lean ideology utilizes, e.g. the following methodologies and tools (Pažek 2021)

- Kaizen
- Total Quality Management
- Value stream mapping (VSM)
- Six Sigma
- 5S
- Kanban

Lean aims to eliminate all the waste from the production process. Waste is an action that will increase cost of the product, and it can be said that waste is an additional process or action that will eventually decrease the value of the product. The eight wastes defined by lean are defects, overproduction, waiting, unnecessary motion, over-processing, transportation, inventory, and non-utilized talent. Identifying the waste and perceiving it exists are the initial steps to tackle it. VSM is a Lean Management tool to identify the state currently, and design the preferred future state. It is an effective strategy to recognize these additional inefficent activities and reduce waste. (Pažek 2021).

Lean adoption has many benefits, including eliminating waste, less workload, skilled and qualified employees, zero delays, time savings, and cost reduction. Lean production changed the working habits in the mass production industry, and it introduced many benefits compared to the traditional way of manufacturing, such as higher customer satisfaction, short lead time, more efficient inventories, higher flexibility, and increased empowerment. (Pažek 2021).

Lean adoption can also have some disadvantages. As with changes in general, new concepts and methodologies in the company are not always readily accepted by employees. This makes lean adoption even harder; it is considered

challenging to implement in practice. The created barriers by new concepts can prevent employees from performing their tasks. However, Lean can help in overcoming the barriers with cooperative working environment. (Pažek 2021).

Kaizen

Kaizen is a Japanese term which means change for better. It is a Japanese business ideology that drives processe and operations to continuous improvement. Kaizen sees the improvement in processes as methodical and gradual process. It focuses on making working more effective by creating a team driven environment, where everybody can affect the positive outcome. It drives to make the working more fulfilling and safer. Kaizen supports change towards better from any employee at any time. (Tarlengco 2023.)

Roots of Kaizen can be traced back to time after World War II, when economic rise took over in Japan. After Toyota Motor Corporation implemented the system in May 1951, innovation and changes led to better product quality and productivity. Today, variety of organizations across the world and industries adopt Kaizen as part of their core values and base for the continues improvement. (Tarlengco 2023.)

Key intention of Kaizen is to drive quality control, efficient equipment, standardized work, and waste elimination. The main target is to make little steps and changes in long-term

to drive continuous improvement within a company. Idea is that small improvements can make huge impact in long-term and big picture. (Hargrave 2023.) Kaizen is integrated to the company's culture, and therefore it becomes natural also for the employess. The idea revolves around the following key principles (Hargrave 2023)

- Knowing your customers and increasing customer value
- Let it flow and drive zero waste
- Empower employees and organize your teams

- Increase transparency with actual and real data
- Focus on creating value where the things actually happen

These major principles lead to three outcomes: Waste elimination, standardization, and efficient housekeeping. Kaizen offers some key benefits, such as improved customer satisfaction, stronger loyalty of employees, decreased costs, efficient production, and efficient problem solving. (Hargrave 2023.) Kaizen is the base for the continuous improvement process in Company X. It is embedded in the company culture which fosters better quality and shows in the company's everyday life.

3.2 PDCA Cycle

One of the key principles in process management, which is widely applied to enhance quality and efficiency in various sectors, including services, is the Plan-Do-Check-Act (PDCA) cycle. This quality management system has found relevance not only in manufacturing but also in diverse areas like offshore operations, projects, and various organizations. Dr. Edwards Deming, an American expert in quality, introduced and popularized the PDCA cycle in the 1950s. (Isniah, Hardi Purba & Debora 2020.)

The PDCA method serves as a valuable approach for effecting continuous improvements without interrupting ongoing operations. It is fundamentally forward-looking, adaptable, logical, and a highly rational methodology for driving progress. Furthermore, it encompasses a comprehensive framework that outlines all the key components of the plan that is developed for the improvement process. (Isniah, Hardi Purba & Debora 2020.)

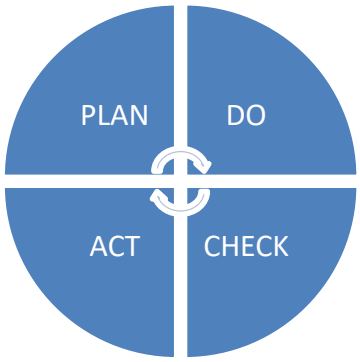

Figure 2: Basic PDCA cycle (Patel & Deshpande 2017)

As illustrated in the previous chart, the improvement projects generally follow the basic PDCA cycle format. The format was developed by Shewhart and is a remarkably efficient quality technique. (Engineer book.) Execution of PDCA cycle means continuously checking for better measures on improvement, and it means two types of corrective actions – permanent and temporary. The temporary actions basically aim to tackle and fix the issue. The permanent actions consist of investigating and eliminating the system related root causes and aims to sustain the improvement process. (Patel & Deshpande 2017.)

Continuous improvement process follows four straightforward steps. The initial step involves careful planning of what needs to be implemented. Subsequently, the plan is put into action and executed. The third step involves examining and assessing the results. During this phase, it is crucial to review whether the plan unfolded as intended or if any unexpected outcomes occurred. The final step entails acting based on the results, implementing what worked effectively, and identifying areas that may require improvement within the process. By harnessing the knowledge accumulated through this cycle, it becomes possible to refine and enhance the process when it is repeated. The PDCA method is recognized as a more simplified tool for the improvement process. These four steps are reiterated continuously as part of an unending cycle of continuous improvement. (Patel & Deshpande 2017.)

4 Cost of Quality

The quality costs methodology can be traced back to 1950s. Back then the Cost of Quality (CoQ) methodology was introduced by Juran's Quality Control Handbook. Since then, the importance and effectiveness of quality-related costs has been widely recognized. This is also because these costs cover a reasonable part of the company's total costs. Many research have proved that those costs are way too substantial for companies to ignore. Reducing of quality-related costs enhances the quality to meet the expectations of customers. (Modhiya 2016.)

CoQ is often seen as the total of cost related to conformity and non-conformity. Conformity explains as the cost of preventing the poor quality, and non-conformity is the costs caused by failures in product, production, and service. Simply explained, conformance is the Cost of Good Quality (CoGQ), and non-conformance is the Cost of Poor Quality (COPQ). (Mahmood & Co. 2014) In the Company X the focus is to improve the quality is on COPQ, as illustrated in the figure below. This thesis focuses on COPQ improvement projects, and in this case COPQ is the main topic of the theoretical framework as well. However, improvement projects are categorized below the tree of CoGQ.

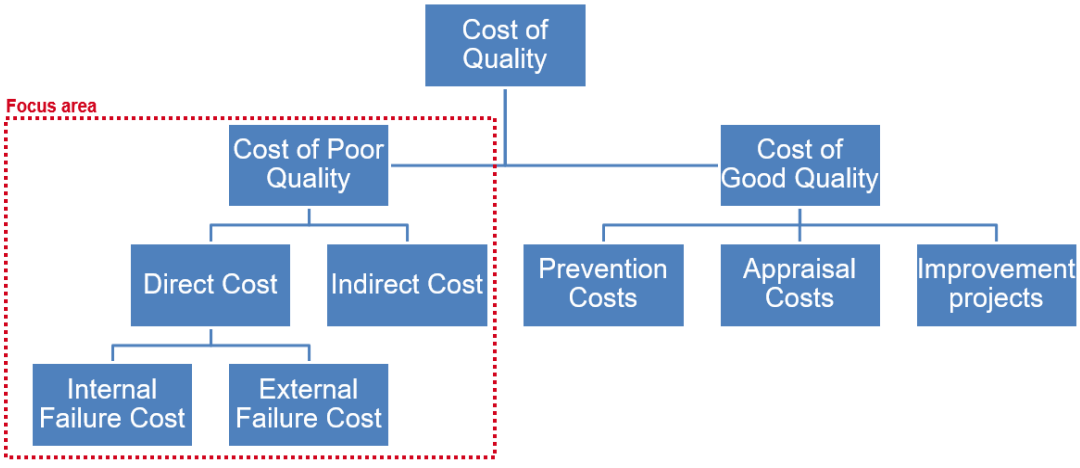

Figure 3 Tree of Cost of Quality (Modified from Modhiya 2016)

4.1 Cost of Poor Quality

COPQ is cost related with delivering non-quality products and services, due to the challenges to meet the customer requirements and quality standards. What costs money is the inefficient non-quality actions, which includes all the topics not done correctly the first time. Costs incurred due to post-order defects that require correction and rework are known as failure costs. These costs can be divided into external and internal costs. To calculate the total amount of COPQ all the costs are added together. (Mahmood & Co. 2014.)

Internal Failure Costs

Internal Failure Costs are the costs based on product/production failures prior to the product is delivered to the customer. Those expenses include the costs of rework, production scrap, waste, problem solving (A3, 8D), failure analysis, supplier rework, down-time, etc. (Mahmood & Co. 2014.) In conclusion, these costs are incurred when the results do not meet design quality standards and are identified before the product reaches the purchaser (ASQ 2024).

External Failure Costs

External failure costs are detected after the product reaches the customer within the warranty period. Examples of the possible external failure costs revolves around complaints from customer, warranty claims, returns, repairs, product recalls and liability costs. Furthermore, external failures can include the labor costs of investigation and repair of failures. (Mahmood & Co. 2014.)

Indirect Costs

Indirect or hidden costs is used to describe failure expenses that are not adequately recorded or costs that might never be discovered. These costs can

include customer related costs, customer dissatisfaction costs and reputation loss costs. Such costs can be remarkable, and hard to calculate. Some researchers suggest that indirect costs could be many times the visible costs. (Modhiya 2016.) Hidden costs can include (Modhiya 2016)

- Loss-of-reputation costs
- Loss of productivity
- Lost discounts
- Customer dissatisfaction
- Overtime to cover errors
- Pricing errors
- Unused capacity

4.2 Cost of Good Quality

The Cost of Good Quality is the cost of preventing and avoiding quality issues. These costs are often revolving around administrative work and associated with the implementation of quality management strategy and systems. Preventive actions are planned prior to the execution of actual operation, and the costs of the actions can be separated to preventive costs and appraisal costs. (ASQ 2024).

Prevention Costs

Prevention costs represents the costs that builds up when making actions to prevent occurrence of the defects (Firescu & Popescu 2015). Costs can include following actions (Firescu & Popescu 2015)

- Quality improvement program
- Quality management system and documentation
- Quality awareness trainings
- Supplier evaluation and auditing

- Internal audits
- Quality system implementation
- FMEA, APQP

Appraisal Costs

Appraisal costs represents the costs incurred with checks and inspections when determining whether the quality requirements are met. More specifically, the appraisal costs represent the costs incurred when making sure the non-conforming product won't reach external or internal client. (Firescu & Popescu 2015.) This category can include following measures (Firescu & Popescu 2015)

- Inspections and testing of products
- Production testing and inspections
- Finalised product reviews
- Test equipment maintenance and related costs
- Laboratory testing
- Testing documentation
- Materials and products destroyed during testing

5 COPQ Improvement Process

Some of the most successful organizations are those where all members of organization believes that part of their daily job is to drive continuous improvement efforts. (Burke & Silvestrini 2017). There are variety of tools that may be used to drive continuous improvement. To understand the continuous improvement practices and COPQ improvement projects in Company X, it is necessary to go through step by step the whole process. COPQ improvement process in the company includes four steps:

As illustrated in the model below, the first step is to identify quality problems and utilize COPQ calculations to prioritize the incidents needed to act first. If the amount of COPQ is high, it must be addressed first. The second step is problem-solving. The target is to solve product-related root causes and identify system-related root causes by using the A3 tool. 8D tool is used for reporting standard customer complaints with less impact. All the identified system-related root causes are summarized with relevant data. This data defines improvement projects to eliminate the system-related root causes and reduce the COPQ. Defined improvement projects are conducted to avoid similar incidents from happening in the future.

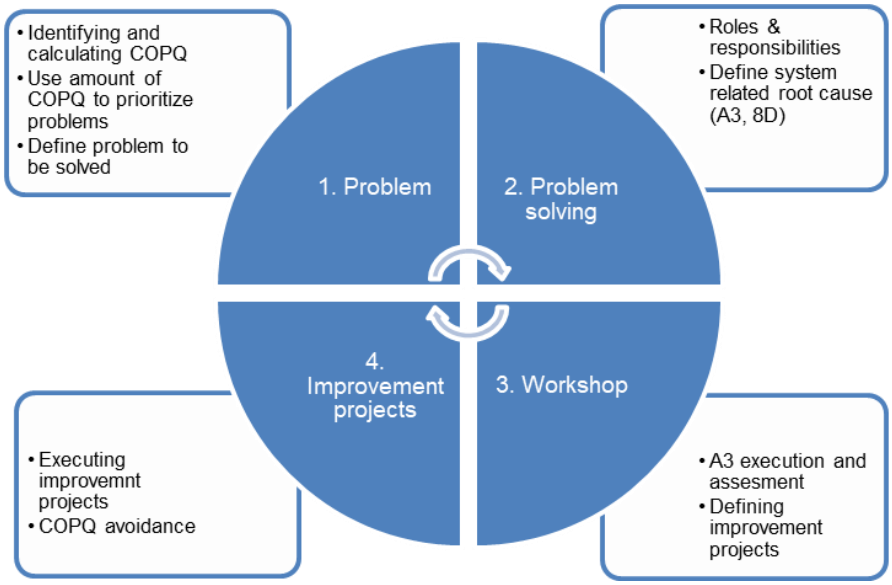

Figure 4 COPQ improvement process (Company X Intranet 2023)

5.1 Problem solving workshops

Problem solving tools, such as A3 and 8D, are methods based on PDCA cycle to define the root cause of problems, implement a short-term solution, and finally plan permanent solution to prevent further reoccurring issues (Elangovan 2021). It is important to clarify, that reports like A3 and 8D describes the problem solving after it has happened. These tools can be used to document and guide the process, but completing the report doesn't mean that problem is solved. Problem solving actions needs to be done before entering anything to the reports. (Verble 2020.)

The most significant difference between these tools is in the scope these tools are used for. The 8D is more used in the operational and production level, and A3 is process is conducted more on the management level problems. This is also because 8D report is faster to complete and, in this case, more efficient tool to answer customer or supplier issue. A3 in other hand takes more time and is efficient to make long term improvement. The comparison between these tools is illustrated in the following table. (Verble 2020.)

PDCA	A3 Main application: Problem solving, business process improvement Duration: Weeks / Months	8D Main application: Customer complaint solving, supplier issue Duration: Fast reaction, Days / Weeks
Plan	Headline: Title, Owner, Team, Sponsor	D1: Create team
	Box 1: Reason for Action / Problem Statement / Impact	D2: Describe the problem
	Box 2: Outset Situation	
	Box 3: Target state	D3: Define containment actions
	Box 4: Root Cause Analysis	D4: Root cause analysis
	Box 5: Solutions explored	D5: Define possible corrective actions
	Box 6: Pilots conducted	
Do	Box 7: Rollout approach	D6: Implement corrective actions
Check	Box 8: Results Achieved	D7: Define actions to avoid reoccurence
Act	Box 9: Learnings / sustainability	D8: Congratulate team

Table 1 Comparison of A3 and 8D methods (Company X Intranet 2024)

In conclusion, 8D report is used more in the plants and A3 in cross-functional and strategic level. Comparison between these tools is illustrated in the table below. (Verble 2020.)

5.1.1 A3

The A3 process is a problem-solving framework developed by TPS to build up a learning culture, collaboration and personal growth among its people. The term "A3" is based on the size of paper used to gather ideas, plans and objectives throughout the improvement process. (Lynn 2023.)

That's why using an A3 process is important. Many organizations and teams don't use strategic collaboration enough. In meetings, ideas are never fully formed, and solutions are implemented without everyone understanding the critical details. This leads to slow progress on projects and a lot of duplicated work - symptoms of a lack of alignment. The A3 method offers a solid approach for teams to actively work together, highlighting the objectives, aims and project plan. It fosters in-depth issue resolution at each stage and establishes changes where needed to ensure that the project is appropriately in line with its intended goals. By supporting efficient collaboration, the A3 process strengthens the organizational abilities, empowering teams to utilize their greatest problem-solving competencies. (Lynn 2023.)

Effective collaboration among talented employees is vital to foster innovation and make progress. Utilizing the A3 process to enhance collaboration allows organizations and teams to invest their resources - time, finances, and momentum - most effectively. (Lynn 2023.)

Step-by-Step Overview

This chapter dives into the core steps of the A3 process and their significance in promoting efficient decision-making and process improvement. A3 project method follows the PDCA cycle that was introduced previously. To be able to perform efficient decisions and actions the phases illustrated in the figure below needs to be completed. (Lynn 2023.)

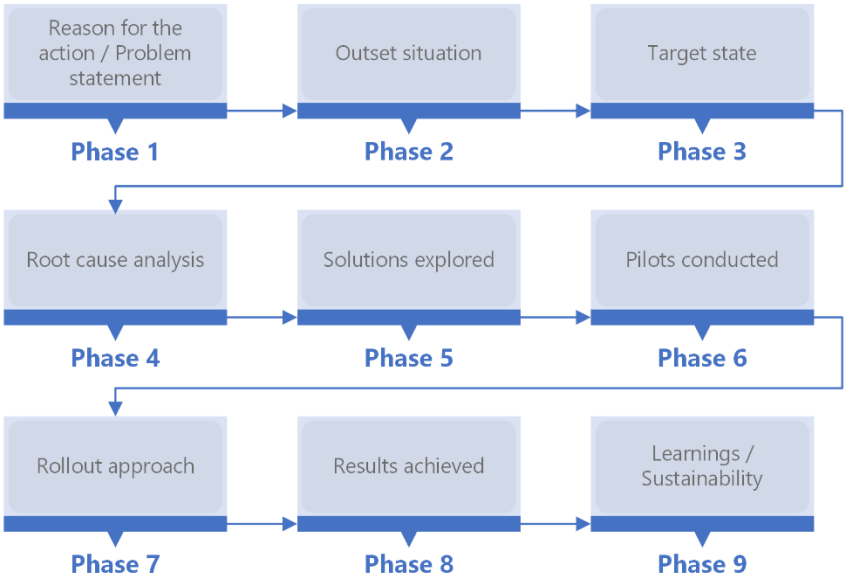

Figure 5 A3 process (Lynn 2023)

The process starts with problem identification. Problem identification serves as a base to define which specific issues needs to be resolved. The identification process starts with defining the status of the situation. This phase focuses on reviewing the existing processes related to the identified problem. Project team can utilize various tools and techniques to identify the processes around the issue such as whiteboard brainstorming and data visualization to reach overall picture. (Lynn 2023.)

After the identification of current state, the next step is to conduct a root cause analysis. This method aims to identify the underlying root cause for the problem. One of the widely used analysis tools is "5Whys" technique, which helps to identify the system related root cause by asking "why" until the actual root cause is identified. After the root cause is identified, the next step is to implement corrective actions. For the corrective actions process all the necessary functions should be included. It is necessary to map clear process and responsible for each process step to eliminate inefficiencies. It is as well necessary to define target state to be reached, so the evaluation of the corrective actions could be done. Target state is the ideal situation that could be achieved through improvement measures. This target state should be communicated to all the necessary stakeholders. (Lynn 2023.)

The implementation planning phase follows the root cause analysis and definition of the target state. A detailed plan is created to achieve the target state. A plan typically includes a to-do list, assigning responsibilities, and setting deadlines for important tasks. This complete plan is often documented with an A3 report. At the same time, the team develops a follow-up plan. This plan is important for validating if the changes were successful. These steps ensure that that the plan is executes and the expected results are achieved and validated. Effective plan and execution require reaching cross-functional consensus; therefore, all the parties should be involved in the process. Depending on the projects scope all the stakeholders that are affected should be informed of the project status as well. (Lynn 2023.)

After the stakeholder engagement the implementation of the corrective and preventive actions begins. In this phase the planned changes are implemented according to the plan and responsibilities. During the implementation plan the possible further improvements should be noted and executed as well. (Lynn 2023.)

The A3 process is concluded with evaluation of the project results. It's needed to validate the results by comparing it to the target state and original predictions. If the final results differ significantly of the expectations, further corrective actions and adjustments should be planned and executed. The whole A3 process represents a structured approach for effective planning and execution in continuous improvement initiatives inside the organization. (Lynn 2023.)

5.1.2 8D

The 8D problem solving tool originates from Second World War, and the methodoly was later implemented by Ford. The process target is to offer efficient method for problem solving. This process is used to research and define the root causes of the problem, devise fixing measures, and implement ongoing improvement. The core benefits of the method are structure, discipline, and clear method. Methodology is used in many industries to assess complaint

handling as well. (Elangovan 2021.) The process starts with plan step and proceeds through the other steps as illustrated in the following figure.

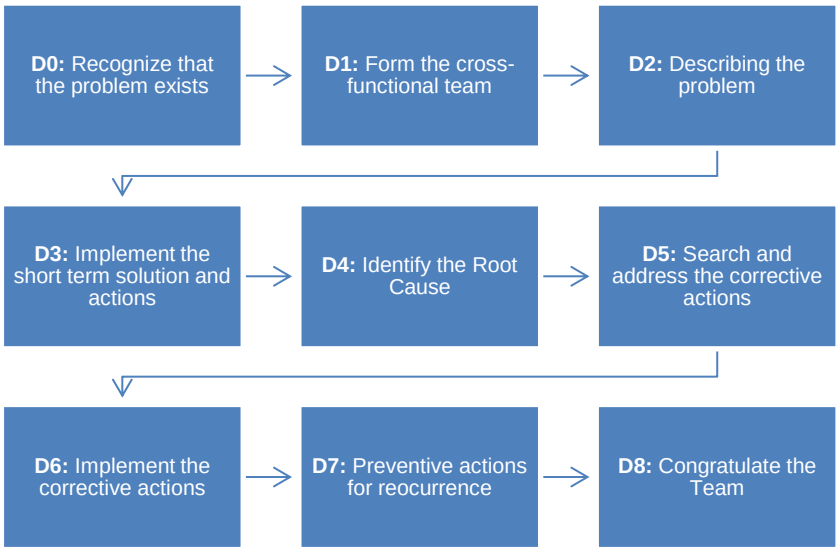

Figure 6 8D process (Burke & Silvestrini 2017)

8D model is problem solving methodology often initiated by quality managers and quality engineers.

D0: Recognize the problem

Proper outcome always leads to good start. In this case, even before the 8D process begins, it is good idea to consult expert with their view and suggestions. Before thinking about building the team, it is necessary to address the problem and identify the pre-requisites and resources needed. (Kulkarni 2017.) It's also necessary to prioritize and identify the opportunities for improvement (Burke & Silvestrini 2017).

D1: Form the cross-functional team

First step to establish a team with essential skills and knowledge to identify and solve the problem. Team members also needs to have time and resources to

commit to the 8D process. It's also important to include persons rather from different fields to have creative solution than people with the same outlook. Good leader and moderator who understands the processes is needed as well. (Kulkarni 2017.) Furthermore, the whole team should have good product and process knowledge (Burke & Silvestrini 2017).

D2: Define and describe the problem

The primary focus of the 8D method is to accurately describe the problem by using available data and categorizing it (Kulkarni 2017). It is beneficial to answer questions who, what, where, when, why, how, and how many for the problem. Simplified, it is necessary to specify the problem bey identifying it in quantifiable terms. (Burke & Silvestrini 2017.)

D3: Implement the short-term solution and actions

After the problem is defined by the team, it is necessary to plan a temporary solution for the problem (Kulkarni 2017). This is necessary step to isolate the problem from any customer (Burke & Silvestrini 2017). The temporary solution should be easily implemented and understood. In this phase the primary idea is to prevent any further defects in the product. This solution might be removed after the final solution is implemented. Examples of the actions is production stop, and segregation of the goods. (Kulkarni 2017.)

D4: Determine, and verify the root causes

The most important step of the 8D is to identify and verify the root causes. This step requires prior knowledge of the problem so that the corrective measures can be taken to solve it permanently. (Kulkarni 2017.) It is important to identify why the problem was not identified at the time it incurred. Cause and effect diagrams are utilized to map the causes against the problem. (Burke &

Silvestrini 2017). Root cause analysis such as 5 whys, and Ishikawa diagram are used to find the system related root cause (Kulkarni 2017).

D5: Choose and verify the permanent corrections for nonconformity

Once the permanent solution is determined and verified, it is necessary to make sure that it is tested completely before implementing. The final solution is decided based on costs, quality, and reliability. (Kulkarni 2017.) Through pre-production programs, carry out quantitative confirmation that the selected correction will solve the problem of the customer (Burke & Silvestrini 2017).

D6: Implement and validate the corrective actions

To implement the solution, it's necessary to define the best corrective actions (Burke & Silvestrini 2017). Proper and well-designed planning for implementation is essential. Plan should consist of great communication, clear steps, improvement, quality, and lessons learned. Activities of this step concludes project plan, communication of the plan, and validating the corrective measures. (Kulkarni 2017.)

D7: Preventive actions and reoccurrence

The next step is defining which actions are essential to prevent the further occurrence of the problem. Here the possible replacement of the D5 is defined. This step could include changing the documentation, process, and procedures to prevent similar problems in the future. (Kulkarni 2017.) In addition, modifying the management systems, operation systems, and best practices are necessary (Burke & Silvestrini 2017).

D8: Congratulate the team

In the final stage, it is crucial to reach a conclusion on the team's performance and examine what each individual has learned. Besides the collective team review, it is important that the team is formally thanked by the organization. (Burke & Silvestrini 2017).

5.2 Root cause analysis

What is a root cause? A root cause is the most important and actual reason that problems occur. If the root cause is eliminated it will prevent similar problems from arising. Causal factors can be infinite, but the ones that truly impact the processes and creates negative effects are very few. That's also the reason why identifying the system related root causes is vital. (Suárez-Barraza & Rodríguez-González 2018.) Root cause analysis (RCA) is a problem-solving method that was introduced by TPS and Lean approach. RCA is tool used for investigating and defining the cause of production disturbance. It targets to identify the system related root cause and implement corrective actions. The disturbance of production is only eliminated if the root cause is identified and corrected. (Ito 2022.)

Root cause analysis is performed as part A3 and 8D problem solving. It is conducted by group of people from diverse background, for example, logistics, quality, and engineering. Defining the root causes can be a long process. However, the long process is necessary to gather all the relevant information, make conclusions, analyse the data, identify the root causes, and implement the counter measures. Finding the actual root causes can be very difficult tasks, and many times experienced mentor is needed. Since in many companies time and resources are limited, still great amount of issues end up not being identified and investigated. Nevertheless, it is necessary to invest time and resources to conduct well designed RCA. (Ito 2022.)

When conducting root cause analysis, variety of tools can be utilized. Among the most popular RCA tools are 5-Whys, Ishikawa diagram, and Pareto chart. (Ito 2022.)

5.2.1 Five whys

When trying to solve a problem, it helps to start with the result and reflect on what caused that (Serrat 2017). The Five Whys (5 Whys) root cause analysis traces its roots back to the Toyota Production System. It plays key role in many methods including Lean and Six Sigma. (Card 2016.) Basis for the 5 Whys tool is to ask five times why when problem occurs. By repeating the question five times nature of the problem and root cause becomes clear. The 5 Whys technique drives simplicity and allows the users to define root cause that otherwise would be hard to outset. (Card 2016.) There are three key elements to conduct effective analysis (Serrat 2017):

1. Complete and accurate state of the problem
2. Complete transparency and honesty when answering the question
3. Determination to define the root cause and solve the problem

The Five Whys technique is more efficient when conducted in a team, and there are structured steps to complete it (Serrat 2017):

- Gather team with competence to define the problem statement. After the problem is defined, review if additional team members are needed to resolve the problem.
- Ask the first “Why”. What is the reason the problem is occurring? There could be multiple answers, and all of them should be recorded.
- Ask four more successive “Whys”. Root cause will be defined when asking “Why” again won’t give useful information. Eventually, there could be more or less questions than five.
- Among the last answers for the question “Why” look for systematic root causes for the problem. Discuss the answers with the team and define

the most likely system related root cause. Review the result of the method with others and verify the logic and results.

- After defining the most apparent root cause for the issue, it's necessary to develop appropriate corrective actions for the problem. Target is to eliminate the root cause of the system and define correct team to implement the planned corrective actions.

The simplified process of the Five Why's technique is illustrated below:

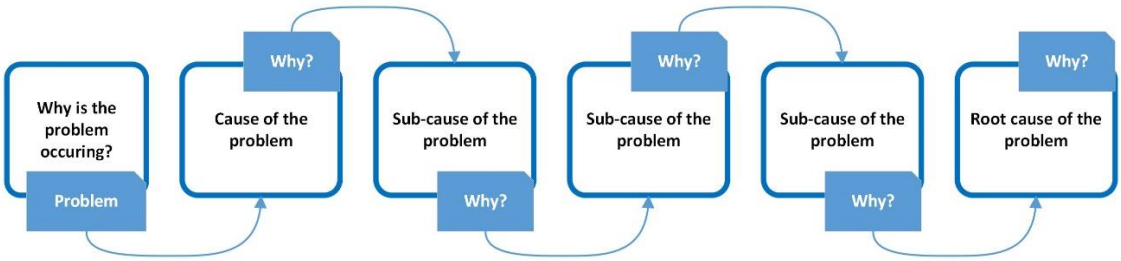

Figure 7 Five Why process (Serrat 2017)

The Five Whys technique has been criticised for being too simplistic for conducting a thorough root cause analysis and ensuring that the root cause is resolved. Major issues could arise if the investigators stop at symptoms and won't proceed to the final root cause. Different teams could also come up with different answers for the same issue. Clear execution of the process, and careful verification of answers should help with these issues. (Serrat 2017).

5.2.2 Ishikawa diagram

Ishikawa diagram is a diagram that illustrates the connection between quality characteristics and causal factors. The diagram is part of Seven Quality Control Tools. The "Ishikawa diagram" is also referred to as the "fishbone diagram", as it resembles a fish skeleton. (Suárez-Barraza & Rodríguez-González 2018.)

The Ishikawa diagram is a problem-solving tool focusing entirely on finding the cause, and not its effects. The diagram allows to create quality control from the process perspective, where the responsible person or department will take over

the responsibility to identify the root causes and eliminate them. Ishikawa diagram is an efficient tool for examining the system related root causes. Solving complex problems can be challenging, and structured tool like Ishikawa diagram allows to present data in systematic and simple way. (Suárez-Barraza & Rodríguez-González 2018.) There are three steps to create an Ishikawa diagram (Suárez-Barraza & Rodríguez-González 2018)

1. Determine the quality issues to be improved, write it in a block, and draw an arrow pointing to the block.
2. Define the main factors that may cause the quality issues at the end of a branch arrow connected to the main arrow.
3. Next to each branch arrow, define the factors that contribute to the main cause.

As seen in the simplified illustration of the Ishikawa diagram, the first step of the process is to define the issue or problem. In manufacturing these non-conformities could be for example poor quality parts, long cycle-time, and assembly failures. (Suárez-Barraza & Rodríguez-González 2018.)

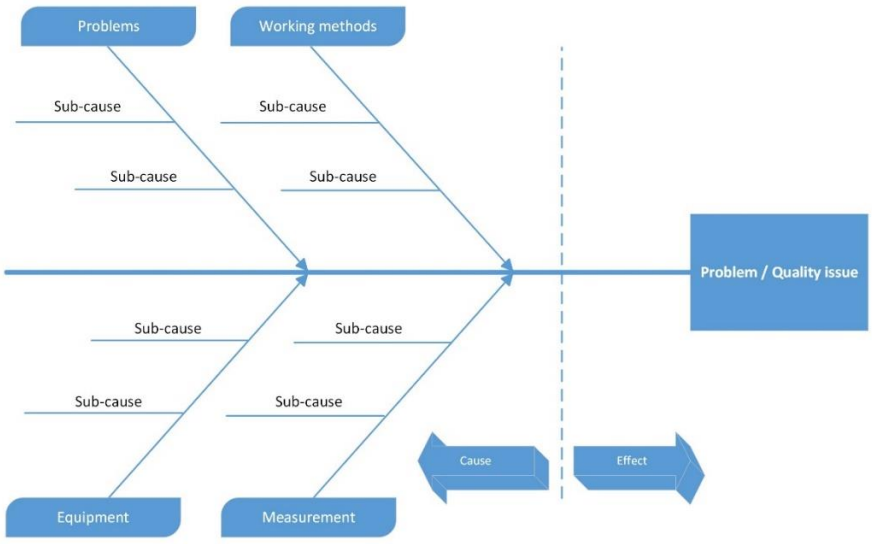

Figure 8 Example of simplified Ishikawa diagram (Suárez-Barraza & Rodríguez-González 2018)

Once the problems are identified, the next step is to construct the diagram. To do this, the square is placed in the right side of the diagram including the problem definition inside. Once the problem is in place, the next step is to write down the primary causes. To define the main causes, 5 Whys method could be utilized. (Suárez-Barraza & Rodríguez-González 2018.)

After the primary causes are defined, the next step is to write down the second-level causes beneath the primary one. Such causes are known as medium-size bones. There could be many levels of these causes, reaching even fifth level causes. Idea of these steps is to break down each cause to its basic elements. (Suárez-Barraza & Rodríguez-González 2018.)

The final step is to analyze the Ishikawa diagram. It is critical to specify which root causes deeply impacts the higher-level problem selected. It is necessary to point out that analysis needs to be carried out by weighing the root causes and select the ones that has significant impact on the problem. (Suárez-Barraza & Rodríguez-González 2018.)

5.3 Improvement projects

The last part of the COPQ process is the implementation of Corrective Actions and Preventive Actions (CAPA) through COPQ improvement projects. Corrective Actions eliminates the detected non-conformity, and Preventive Actions is a process to eliminate the root cause and drive continuous improvement. CAPA is vital step towards actual improvement and efficient execution of Quality Management System. Corrective actions to correct the problem is implemented by following A3 process. Target of this action is to remove the cause of the non-conformity. There can me multiple causes for the problem. These actions are taken to prevent reoccurrence and give “first-aid” to the problem. The preventive actions are a process to eliminate the system related root cause and prevent having potentially new non-conformities. By implementing the plan, the target of eliminating the reoccurring issues can be implemented and continuous improvement could be achieved. (Abishek 2016).

6 Methodology

The primary objective of this thesis is to investigate and assess the major challenges of the COPQ improvement projects in Company X. To be able to reduce COPQ in the company, it is more than necessary to conduct a sufficient amount of improvement projects. The case company has identified gaps in this process, and to improve it is required to review the root causes of this issue. Now that the theoretical framework of the research is gathered and reviewed, the next step is to introduce the research methodology to address the research question.

6.1 Qualitative research

This research is conducted with qualitative method. The target of qualitative research is typically to investigate the phenomenon from the point of view of the research subject. This simply means that the aim is to gather valuable information about the subjective experiences, learnings, and ideas of the target group of this research. Research methodology means the entity of methods used to study the subject and answer the research questions. (Puusa & Juuti 2020.)

The reason why qualitative research method was chosen is the nature of the study. In qualitative research the target may be to describe a event or phenomenon to understand certain actions or provide a theoretically pleasing description of an event. Therefore, it is vital that the persons that are the source of information know as much as possible or they have a lot of experience regarding the matter. (Tuomi & Sarajärvi 2018). Objective is to gather information of the experiences of the target group and identify the root causes of the gaps. To identify the root causes and especially utilize efficient measures to conduct corrective actions for the problem, it is vital to understand the underlying issues experienced by the target group. Therefore, it is valuable conduct qualitative research and investigate the opinions and perspectives of

the competent people that are constantly working with the topics. (Puusa & Juuti 2020.)

Different kind of interviews are the most common methods to gather data in qualitative research. Interview has the advantage to gather information from the people that already has a lot of experience of the topic. (Puusa & Juuti 2020.) In this research interviews are conducted through semi structured questionnaire in Microsoft Forms. Questionnaire is based on open questions to gather meaningful, specific, and insightful data. Since the target of this thesis is to combine valuable information of theoretical base and practical experiences, the gathered data needs to be up to date. For this purpose, conducted questionnaire is great method.

Thus, gathering data from COPQ professionals is needed. By analyzing the data collected, it is possible to create meaningful outcomes for the research, and from effective recommendations to enhance the COPQ improvement initiatives in the future.

Target group and research design

The way of collecting data in this research is elite sampling. In the elite sampling informants of the research are the ones that is expected to have the most information and experience of the matter. (Tuomi & Sarajärvi 2018). Therefore, the informants are the Heads of Quality Managers and COPQ team members from different business units and plants. By questioning people in different BUs and plants around the world allows to get a good overview of the problems experienced in the corporation.

One way of determining the sufficiency of the data is to talk about saturation. Therefore, the aim of this study is to gather information as long as the new data does not provide additional information on the research question. (Tuomi & Sarajärvi 2018.)

The interview questions of this research are related to the theoretical framework, and concluded in the Microsoft Forms template. The questionnaire form was distributed by email to the Heads of Quality Managers, who forwarded it to the relevant COPQ team members as well.

6.2 Data collection

The semi-structured questionnaire (Appendix 1) consisted mainly of open-ended questions. The structure of the questionnaire offers the informants opportunity to give their answers in own words and fully focus on the experienced issues. The questionnaire was designed to be easily accessible via email link. This way it was easier to encourage the busy top managers to submit answers. Online questionnaire was best way to reach managers across the world, because it’s challenging to arrange meetings as most of the managers are working in different time zone.

The informant answers were gathered anonymously with Microsoft Forms. Personal data of the participants was neither collected nor stored in the questionnaire. The Microsoft Forms was chosen as it’s in line with the company guidelines and confidentiality. The questionnaire was conducted in English as it’s the official company language and participants are required to speak fluent English. The questionnaire was piloted with a quality manager to ensure that it was clear and understanable. The pilot group considered the form to be clear and understandable. Minor improvements to the questionnaire were made based on the feedback of the pilot group.

The distribution of the questionnaire was made by utilizing email and internal Teams chat. The Q-Heads were encouraged to share the questionnaire with COPQ team members who are strongly participating in the COPQ improvement process. The research invitation included the research questionnaire (Appendix 1) and information participant sheet (Appendix 2).

6.3 Inductive content analysis

The informant's data were was analysed using inductive content analysis. Inductive content analysis is a structured approach to analyse textual content that can be utilized in both quantitative and qualitative research. The analysis can be roughly separated to three phases as seen in the process chart below: Data reduction, data clustering, and abstraction. (Tuomi & Sarajärvi 2018.)

Figure 9 Inductive content analysis process (Tuomi & Sarajärvi 2018)

The process started with the reduction of the data. In this case, the information was reviewed, and questionnaire results were written clean. In the reduction of the data, the first phase was to weed out all excess material. This meant that the original phrase was condensed and split into sections. In reduction the topics that answer the research question are identified. In this case, the data is searched for all the original expressions that correspond to the research question. The reduced phrases were defined in the table without losing any important information. This action created the base for the clustering of the data. In reduction it was important to remember that in one phrase could be found several reduced expressions. (Tuomi & Sarajärvi 2018.)

The following phase of the inductive analysis was the data clustering and grouping. This involved a careful review of the reduced expressions coded in the data and a search for concepts that described similarities and differences. The concepts that described the same phenomena were concluded to clusters. The clusters were named with the concept that described the cluster. Clustering condenses the data by incorporating individual factors into more general

concepts. The clustering provided the basis for the basic structure of the research and preliminary descriptions for the phenomenon of the study. First step was to conclude the reduced phrases to sub-categories. (Tuomi & Sarajärvi 2018.) Below is the clustering example of the conducted inductive content analyses of this research. In this table the reduced phrases are concluded to sub-categories, which is named after the content of the data. The clustering is continued by combining the sub-categories to form main categories that are connected to the research questions. (Tuomi & Sarajärvi 2018.)

Original phrase	Reduced expression	Sub-category	Main category
In P8, we have enough CoPQ improvement project numbers.	Adequate number of CoPQ improvement projects.	Enough projects.	Successful initiation of projects.
Limited number of complaints. No other CoPQ initiatives being driven currently.	Challenges in initiating enough CIP due to a limited number of complaints, and lack of new initiatives.	Challenges related to the limited number of complaints and initiatives.	Limited number of issues.
Availability of resources to execute those projects at full speed and focus.	Lack of resources to execute improvement projects.	Challenges relate to the sufficient amount of resources.	Limited resources.
Limited resources. Such projects are many times see as on top of everything and not as investment into the future that pays-off	Challenges in perceiving CoPQ improvement projects as an investment due to the limited resources.	Perception and resources as a challenge.	Limited resources. Limited perception

Table 2 Example of raw data analysis

Next phase was the abstraction of the data, in which the essential information is molded to the theoretical content. Clustering is seen to be part of the abstracting process. Abstraction progresses from the linguistic expressions used in the original data to theoretical concepts and conclusions. (Tuomi & Sarajärvi 2018.)

In inductive content analysis, concepts are concluded to provide answers to the research questions. The whole process is based on interpretation and reasoning. The process flows from empirical data content to more conceptual view of the phenomenon of the research. In the content analysis and conclusion, the target is to understand what the topics means for the participants of the research. (Tuomi & Sarajärvi 2018.)

7 Results

The results of the data analysis of this research are presented in the following figure, and the results fall into two categories. The quotes of the informants are necessary to present the specific data content and not to lose the voice of the participants. Informants of this research are highly experienced professionals. They work with quality measures on strategy and operational-level. Therefore, they have the knowledge and competence to address the issues related to the challenges of initiation and execution of the COPQ improvement projects. Five out of nine participants stated that they have over twenty years of experience, and only one had less than ten years of experience.

The answers and responses varied, but themes that arose were widely similar. The questionnaire structure with open questions gave the participants possibility to answer thoroughly and provide exact answers. The results will be reviewed in the next phase based on the research question: “What are the underlying factors that hinder the initiation and execution of new improvement projects targeted to reduce the COPQ within BU’s and plants?”. The results are illustrated in two categories: challenges in initiation and execution. The following figure concludes the main challenges in both categories.

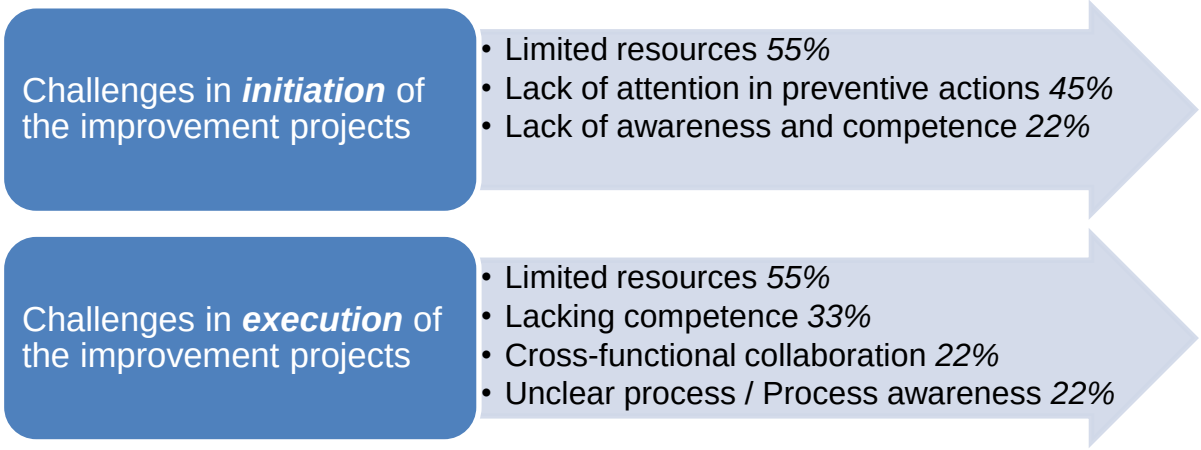

Figure 10 Challenges in initiation and execution of the improvement projects

7.1 Challenges in project initiation

When it comes to the issues with initiation of the COPQ projects, there were three main categories that raised. These themes were resources, limited attention to preventive actions, and lack of awareness and competence in the teams.

One of the recurring topics in within the informant responses regarding the initiation of the COPQ improvement projects were limited resources. Over fifty percent of informants experienced this as an challenge. The organization tends to prioritize the projects which have immediate and measurable impact on sales growth. Given that the COPQ project resources are needed to be assigned a head of time creates additional challenge. Following phrase by participant highlights this problem.

> "COPQ projects also cost resources and the return takes time. The organization commonly prioritizes projects which will have faster and more direct impact on sales growth (directly measurable) and will accept risks."

Improvement projects may be seen as theoretical and challenging to see the long-term benefits. In this case, the continuous improvement projects are not the main priority when it comes to the resources. Larger and more urgent projects are easily taking the main resources and sets a high competition. Additionally, if there are limited amount of Customer Complaints, this might lead to conclusion in management that COPQ projects are not urgent and top priority. Such perception hinders the initiation of the projects and creates great challenge to commit resources for the essential continuous improvement and long-term quality management.

The second reoccurring challenge identified is the limited focus on the preventive actions. Over forty percent of informants experienced this as an challenge. Even though the resources would be available for the corrective actions, the attention tend to drop down when it comes to the preventive actions. Informants experienced that focus on continuous improvement is many

times hard to maintain, as the focus is quickly in the new and more urgent projects.

Another recurring challenge with initiation of the projects is lack of awareness and competence within the COPQ teams. Over twenty percent of informants experienced this as an challenge. Main issues that were mentioned were competence in the problem solving, lack of consciousness in cross-functional basis, and low motivation to work in the improvement projects. Low process and topic awareness leads to the previous issues. If the people don't have sufficient awareness, it is hard to maintain high motivation for the projects. In this case, the initial step is too difficult to achieve. Individuals often avoid the topics in which they feel like lacking sufficient knowledge. The issue with persistence in change management is frankly similar to the one previously mentioned. The following quote by informant describes this problem well.

> ” Low consciousness in the other departments and low intrinsic motivation to work on projects - awareness is lacking.”

Quote also highlighted the issue with cross-functional collaboration. In the improvement projects there are need for a high collaboration with different departments. For instance, depending on the issue resources may be required from quality, engineering, supply chain management, logistics, and design. Even though the moderators of the project from quality would have high level of awareness and competence, it is more than likely that awareness in other departments is lacking. This leads to the difficulties with motivation in cross-functional basis.

7.2 Challenges in project execution

Challenges in the execution phase of the projects follows mainly the same themes with initiation, but some variation can be identified as well. Main themes identified in the execution phase are limited resources, lacking competence, collaboration challenges, and unclear execution process.

As in the initiation, the main category identified in the research is limited resources when executing the projects, and over fifty percent of the informants identified this as an challenge. Informants experienced the lack of resources in the execution phase, which leads to issues to perform with full speed and focus. For instance, solving the problem sustainably is frankly challenging with limited resources. The attention and resources allocation tends to drop after solving the initial problem. Finding resources for smaller projects with lower benefits can be challenging, especially. Following quote from informant describes these challenges well.

> "Solving a problem sustainably with sometimes limited resources or when a business case is not given. (No one would invest 50.000 to solve 5.000 / year costs)."

One of the informants mentioned that calculation of the COPQ figures is relatively difficult as it is also criteria for target achievement for the BU's and plants. In this case there could be conflict of interest reporting the data correctly, as it affects the KPI target. Each organizational unit themselves is responsible to execute the measures in high level. Calculation of the COPQ in different phases of the project requires an effort, and in smaller projects its questionable if it is worth to assign the resources for detailed execution. However, this conclusion is based on the response of one informant and therefore cannot be generalized. In the following quote the issue with the calculation is highlighted.

> "Calculation of COPQ depending on situation is sometimes difficult and is questioned as this is the criteria for reaching the KPI target. For smaller projects benefit and calculation the COPQ of degree of implementation can be difficult with low benefit."

One of the major themes that saturated a lot within the answers was competence of the team members. Over thirty percent of the informants experienced this challenge. This issue originates from the limited awareness and training of the project participants. Limited competence within the teams can lead to low employee motivation and inefficient use of existing resources. Lack of employee competence can lead to ineffective problem solving and project execution. Additionally, a lack of expertise in calculations of COPQ can lead in an incomplete overview of data in strategic level. Strategic level

improvement projects are defined based on the data from BU's and plants. Therefore, it is important to have sufficient competence in this level to have efficient strategic decisions.

Over twenty percent of the informants experienced challenges in cross-functional collaboration. Improvement projects usually require resources from various functions such as design, engineering, and quality. The functions that are not as familiar with the tools and methods are likely to be less motivated to participate and give their full focus on the improvement projects. This can lead to inefficient project execution.

7.3 Recommendations

The natural next step after inspecting the major challenges related to the research question is to to review the recommendations for process improvements. To provide extensive and complete recommendations, the participants were asked to provide their recommendations as part of the questionnaire. By combining the experience of the informants with the process knowledge of the researcher, a comprehensive outlook of the recommendations can be achieved.

The major findings and challenges related to the initiation and implementation of COPQ improvement projects revolve around resources, awareness, and competence. Therefore, it is useful to link the recommendations to these issues. By utilizing the view of quality professional in addition to the author's analysis, efficient improvement actions can be taken.

7.4 Recommendations from informants

The thesis informants had a lot of great recommendations, which were fueled by their extensive experience of the topic and the challenges faced. Due to their strong professional point of view, it is beneficial to handle the recommendations based on their ideas.

The most significant challenge identified in the research was limited resources for the COPQ improvement project initiation and execution. Some recommendations were introduced by the quality professionals to tackle this major issue. The following quotation from informant highlights the recommendation.

> Have always a "reserved" amount of resources for COPQ (as continuous improvement should always be on the agenda as priority).

As stated in the proposal, there should be reserved budget in annual basis for the implementation of the improvement projects. This would make it much easier to start new initiatives and keep the COPQ in high priority throughout the year.

As recognized in the analysis of the challenges of initiating and executing the projects, there is a lack of awareness and competence in the COPQ topic. Several recommendations were mentioned to improve the knowledge and awareness of the process. For example, the following statements offer opportunities to improve the awareness and competence.

> Define the regular meeting to drive the quality problem solving.

> Every Engineer and Coach should have an A3 training and knowledge (perhaps a shorter training or online quiz / self-learning is sufficient as a fast entry). Also, it should be a mandatory training for new employees.

By arranging a regular meeting with the COPQ leader of each BU and plant, the awareness regarding the process and methods could be transferred across the functions to all stakeholders. There is currently a bi-monthly meeting, but more frequent meetings could be beneficial to foster the awareness and underline the importance of the topic. In addition, A3 training should be offered to each new employee and strongly marketed. This is particularly important for those who work with quality issues. As mentioned in the proposal, a shorter self-learning material would make the onboarding of new team members more efficient. This would increase significantly the awareness of the improvement project process and execution. Furthermore, these improvements would increase the overall competence in all functions and improve the quality of implementation.

One of the recommendations by informants was regarding the benefit sharing of the whole COPQ topic. As the topic is highly important and driven by the strategy team, the benefits of the COPQ measures should be more visible and shared with the BU's and plants. The following quotation from informants highlights the importance of this recommendation.

> Quantify the benefits of the COPQ initiative (BoD).
>
> Tone from the Top regarding the importance of prevention.
>
> The ability to show value of these improvement projects.

The management team should focus on clearly demonstrating the benefits of COPQ measures and improvement projects. If the tone from the top is not strong, organizations won't see the topic as important enough. This is also linked to the resources, and if the management reserves a budget to the COPQ initiatives, this also highlights the importance of the topic. As mentioned by the informant, the targets for the organizations should be defined at the beginning of the year to also underline the importance of a continuous focus on the improvement projects.

Informants had a recurring recommendation on how management could better support the COPQ improvement initiatives. It was clear that organizations expect recognition and showcasing of the successful improvement initiatives. By sharing such projects, organizations could gain recognition and motivation to implement the improvements at a high level.

7.4.1 Recommendations from author

The author of the thesis works closely with the research topic and has high level of understanding of the COPQ process. Therefore, it is beneficial to review the recommendations from this perspective, but still based on the challenges identified from the informant responses. Many of the recommendations are already addressed in the informant responses, but there are a few ideas that could benefit the company in further developing the COPQ process.

One of the main issues identified in the research was related to awareness of the COPQ process and metrics. Currently, a bi-monthly team meeting is arranged to give an update of the COPQ target status and other pressing topics. Rather than solely focusing on the target achievement, the team meeting could be partly utilized to develop the process understanding and awareness. Furthermore, the COPQ responsible of each BU and plant could transfer the knowledge shared in the team meeting across the functions within their own organization. This would raise the awareness and competence in the throughout the respective business area of the company. To raise awareness within the new employees, it would be necessary to provide better self-trainings to gain deeper understanding of the COPQ process.

As recognized in the research, the process is unclear to many organizations. Therefore, it would be beneficial to simplify the COPQ process and focus on the important aspects of the process. For example, the COPQ metrics should be revised and the COPQ reporting tools unified. The process should be as easy as possible to lower the threshold to start new initiatives. These actions would make the whole process clearer and more efficient.

As the limited resources were one of the main issues identified in the research, the allocation of the resources should be addressed periodically. This would promote the importance of the topic, but also make it much easier to start new initiatives. Therefore, the top management should highlight this and underline the importance of allocating enough resources. After all, the improvement projects save money in long term and are often worth the investment of resources. Improvements also increases the customer satisfaction which raises the benefits of the improvement activities even more.

8 Discussion and conclusion

The aim of this research was to investigate the challenges faced by the Quality Managers in Company X regarding the COPQ improvement projects. The research was carried out with extensive theoretical framework and semi-structured questionnaire. The results of the research questionnaire were verified with inductive content analysis.

Theoretical framework provided a solid basis for the research and introduced the COPQ process and related measures. Cost driven quality has been an important part of automotive industry for some time, and the same measures can be seen increasing in other areas of the manufacturing industry. The growth in interest and importance can be seen in the number of academic journals published during the last decade.

The research question addressed the challenges faced in the COPQ improvements, and the reasons for the insufficient number of improvement initiatives: *"What are the underlying factors that hinder the initiation and execution of new improvement projects targeted to reduce the COPQ within BU's and plants?"* The theoretical part introduced the theory behind the COPQ process in the company. This helped to understand the possible bottlenecks and gaps in the process and to analyze the research results. It would be difficult to understand the input from the informants without introducing the theory and processes behind it.

The interview part of the thesis delved into the research questions and focused on delivering answers to them. The thesis questionnaire was designed to provide answers based on the actual experiences of the quality professionals. Therefore, the questionnaire was conducted in a semi-structured manner. Open questions gave the opportunity to answer in own words and in detail. The results of the questionnaire were reviewed with inductive analysis to identify the common challenges of the COPQ improvement projects.

8.1 Key findings and recommendations

Based on the research question the key findings revolves around major challenges experienced in the initiation and execution of the COPQ improvement projects. These findings can be separated and consolidated to five main categories. The categories are limited resources, lacking awareness and competence of employees, inefficient cross-functional collaboration, and unclear COPQ process.

The research informants provided recommendations based on their daily and long-term experiences. These recommendations were strongly linked to the key findings. Therefore, it was important to review their recommendations to make sufficient improvements. As the recommendations were gathered from various business units and plants, the reoccurring ideas are likely to be efficient to tackle the challenges identified.

The case company can utilize the findings and recommendations to further improve their COPQ process and develop strategic development plan to increase the efficiency of the measures. Therefore, the research is beneficial to the case company, and it gives the insight that was initially requested by the company.

8.2 Limitations

The limitations of the study relate to the research methodology of the study. This thesis revolves around a single case study and focuses on a single company. Therefore, it is not possible to generalize from this research. Each company has its own implementation of processes and measures. The informant responses represent the current state of the company at the time questionnaire was conducted. The online format of the questionnaire limits the depth of the responses as the informants may complete the form in a hurry.

8.3 Suggestion for future studies

As mentioned in the “Limitations”, this research focuses on single case. Therefore, it could be beneficial to widen the research to other companies that utilizes COQ methodologies in the daily quality management. This would make it possible to get insight into tools, methods, and processes in other organizations. Additionally, it could offer good benchmarking between the companies to further develop their own functions. In conclusion, performing wider research with solid benchmarking could offer much more insight into the world of COQ in the companies.

In this research the informants were part of the quality department. However, in the future it might be beneficial to focus on the other functions as well. For example, interviewing the plant managers of different functions could provide a different perspective on the challenges.

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Thesis questionnaire and informant answers

Questionnaire

1. By approving this form, I confirm that I voluntarily consent to participate in this study.
    a. Yes
    b. No
2. How many years of working experience do you have?
3. Have you been involved in COPQ improvement projects within your organization?
    a. Yes
    b. No
4. How does your organization prioritize and define COPQ improvement projects?
5. What kind of tools and methods is your organization using in execution of the COPQ improvement projects?
6. How does your organization define the team that conducts the improvement projects?
7. What are the major challenges and obstacles you have faced in initiating a sufficient number of COPQ improvement projects within your organization?
8. What are the major challenges and obstacles you have faced in execution of COPQ improvement projects within your organization?
9. What recommendations or best practices would you suggest to improve the initiation and execution of the COPQ improvement projects within your organization?
10. How could the management team better support COPQ improvement initiatives?
11. Do you have any additional comments or insights regarding the challenges and opportunities related to COPQ reduction within your organization?

Informant answers

1. How does your organization prioritize and define COPQ improvement projects?
    a. Priority is very high in as organisational unit is continuously driving operational excellence improvements as well as quality improvements.
    b. Based on risk and business opportunity.
    c. Main driver is corrective action derived from complaints.
    d. The causes that contribute as underlying cause for multiple problems are defined as improvement projects and prioritized based on synergy with other units.
    e. By CAT case risk.
    f. Very high.
    g. Find the big impact (High COPQ) problem and high reoccurring problem.
    h. By the initial estimated costs (Business Case) looking one year in the future or past. This also includes the risks associated with it. E.g. a failure happened and the costs estimated were 10.000 CHF. The probability of this failure affecting the goods produced is 20%. Meaning this failure could affect 20% of all goods produced from this point forward. Or this failure could affect 1 in 5 batches.In general the source of COPQ projects are customer complaints or internal complaints.
    i. Highest pertaining to identifying root causes, preventive actions and continuous improvements. It is our commitment to ongoing improvement in quality and the proactive management of COPQ
2. What kind of tools and methods is your organization using in execution of the COPQ improvement projects?
    a. A3, 8D and Toyota Production System 8-Steps Method.
    b. Root cause analysis as basis to define sustainable measures.
    c. Root Cause tools: 8D, Ishikawa, 5 why.

   d. Excel based calculation sheets.
   e. A3/5Why.
   f. A3, 8D and specific Quality Projects.
   g. A3 report.
   h. A3, 5S, Ishikawa and effort / benefit matrix.
   i. Problem Solving A3, Root Cause Analysis, AFMEA.
3. How does your organization define the team that conducts the improvement projects?
   a. Normally just Quality, Engineering, and Production.
   b. Depends on the topic, bigger topics have an assigned Project Leader.
   c. Defined by the BU product care teams - alignment with plant 10.
   d. Cross location, Cross unit (BU and Plant), Cross functional.
   e. Depends on case: often x-functional involving Q, Product Care, Engineering, Plants or Supplier respresentative.
   f. Each function that is needed is part of the team.
   g. According to the problem type with big relative to which function.
   h. Usually the Quality Manager is the initiator and moderator. Depending on the circumstances the project is aligned with the area head and team leaders to approve of resources needed (financial and personal). This can be discussed during the Shopfloor Level 2 meeting, bi-weekly exchange meeting or on a 1:1 basis.
   i. Quality Managers are the Lead and Conductors of these initiative.
4. What are the major challenges and obstacles you have faced in initiating a sufficient number of COPQ improvement projects within your organization?
   a. We have enough COPQ improvement project numbers.
   b. COPQ projects also cost resources and the return takes time. The organization commonly prioritizes projects which will have faster and more direct impact on sales growth (directly measurable) and will accept risks.

c. Limited number of complaints. No other COPQ initiatives being driven currently.
d. Availability of resources to execute those projects at full speed and focus.
e. Once the problem is contained, the attention drops to work on prevention.
f. Limited resources. Such projects are many times see as on top of everything and not as investment into the future that pays-off.
g. Find the root cause (problem solving competence need to improve). 1. Concept is sometimes theoretical and difficult to understand for new colleagues. 2. Low consciousness in the other departments and low intrinsic motivation to work on projects - awareness is lacking. 3. Other bigger projects take away resources. Also resources are always limited and COPQ projects are dificult to plan ahead of time and reserve resources.
h. Lack of capacity.

5. What are the major challenges and obstacles you have faced in execution of COPQ improvement projects within your organization?
   a. The major challenges are team member competence and resources.
   b. Most COPQ projects come from historical "issues" and/or previous way of working. The learnings are implemented for future projects but the existing extensive product portfolio is not "cleaned up" (which would be reactive COPQ projects to mitigate existing risks).
   c. None.
   d. Availability of resources to execute those projects at full speed and focus.
   e. People having new / other priorities once the problem is contained.
   f. Limited resources. Such projects are many times see as on top of everything and not as investment into the future that pays-off.

g. Team competence improvement.
h. 1. Calculation of COPQ depending on situation is sometimes difficult and is questioned as this is the criteria for reaching the KPI target. For smaller projects benefit and calculation of DOI can be difficult with low benefit. 2. End-evaluation criteria of A3 quality are not standardized - what are the most important criteria that define a good A3? 3. Solving a problem sustainably with sometimes limited resources or when a business case is not given. (No one would invest 50.000 to solve 5.000 / year costs).
i. Lack of cross-functional collaboration. More focus on products delivery to market than continuous improvements. Resistance to change. Lack of capacity.

6. What recommendations or best practices would you suggest to improve the initiation and execution of the COPQ improvement projects within your organization?
    a. Set up target at early of the year for relevant TMs.
    b. Quantify the benefits of the COPQ initiative (BoD). Have always a "reserved" amount of resources for COPQ (as continuous improvement should always be on the agenda as priority).
    c. We could quantify improvements made in areas like supplier/plant process capability as COPQ relevant.
    d. Good practice in place currently.
    e. Tone from the Top regarding the importance of prevention.
    f. Use running projects to implement new quality standards and make use of the synergies to the rest of the "working system".
    g. Define the regular meeting to drive the quality problem solving.
    h. Keep it as simple as possible. Oftentimes we face smaller projects with a simple and obvious root cause. In such cases a complete A3 approach can be overhelming and not efficient. Every Engineer and Coach should have an A3 training and knowledge (perhaps a shorter training or online quiz / self-learning is sufficient as a fast entry). Also it should be a mandatory training for new employees.

Defining what the specific root cause categories are and when you should chose them (e.g. Risk Management - PFMEA...).

i. Process and Understanding alignment. The ability to show value of these improvement projects

7. How could the management team better support COPQ improvement initiatives?
    a. Fix platform to review and recognize the good COPQ projects.
    b. One Voice x-organizations (Quality - Oper. Exc. - Project Mgmt). Sharing/showcasing examples on what went wrong and what was achieved with COPQ improvement intiatives (successes). Top down decisions for non-negotiable topics, integration COPQ initiatives in targets beyond quality.
    c. Define COPQ in areas outside of complaints.
    d. Commit to the resources through out the execution phase.
    e. Tone from the Top regarding the importance of prevention and acknowledge preventive activities.
    f. Continue to support such initiatives and keep Quality awareness on a high level.
    g. Keep transparency and review in management team meeting with regularly.
    h. Supporting quality in upholding the importance of A3 / COPQ and create awareness.
    i. Align with other management to influence team collaboration.
8. Do you have any additional comments or insights regarding the challenges and opportunities related to COPQ reduction within your organization?
    a. No, all good.
    b. The COPQ metrics should be revised + we should calibrate how to calculate x-BU.
    c. No.
    d. The approach should be expanded beyond the Quality team to other functions as well.

e. No.
f. Reducing COPQ can be a driver for gaining productivity. This should be combined in a smart way to overcome resource restrictions.
g. Similar process with similar problem can have exchange lesson learnt from each other in X- plant.
h. At the moment there is one concept used for both BUs and plants. In general the complexity and size of projects vary between these organizations, also the number of projects. Perhaps a less complex and faster, operative approach could be created (reduction of DOI...). Maybe depending on the calculated costs. Any project <10.000 CHF could be tackled with a faster approach and >10.000 with the standard approach without losing the needed A3 quality.
i. Cost of Poor-Quality (COPQ) tracking in the software segment is not 100% accurate, as it is a challenge to precisely track.

Example of inductive content analysis

Challenges in initiation of sufficient number of projects:			
In P8, we have enough COPQ improvement project numbers.	Adequate number of COPQ improvement projects.	Enough projects.	Successful initiation of projects.
COPQ projects also cost resources and the return takes time. The organization commonly prioritizes projects which will have faster and more direct impact on sales growth (directly measurable) and will accept risks.	Resource limitations, and time efficient direct impact projects prioritized over long term improvements.	Resource allocation and project prioritization challenges.	Limited resources. Project prioritization challenges.
Limited number of complaints. No other COPQ initiatives being driven currently	Challenges in initiating enough CIP due to a limited number of complaints, and lack of new initiatives.	Challenges related to the limited number of complaints and initiatives.	Limited number of issues.
Availability of resources to execute those	Lack of resources to execute	Challenges relate to the sufficient	Limited resources.

projects at full speed and focus.	improvement projects.	amount of resources.	
Once the problem is contained, the attention drops to work on prevention.	Shift in focus when moving from problem solving to prevention.	Transition in attention from corrective actions to preventive actions.	Limited focus on preventive actions.
Limited resources. Such projects are many times see as on top of everything and not as investment into the future that pays-off	Challenges in perceiving COPQ improvement projects as an investment due to the limited resources.	Perception and resources as a challenge.	Limited resources. Limited perception.
Find the root cause (problem solving competence need to improve)	Problems with root cause identification and employee competence.	Difficulties in competence and awareness.	Limited competence. Limited awareness.

Participant information sheet

Study title: Challenges of COPQ Improvement Projects in Company X

Invitation to participate in research study

I would like to invite You to take part in my research study, where my purpose is to define the challenges and issues in developing a sufficient amount of improvement projects to reduce COPQ in plants and business units of the company. Therefore, I would like to hear your experiences and suggestions. All data will be collected anonymously, and no personal data is included.

This information sheet describes the study and Your role in it. Before you decide, it is important that You understand why the research is being done and what it would involve for You. Please take time to read this information and discuss it with others if You wish. If there is anything that is not clear, or if You would like more information, please ask me. After that I will ask You to sign a consent form to participate in the study.

Voluntary nature of participation

The participation in this study is voluntary. You can withdraw from the study at any time before submitting the data without giving any reason and without there being any negative consequences. After submitting the e-form it is not possible to remove the data due to the total anonymity of the survey. The data collector is not able to connect the participants to the submitted answers.

Purpose of the study

This research aims to define the challenges and issues in developing a sufficient amount of improvement projects to reduce COPQ in plants and business units of the company. The extensive questionnaire seeks to gain valuable and reliable data to answer the research question: "What are the underlying factors that hinder the initiation and execution of new improvement projects targeted to reduce the COPQ within BU's and Plants?". The results and outcome of the thesis can be utilized in Company X to improve the Quality practices and reduce the COPQ in the BU's and Plants.

Who is organising and funding the research?

The study is conducted by Bachelor's degree student Eemil Uitto from Turku University of Applied Sciences. The supervisor of this study is Janne Siivonen (DI, Lecturer) from Turku University of Applied Sciences.

No outside funding on this research is required. There is no affiliation or identified bias between the researcher and study setting.

What will the participation involve?

The data collection will conduct as e-form, an anonymous online questionnaire. The questionnaire includes nine open questions, and it takes 10-15 minutes to answer. No personal information is collected. The researcher will not know the identity of the participants. The recruitment of participants is done through company email by invitation letter including a link to the online data collection e-form. The consent form does not require personal information. Also, the IP address used to answer the questionnaire will be secured by the company security compliance.

Data management

The data collection via forms link will be anonymous, so no personal data is registered. The data will be stored by following EU data protection protocols and accessed by password only. The anonymous data is stored on author's personal computer on secure database. The supervisor of the thesis has access to the anonymous data. The electronic anonymous data collected is destroyed two years after thesis approval. This ensures possibilities for potential research integrity assessments.

Possible benefits of taking part

Participating this research will help the participants to improve their future COPQ initiatives, and therefore benefit the company as well. Strategy level management will also get overview of the outcome and make improvements in higher level.

Possible disadvantages and risks of taking part

Participating in anonymous and if you have any questions or thoughts, you can contact the researcher. Questionnaire takes approximately 10-15min min of your time.

Financial information

Participation is free and there is no costs.

Informing about the research results

The results and the thesis will be published in spring 2024. The thesis can openly be accessed in the Theseus archive.

Termination of the study

The researcher will be conducting the study with best effort to complete.

Further information

Further information related to the study can be requested from the researcher / person in charge of the study.

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