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ENGELSK TITTEL: Increased functionality of quality procedure by applying Lean Six Sigma methodology

FORFATTERE (**NB!** maks tre studenter pr oppgave):

Kandidatnr:

7804

Navn:

Stig Fuglestad

VEILEDER:

Jan Frick

# Acknowledgement

This represents the final and conclusive thesis of my bachelor's degree in business administration at the University of Stavanger. The objective of the thesis was to investigate if a quality procedure within Baker Hughes could increase functionality by applying Lean Six Sigma methodology.

First, I wish to thank my supervisor, Jan Frick, for guiding me through this process, providing both professional advice and moral support.

I also wish to thank management with Baker Hughes for letting me use the company as a research subject, and the employees who were interviewed for taking their time to contribute to the study.

Lastly, I would like to extend a very special thanks to my wife for valuable input, discussions and moral support in writing this thesis. It has been highly appreciated.

# Abstract

The purpose of this thesis has been to investigate if the quality process could be improved to increase functionality using lean six sigma methodology.

By performing a qualitative case study utilising first-hand knowledge and data collected in eight interviews, an in depth analysis were performed to gain understanding of how the quality procedure in Baker Hughes is functioning. Lean six sigma, with relevant tools and techniques, formed the theoretical framework. The collected data were applied to an Ishikawa diagram where five root causes were identified. These root causes were then analysed using A3 process. The proposals identified were: training employees in quality procedures and processes, raise communication internally, involve employees in forming organizational procedures and implementing an automated data system. These proposals were presented in a prioritisation matrix showing the impact and the ease of implementation for each of the proposals.

The results show that the functionality can be improved by increasing knowledge of the procedure through training the employees in quality management, increasing focus on raising communication in the organization, and by implementing a system that makes it easy for the employees to take ownership to quality. It is also believed that the employees will perceive a procedure less complex if they are involved in forming the procedures, and if their experience is increased. In addition, the employees will likely find it easier to utilise the procedure if it is run in a data system, where they are guided through the entire process and can find relevant information about previous quality issues.

The results show that by implementing the proposed solutions, this will increase the employees' knowledge and reduce their perception of complexity, leading to the procedure functioning to its purpose.

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# 1 Introduction

In this chapter the background for this thesis will be presented, along with the arguments behind the selection of company, the purpose of the thesis and the chosen problem.

## 1.1 Terminology

OTR: Order to remittance. This is the department all project managers within Baker Hughes are located. All activities to execute an order and invoice the customer is done by this department.

## 1.2 Background for thesis

I chose to write this thesis based on my background as a project manager in Baker Hughes. My interest was piqued after getting an introduction to six sigma and lean. Obtaining that knowledge, I got more interested in how we can improve our procedures and processes in the company. Working as a project manager I often see the backside of poor quality, and how it is handled internally. I started wondering if I could use some of the different methodologies to make an impact in my workplace. In this thesis I have focused on the cost of quality procedure we currently are using in Baker Hughes.

## 1.3 Choosing a company

When the oil and gas industry experienced a downturn in 2014, this called for a stronger focus on cost management. Before this downturn focus on cost was not as apparent in the oil and gas industry. For Baker Hughes to remain competitive in the market there was a need to adapt to the new market climate. There was however not a substantial focus on improving quality and reducing quality cost. In my experience as a project manager leading many projects, my perception is that quality is often given little thought. The company has procedures and processes in place to ensure good quality, but there is little focus on poor quality, and on how to mitigate this. There are few lessons learned on how to prevent poor quality issues from happening again, and insufficient focus on continuous improvement.

Since the poor quality is kept as a cost within the project, management never gets an understanding of why the operating profit is reduced, or why we are not hitting the targets that has been set at the start of the year.

## **1.4 Thesis question and purpose**

Through my own experience in the company my overall impression is that the quality procedure in Baker Hughes is not being followed and/or adhered to. The purpose of this thesis is therefore to answer the following question:

“Can the quality procedure be improved to increase functionality?”

To answer this question, I have chosen the following research questions to go more into depth of the subject:

RQ1 Is the current procedure perceived as too complex for the co-workers to understand?

RQ2 Are co-workers not aware of and/or have sufficient knowledge about the existing procedure?

## 2 Theory

The theoretical framework in this thesis is concentrated around Six Sigma and Lean as these theories are relevant looking at company procedures and processes. Furthermore, Ishikawa diagram and A3 process will be described, two methods often used in problem solving working with processes. Subsequently a description of a strategy prioritisation matrix is presented, and finally Baker Hughes' definition of quality and how they are practicing quality management will be described.

### 2.1 Six Sigma

Six Sigma can be described as a set of techniques and tools for process improvement, and was developed at Motorola in the eighties to improve quality and reduce quality cost (Wikipedia Contributors, 2018). Six Sigma usually starts with the customer as customer satisfaction is the main priority for companies. The success of any company depends on the ability to ensure the highest quality at the lowest cost (Taghizadegan , 2006). According to (Shankar, 2009) Six Sigma is all about improving quality by reducing defects, using data analysis and improving organizational processes. The way Six Sigma achieves this is by using various tools and techniques, and one technique for problem solving is the DMAIC, an acronym for Define-Measure-Analyse-Improve-Control (ibid).

**Define** is the starting point. This is the step where business drivers must be identified, customer critical processes is selected, projects are defined and an implementation plan is developed (Taghizadegan , 2006).

**Measure** is the step where information about a process requiring improvement is gathered (Shankar, 2009). This is gathered to gain a better understanding of how the process is functioning, and where the problem may lie. Data is usually gathered by looking at historical data and examining how many times the process has failed (ibid).

**Analyse** is the step where one tries to get a better understanding of the cause and effect relationships (ibid). By creating a causal diagram of the gathered data, the findings can be used in an Ishikawa diagram, which will be described below.



**Improve** step is performed when the analysis step is completed, and it is clear why the process is failing. The improve step is where you identify a potential solution to your problem (ibid). A tool that can be used is A3 problem solving process. This tool will be described below.

**Control** step is where the process is being maintained. This is the step where the revised process is looked at, including verifying the potential benefits and tracking the improvement (Deepali , 2010).

## 2.2 Lean

The term lean stems from the book “The machine that changed the world” by James P. Womack, Daniel T. Jones, and Daniel Roos. Lean can be described as a philosophy, a framework, a methodology or tools and techniques, and is a holistic and sustainable approach (Sayer & Williams, 2012). The idea is using less to give you more (ibid). (Heizer, Render, & Munson, 2020) defines lean as a focus on perfection by eliminating waste, where any activity that does not add value to the customer is considered waste. Taiichi Ohno, an employee at Toyota Motor company and one of the founders of lean, developed the seven wastes, or muda in Japanese: 1. Overproduction, 2. Queues, 3. Transportation, 4. Inventory, 5. Motion, 6. Overprocessing and 7. Defective product (ibid). According to (Yankelevitch & Kuhl, 2015) lean focuses on employee involvement in implementing and driving continuous improvement (“CI”). It is mentioned that both top management and department managers must remember that the task of continuous improvement cannot be delegated away as this is an important part of their job. In addition, the importance of involving employees to drive continuous improvement is highlighted as crucial (ibid).

Kaizen is a concept in lean that usually refers to both a continuous improvement tool and a process management tool (Fredendall & Thürer, 2016). Kaizen is used to reduce waste and utilises seven steps when looking at a process:

1. Process complexity: looking at how many steps there are, how often does it change hands or require a signature.
2. Process steps: total number of steps to complete the process (to try and reduce steps).

3. Value-added process steps: Number of steps which adds value to service or product (aim to increase value adding steps and reduce non-value adding steps).
4. Decisions: Identify decision points where the process changes (aim for reduction of decision points).
5. Signatures required: Number of approvals required, which usually delay the process (aim for reduction).
6. Handoffs: numbers of time a process changes hands, which may be a source for miscommunication, errors or delays (aim for reduction).
7. Loop backs: steps in the process that needs to be repeated, usually to correct an error or identify missing information (aim for reduction).

### **2.2.1 Ishikawa diagram**

According to (Wikipedia Contributors, 2019), an Ishikawa diagram are causal diagrams showing potential causes for an effect or a problem. The common use of Ishikawa is to identify quality defects or to create product designs. There are different categories of Ishikawa diagrams, for example 8P used in product marketing, 4S used in service industries and the 5Ms which is used in manufacturing. The 5Ms, which is relevant to this thesis, are man (employees), machine (equipment/technology), material (raw material, consumables), method (process) and measurement (inspection, environment). This can be extended to the 8Ms to include management (leadership), mission (purpose) and maintenance. Ishikawa diagrams focuses on finding the root cause to the problem. A root cause is an underlying cause, or a condition that leads to an effect (ibid). Root cause analysis focuses on trying to reveal important relationships among the various variables. The possible causes can be used as insights into how a process behaves.

Lack of employee training topic is addressed in the following references: (Kim, Kumar & Kumar, 2012), (Flynn, Sakakibara, & Schroeder, 1995), (Huselid, 1995), (Ichniowski, Shaw, & Prennushi, 1997) And (Swart, Mann, Brown, & Price, 2005).

Lack of communication topic is addressed in the following references: (Yuhashi & Iijima, 2010) and (Banaeianjahromi & Smolander, 2019).

Lack of automated data system topic is addressed in the following references: (Alic, 2018), (Panorama Consulting Solution, 2016) and (Deloitte, 2016).

Lack of experience topic is addressed in the following references: (Kuhlthau, 1999).

Lack of employee involvement in forming a procedure topic is addressed in the following references: (Liat & Itzhak, 2016) and (Heizer, Render, & Munson, 2020).

### **2.2.2 A3 process**

(A3 Problem-Solving: Fight the Root Cause, n.d) defines the A3 process as an approach for problem solving and continuous improvement. (Nicholas, 2010) describes A3 problem solving as a full report where all information is on one sheet including graphs and figures. The process evolves around sharing and communicating information about problems and decisions in a simple and effective manner, and serves to structure problem solving and maximize learning. This single document shows the entire process which usually is seven steps long; background of the problem, the current situation of the problem, set goals/targets for desired outcome, perform a root cause analysis to find out where the problem stems from, create countermeasures to the problem, implement by using a list of actions and responsible persons, and creating a plan on how to follow up the actions.

### **2.2.3 Strategy prioritisation matrix**

(Marous, 2013) defines the strategy prioritisation matrix as a tool used to identify which initiatives are most beneficial based on the impact it provides, and the amount of effort needed to implement the action. The four boxes are categorized into “quick wins”, “must haves”, “low hanging fruit” and “money pits”. The tool is useful to see which actions should be prioritised based on their position within the matrix. “Quick wins” are the most attractive as these have high impact and requires little effort. “Must haves” provide high impact but take longer to implement and may potentially cost more. These actions are secondary after “quick wins”. “Low hanging fruits” are easy to implement but have little impact. These should be prioritised if there are no “quick wins” or “must haves”. “Money pits” have little impact and are hard to implement. These should therefore be avoided at all cost.

## 2.3 Quality at Baker Hughes

The following can be said about what quality means for (Baker Hughes, 2019): Quality is to meet the needs and expectations of their customers, and that their products are in compliance with customer, statutory, regulatory, internal, and industry safety and quality requirements. Baker Hughes tries to go beyond these requirements by continually reviewing and improving their quality management system. This is sought to be achieved by enhancing their performance to increase the customer satisfaction, and to achieve the organizational goals and quality objectives. Baker Hughes expect every employee to share this dedication to quality, and to play an important role in maintaining and improving quality by following these fundamental principles: customer focus, compliance, risk management, flawless execution and improvement. To meet this commitment, Baker Hughes have clearly documented quality objectives, routine management reviews, and an all-encompassing quality culture to employ digital analytics, Lean Six Sigma and simplification.

Cost of poor quality is defined by the company as *“a set of common data that includes internal and external costs due to product/service failures, defects, and nonconformances which negatively impact the business operating margin”*.

Baker Hughes’ quality management system is called Agility and is approved according to ISO-9001. This means that there is an established, documented, implemented and a maintained quality system, and that they have comprehensive evidence to prove their ability to constantly provide products and services that meets customer, statutory and regulatory requirements. Baker Hughes aims to enhance their customer satisfaction through application of quality management system.

### 3 Methodology

This thesis is a qualitative case study where action research was selected as research method.

According to (Wikipedia Contributors, 2018) qualitative research uses data obtained by the researcher usually involving observations, interviews and questionnaires. Case studies involves detailed examination of real cases by going in-depth on a subject, and provides a framework for evaluation and analysis of complex issues (Wikipedia Contributors, 2019). These types of studies are characterized by conclusions being drawn using the data collected and research performed, and that the result often is difficult to generalize (ibid).

The reason why a qualitative case study was selected for this thesis is that the problem is focused on a specific procedure in a single company, where the objective is to gather in depth data about how the procedure and process is working now, and if the functionality can be improved. To gather information for the research, second-hand knowledge about the company was used, in addition to performing interviews with eight persons from four different departments within Baker Hughes, where all have a role in the quality procedure. The interview questions were formed open-ended and were conducted one-on-one by telephone. To present the information obtained in the interviews in a reliable manner, the interviews were recorded.

Action research can be described as a methodology that pursues change and understanding, and is a cyclical method which alternates between critical reflection and action (Dick, 2002). The method is a participative research where the researcher has first-hand knowledge of the subject (ibid). By going through these cycles during the research, one continuously increases understanding by interpreting and reviewing the data collected, which ultimately leads to better understanding of the problem.

Since the author is an employee of Baker Hughes with first-hand knowledge of the company, having experienced that the procedure is not functioning optimally in practice, action research was selected to explore if this can be improved. In writing this thesis the author went through several cycles during the analysis. As information was gathered and reflected upon, the problem was adjusted accordingly.

## 4 Analysis

In this chapter an analysis based on the problem and research questions will be presented, and will be compiled in three sections.

First the interviews with personnel that have a role within the quality procedure will be analysed, resulting in a causal diagram (figure 1, page 15). The respondents are from the following functions within Baker Hughes: workshop (supervisor), quality (quality engineer and quality manager), OTR (project manager) and finance (cost controller).

Secondly, evaluation of the empirical observations is used to create Ishikawa diagrams, where RQ1 and RQ2 are the problems (figure 2, page 16 and figure 3, page 19).

Finally, the outcome of the Ishikawa diagrams will be analysed using an A3 process as the final and concluding step of the analysis.

### 4.1 Interviews about current quality procedure

RQ1 and RQ2 were raised to try and identify if the quality process could be improved to increase functionality. The following questions used in the interviews were formed to gather information about the respondent's knowledge/awareness of the quality procedure and the perceived complexity.

1. What is your title and what do you do?
2. How would you define cost of poor quality?
3. Where would you place your knowledge about the cost of quality procedure?
  - a. No knowledge
  - b. Heard about it
  - c. Aware of it
  - d. Read it
4. Can you explain where to find it?
5. Can you please describe your understanding about the procedure?
6. Can you describe your role and responsibility within the procedure?
7. What is your role regarding a risen cost of quality issue?
8. How do you identify or know that an issue is a cost of quality concern?
9. How are you involved in the process when a cost of quality concern arises?

10. What happens after you have done your “task”? Can you please describe what happens next?
11. Have you raised any cost of quality issues earlier? Yes or No?
  - a. How was your experience in the process after it was raised?
  - b. What was your level of involvement during the process?
  - c. How was the feedback when the issue was being handled? Did you know where it was, and who was doing what?
  - d. Any feedback if it’s closed or still open?
  - e. What is your understanding about the process once it’s running?
12. . Can you please explain where to find the outcomes of raised cost of quality issues?
13. Based on your experience, how is your overall impression about learnings after cost of poor quality issues are resolved?
14. Any additional comments

#### **4.1.1 Analysis of interviews - knowledge/awareness**

When it comes to knowledge/awareness to the procedure, a natural starting point to investigate is whether the respondents know how to define the concept the procedure is created for, in this case cost of poor quality. As mentioned in the theory chapter, Baker Hughes defines cost of poor quality as *“a set of common data that includes internal and external costs due to product/service failures, defects, and nonconformances which negatively impact the business operating margin”*. All respondents mention that the term is connected to extra cost for the business, and six out of eight respondents also ties this term to an error that is done, which may have various causes. In the extension of this it is also natural to investigate if the respondents know how they identify a cost of poor quality. Three respondents mention that they don’t know how to identify cost of poor quality, and another states he cannot define cost of poor quality due to lack of knowledge. Two of the respondents place the term within product quality, while two also mentions it could apply to services or just “something” that has gone wrong.

Further it appears from the answers that the respondents to a greater or lesser degree have knowledge about the procedure. All the respondents answered that they are familiar with the

procedure, but three out of the eight specify that they have only heard about the procedure and haven't used it.

All respondents know where they can find the procedure, which is in the quality management system that Baker Hughes utilises, called Agility.

When asking the respondents about how they define their role and responsibility in the procedure, this provided some interesting answers. None of the respondents were able to define what their role and responsibility are in the procedure. When being asked almost the same question, only in a practical situation, specifically if they could describe their role while working through a quality issue, six of the respondents were suddenly able to explain their role. Some of the respondents have practical experience with the procedure, which can make it easier for them to explain their role when given a practical question.

It is clear from the responses that all respondents have heard about the procedure and know where to find it. However, many of them cannot explain vital information needed to use the procedure, such as defining cost of quality, identifying an issue and their role and responsibility within the procedure. It therefore appears that the employees have received insufficient training on quality and that the company's focus on communicating about quality is not optimal. Both lack of training and communication can lead to insufficient knowledge about the process.

When asked about their involvement once a quality issue is in progress, three respondents stated that they don't have any involvement in the process. The other five explained that their involvement evolves around the departments area of responsibility. For example, the workshop has the responsibility of explaining what went wrong in the production/repair process, but are not concerned with involving in the subsequent process. All except two respondents had some understanding about the next step in the process after their task was completed. What is remarkable is that the two who cannot give an explanation is working within the quality department. The common denominator for all respondents is that they possess a limited understanding about the entire process, or at least not the steps that aren't directly linked to their area of responsibility.



When the respondents were asked about transfer of experience after a quality issue was resolved, the answers from all departments were that this was not functioning well, and that improvement is needed. This can be attributed to the process being defined and maintained by the quality department and reviewed by management. The employees who are using the procedure, are not consulted in forming or reviewing it.

Each department have their own interpretation on how to handle quality issues. For instance, the OTR department is mainly focused on the customer and the promise date. Thus, they are concerned with finding a solution to the issue quickly. The responses from this department with respect to lessons learned from a quality issue, were that this is not present.

In addition to this, none of the respondents know where to find the outcomes of previous raised quality issues, and who were accountable for sharing the knowledge gained throughout the process. The workshop supervisor reported that he struggled with interpreting the findings in the corrective actions/preventative actions (“CAPA”), as according to his understanding there were many varying interpretations of CAPA among workshop supervisors. He also reported that there was hardly any focus at all on getting the workshop personnel to understand what had occurred in the issues, and how they could prevent it from occurring again. The respondent from the finance department stated that she had no knowledge of this as the department’s focus mainly lies with finances.

It would likely be beneficial that each of these departments are not presented with a lot of irrelevant information when following the procedure, to avoid disturbing factors while going through the process. However, ownership might be increased across departments if they are involved in the last step of the process, that is when the quality issue is moved out to track and trend. For the company to be able to drive continuous improvement concerning quality, it is critical that all relevant departments are informed about the results from the CAPA-analysis. This is crucial to learn from previous issues, and to prevent the issues from being repeated in the future. It is therefore believed that lack of an automated data system on handling quality issues can contribute to insufficient knowledge of the procedure, because the lack of this is causing uncertainty on how to drive the process further and where to find information about resolved issues.

### 4.1.2 Analysis of interviews - complexity

When looking at the respondents general understanding of the procedure, it is apparent that this varies a lot. For example, half of the respondents state that they are not able to explain their understanding, while another one can only give a minor description of it. However, the last three respondents state that they do have knowledge on how the procedure works. The results indicate that when five of eight respondents are lacking a clear understanding of the procedure, the procedure is not clear or easy to understand for the employees. This is also apparent when asking the respondents about their understanding of the process while it was ongoing. Five of the respondents answered that their understanding was minimal. One of the five who answered this stated that his focus was finding a solution to the problem, but that he had no knowledge of what happened with the issue next.

Perceived complexity increases when employees are lacking practical experience with the procedure. This can also be attributed to uncertainty on how to use the procedure due to lack of training.

Another example showing perceived complexity of the procedure among the respondents, were their experiences with the process once a quality issue was raised. Six out of eight respondents had previously raised or been part of a quality issue. The varying descriptions given by each of the respondents show that there are considerable gaps between their experiences. Four respondents state that the process is not functioning optimal as of today. Two respondents also mention that when they hand the issue over to the subsequent department, the issue is not being actioned, and there is no learning-outcome or development. Regardless, the common denominator of the responses is that they are negatively charged when it comes to handling a quality issue.

In this regard the respondents were asked about their level of involvement during the process. The answers showed that the employees who had a lot of experience in using the procedure, were highly involved in the process. These were however not consulted when forming and reviewing the procedure. This responsibility was placed solely with the quality department, only being reviewed by management. Lack of employee involvement in forming the procedure can lead to the employees perceiving the procedure as complex, because the

quality department may not know which information is crucial including in the procedure, contrary to the people who are working with it.

When asked about feedback during an ongoing quality issue, mainly what was the current status and who were responsible to act, two of the six who had previously raised a quality issue, answered that they knew who was actioning it. The remaining four answered that they either did not know or were uncertain.

When researching the respondent's knowledge of whether a quality issue was still open or closed, the common denominator was that they had no knowledge of this. Five out of six respondents who had been involved in a quality issue gave this statement. The last respondent who has previously actioned a quality issue were under the impression that the issue was closed. Since this process is linked to various departments, and they all perform various task within the process, it was identified during the interviews that the outcome of a closed issue was not communicated to the employees who has been engaged in the process. These findings show that there are issues with the structure of the process. Due to these factors the process is considerably people-dependent in driving the issue through each step of the process. The practicing of the procedure and the experience transfers between departments has not been formalized, for example by using an automated data system to generate action owners.

The lack of an automated data system increases perceived complexity for employees using the procedure. This is apparent from the responses since the process is manually driven, lacking a system that pings automatic feedback and action owners. It is up to the users of the procedure to drive their quality issues manually through the chain of action owners.

### **4.1.3 Causal diagram**

Based on the above analysis of the interviews, a causal diagram is created to show the relation between the identified causes and the research questions. By examining the collected data, it appears that many of the causes are interrelated, such as insufficient experience, understanding between departments and learning, which can be connected to both lack of knowledge/awareness and perceived complexity. Another finding was that the perceived complexity about the procedure seems to be higher within employees that have low

knowledge/awareness of the procedure. Employees who had used the procedure prior to the interviews seems to have lower perceived complexity of the procedure.

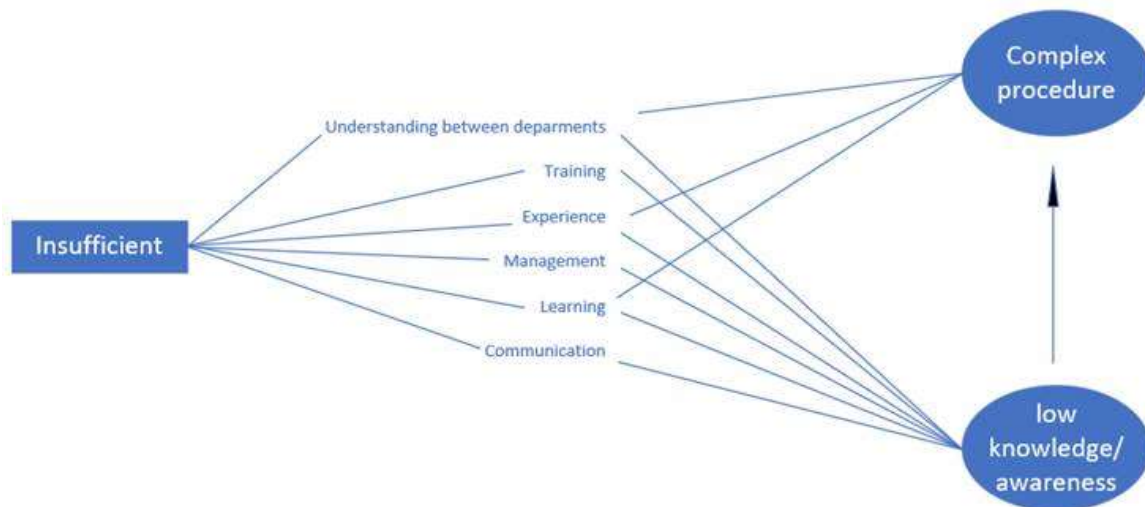


Figure 1 Causal diagram

## 4.2 Ishikawa Diagram

Once the analysis of the interviews has been completed and the causal diagram has been formed, the next step is to try and find the root causes to the problems. The method utilised for this is Ishikawa diagram using the 5M framework. The identified causes create the foundation for further proposals to increase the functionality of the procedure.

When forming the Ishikawa diagrams all the potential root causes identified are linked to the main causes, management and people. The reason why all findings are related to only these two main causes, is that this thesis is focused on a quality procedure utilised by people working in the organisation, and will also be reliant of the management who is the owner of organizational procedures.

## 4.2.1 Ishikawa diagram - knowledge/awareness

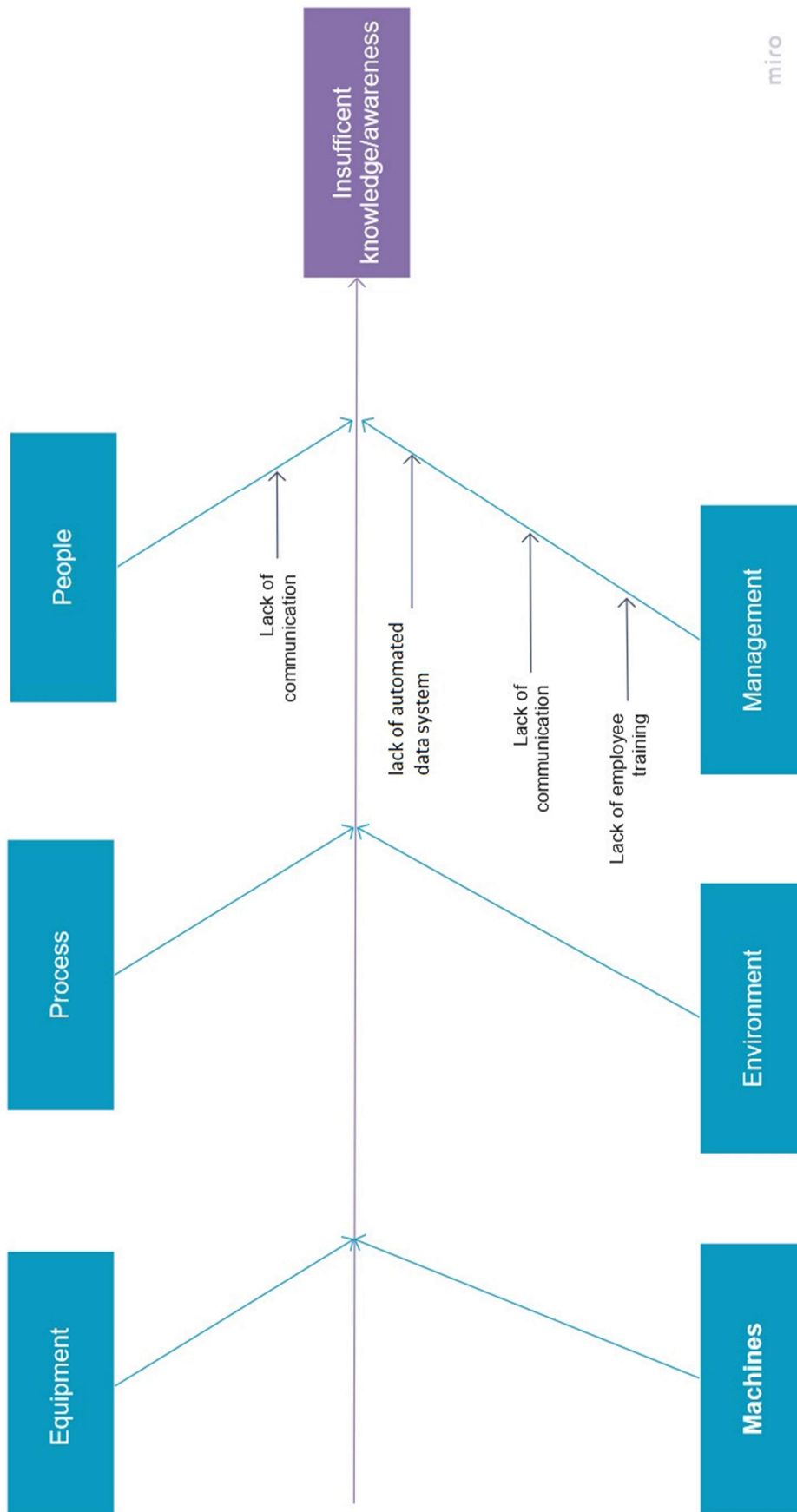


Figure 2 Ishikawa diagram knowledge

Employees having insufficient knowledge or awareness about a procedure may have various causes, and it can be linked to one cause or multiple causes.

**Lack of employee training** is identified as a root cause to why employees have insufficient knowledge about the procedure and process. If employees receive insufficient training, an outcome can be that they are uncertain about their role and responsibility, how to deal with the procedure in practice and on how to communicate with other departments. According to (Kim, Kumar, & Kumar , 2012) training is crucial to develop employee involvement and participation in quality and process improvements. (Flynn, Sakakibara, & Schroeder, 1995) argues that training, not surprisingly, is a success factor for quality management. Observing the respondents inability to define their role and responsibility within the procedure, and that none of them could give a clear answer where closed quality issues were stored, indicates that there are improvements to be made when it comes to quality training. If employees receive sufficient training this will likely increase knowledge and awareness of existing procedures and processes. This is also emphasized by (Huselid, 1995) and (Ichniowski, Shaw, & Prennushi, 1997) who argues that the performance of employees who receive training shows immediate improvements in knowledge and skills. Their abilities to perform work tasks will be elevated and their commitment to the organizational goals will be increased (ibid). Similarly (Swart, Mann, Brown, & Price, 2005) argues that implementing a relevant training program enhances employee knowledge, skills and performance, leading to superior performance, and that this can only occur because of a good quality training program. As stated in the findings from the interviews all respondents are aware of the procedure, but there are several aspects about the procedure that appears to be unclear for many. If Baker Hughes is seeking good quality management, it would be beneficial to invest in employee training, as this can lead to increased focus on quality by the employees.

**Lack of communication** within Baker Hughes is identified as a root cause to why employees have insufficient knowledge about the procedure and process, as communication and collaboration clearly appears to be an issue. (Yuhashi & Iijima, 2010) define communication as *“the interactive processes employed by human beings in order to communicate their psychological content (including knowledge, emotions and will) between one another, using symbols such as body language words, text, images, and so on, as mediational means”*. Based on research by (Banaeianjahromi & Smolander, 2019) lack of knowledge and support inside own organizations can hinder communication and

collaboration between departments. This can explain why the respondents are having issues with explaining what the various departments roles are during a quality issue.

The lack of communication is highlighted by two respondents when asked about feedback on an ongoing quality issue, where the workshop supervisor stated: *“No, I know that OTR got the message and that we needed to give an estimate of the repair, but we never heard anything back. I think it is quality who handle these kinds of things”*. Furthermore, a project manager from OTR said: *“I’m uncertain on how automatic that process is. As I remember there were a 4-blocker that was emailed, but I cannot say if that was correct. I don’t think you could see in the system where it was and who was doing what”*.

**Lack of automated data system** to perform track and trend of quality issues, and to drive continuous improvement inside Baker Hughes, is identified as a root cause to lack of knowledge. (Alic, 2018) argued that the basis for any process improvement is to use software, as this will be easier to handle and more effective for the employees. Furthermore (ibid) identified that by implementing QMS in the ERP system it can help develop critical success factors, such as top management support and increased communication. In the global ERP 2016 report, with 215 participating organizations, 82% state that they utilise an ERP system of some sort (Panorama Consulting Solution, 2016). It can be argued that by implementing the QMS system into the ERP system, this will have a positive impact on reduced complexity within the organization. As identified by (Deloitte, 2016) the benefits of implementing QMS in the ERP system are improved productivity, information availability, improved data reliability, expanded analytics across the enterprise (as part of ERP system) and controls for compliance. Based on the empirical observations it can be affirmed that there are no QMS implementation in the existing ERP system.

## 4.2.2 Ishikawa diagram - complexity

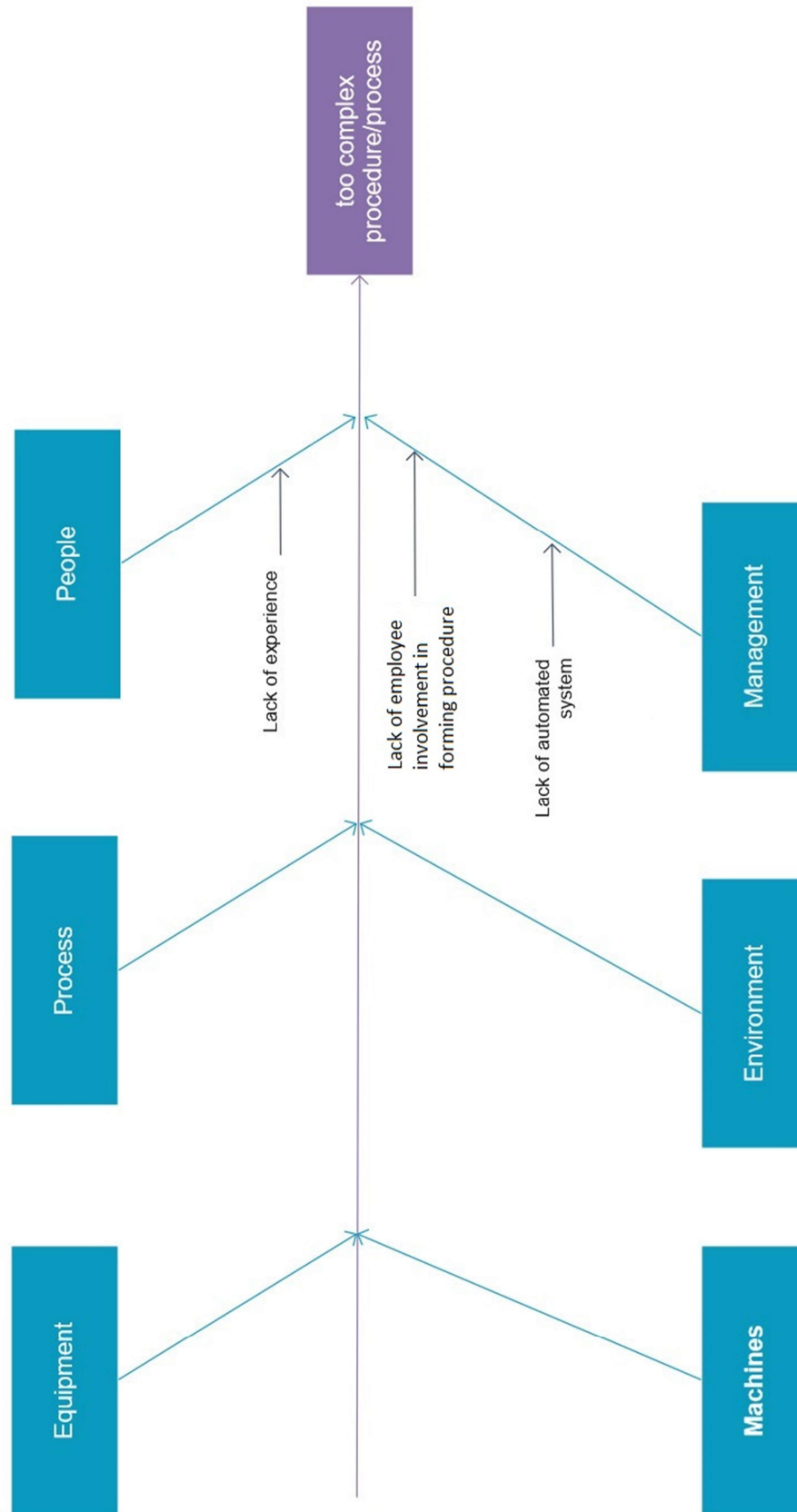


Figure 3 Ishikawa diagram complexity



**Lack of experience** is identified as a root cause to perceived complexity. Empirical observations show that the respondents who had been involved in a quality issue were able to describe their understanding about the process and how it functions. However, the respondents with no experience could not describe their understanding. (Kuhlthau, 1999) identified that complexity and lack of experience are linked together, as research showed that people with little experience considers task more complex, and conversely people with experience deemed them not so complex. It is also seen as highly likely that lack of experience is correlated to lack of training, because empirical observations show that respondents who had used the quality procedure, have gained experience and were able to describe their understanding of how the process works. The respondents who were lacking experience with the process were however not able to do so.

**Lack of employee involvement in forming the procedure** is identified as a root cause to increased complexity. The quality procedures and processes are owned by the quality department and are being reviewed by senior management. The employees who are utilising it are not involved in forming or maintaining them. (Liat & Itzhak, 2016) research shows that employee involvement and engagement will benefit both organization and employees, as employees who are involved show increased proactivity, knowledge sharing, creativity and adaptivity. (Heizer, Render, & Munson, 2020) also argues that the employees who are dealing with the procedures and processes in a daily basis, has the best understanding on how they are functioning. The empirical observations show that the respondents are struggling to describe their understanding of the procedure, and of the eight interviewed, only three were able to give a brief explanation about how the procedure works. The remaining five cannot give a description of their understanding of the procedure. If employees were empowered and included in forming procedures, the complexity can be reduced. The employees will likely be better able to describe the process in a clear manner, than management who are not utilising it.

**Lack of automated data system** is another identified root cause, and this root cause is attributed to both knowledge/awareness and complexity. Lack of an automated data system increases the perceived complexity among the employees, as empirical observations show that a lot of the communication occurs in e-mails between departments. An automated data system removes this manual process, the latter requiring the employees themselves to take action, instead of a system generating the required actions to be taken.

### 4.3 Summary of analysis by using A3 process

As referred in part 4.2.1 and 4.2.2, there are two identified problems that needs to be addressed. RQ1 and RQ2 investigates if the quality procedure can be improved to increase functionality. During the data analysis several causes were identified, and one of these causes were identified in both Ishikawa diagrams. All these findings can be a root cause to why there is lack of knowledge/awareness about the procedure, or employees perceives the procedure as too complex. The identified root causes that results in abovementioned problems are:

- Lack of communication
- Lack of automated data system
- Lack of employee training
- Lack of experience
- Lack of employee involvement in forming procedures

Too root these two problems out, and get a better overview of the current standing, the following A3 diagrams are created for the two problems.

#### 4.3.1 Problem 1: Insufficient knowledge/awareness of the procedure

Background	Insufficient knowledge about quality procedures and processes within Baker Hughes
Current situation and target goals	Employees within Baker Hughes are struggling with using the quality procedures and processes. The target would be to increase employee knowledge about quality procedures and processes to increase the functionality of them.

<p>Root Cause Analysis</p>	<p>The root cause analysis of this problem identified three potential causes to this error.</p> <p><b>Lack of training</b> as employees don't know how to identify quality issues within the organization, and are uncertain about what their role and responsibility are in the quality procedure.</p> <p><b>Lack of communication</b> since employees are uncertain of what happens after they forward a quality issue to the subsequent department. Communication between the various departments involved in the process are lacking and feedback is minimal.</p> <p><b>Lack of automated data system</b> as employees are sending e-mails to the various departments, employees are uncertain who are addressing the issue, and there is nowhere in the current system you can find status of ongoing quality issues within the organization.</p>
<p>Countermeasures</p>	<p>Management should review the need to train employees so that everyone receives the required knowledge to use the quality procedures. Raise the awareness about quality within the organization, and increase communication by involving all departments when communicating the status of CI and track &amp; trend. Check the possibility to implement an automated data system within existing ERP-system to monitor and track quality issues.</p>
<p>Implementation</p>	<ul style="list-style-type: none"> <li>- Train employees in quality procedures</li> <li>- Raise communication internally regarding CI and track and trend</li> <li>- Implement automated data system</li> </ul>

Follow-up	<p>Some of the countermeasure proposals are easy to implement. Starting straight away the management should increase internal communication, where the management shares CI and track and trend. This needs to be shared with the entire organization to raise awareness of quality issues. Secondly, the management needs to review training material, and to increase training of employees to raise knowledge about quality procedures.</p> <p>Implementing an automated data system to monitor and track quality issues is a bit more tedious to implement. This should be prioritised within the next six months.</p>
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### 4.3.2 Problem 2: Too complex procedure

Background	The employees perceive the quality procedure as too complex.
Current situation and target goals	<p>Employees within Baker Hughes are having mixed experience using the procedure, and there seems to be some complexity with the current procedure that is preventing employees to comply. The goal is to reduce the complexity in the procedure to increase the functionality.</p>
Root Cause Analysis	<p>The root cause analysis of this problem identified three potential causes to this error.</p> <p><b>Lack of experience</b> increases the perceived complexity because the employees are uncertain about how to use the procedure.</p> <p><b>Lack of employee involvement in forming procedure</b> increases the complexity because the people responsible for forming the procedure are not utilising it, and therefore might not know what kind of information is crucial to include. Employees</p>

	<p>are unaware of the various steps in the procedure and are having issues with explaining how the process works.</p> <p><b>Lack of automated data system.</b> Employees have no relation to continuous improvement because they do not receive information about where track and trend are being stored. By not having an open system there is reduced possibility for improvement, and the same error may occur repeatedly. Since there is no system in place, employees are uncertain about their ownership to the various tasks and this may increase perceived complexity of the procedure.</p>
Countermeasures	<p>Management should involve employees when forming procedures. Employees can give input of the steps that various departments have in the procedure. This will also raise the knowledge and experience the employees will have using the procedure since they have been involved from the beginning. Procedures should be accessible for potential improvement, and not just finalized and stored in a system. An automated data system for quality issues will make it easier for employees to understand their role and responsibility and make it easier to take ownership of their tasks. This can be realized if they can find information in a system.</p>
Implementation	<ul style="list-style-type: none"> <li>- Raise experience and knowledge by involving employees in forming organizational procedures.</li> <li>- Train employees in company procedures.</li> <li>- Implement automated data system</li> </ul>
Follow-up	<p>Management can start straight away to include people who are using the procedures when forming them. This can also be</p>

	<p>applied to existing procedures in the system. Review training material and increase training of employees to raise knowledge about quality procedures. Implement an automated data system to monitor and track quality issues. This should be prioritised within the next six months.</p>
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For the two problems reviewed in the A3 process, four proposals that potentially can increase the functionality of the procedure were identified. These proposals are: To train employees in quality procedures and processes, implement an automated data system, raise communication internally regarding CI and track & trend, and elevate experience and knowledge by involving employees in forming organizational procedures. These proposals were inserted into a prioritisation matrix where they are ranked on how much impact they will have and how easy they are to implement.

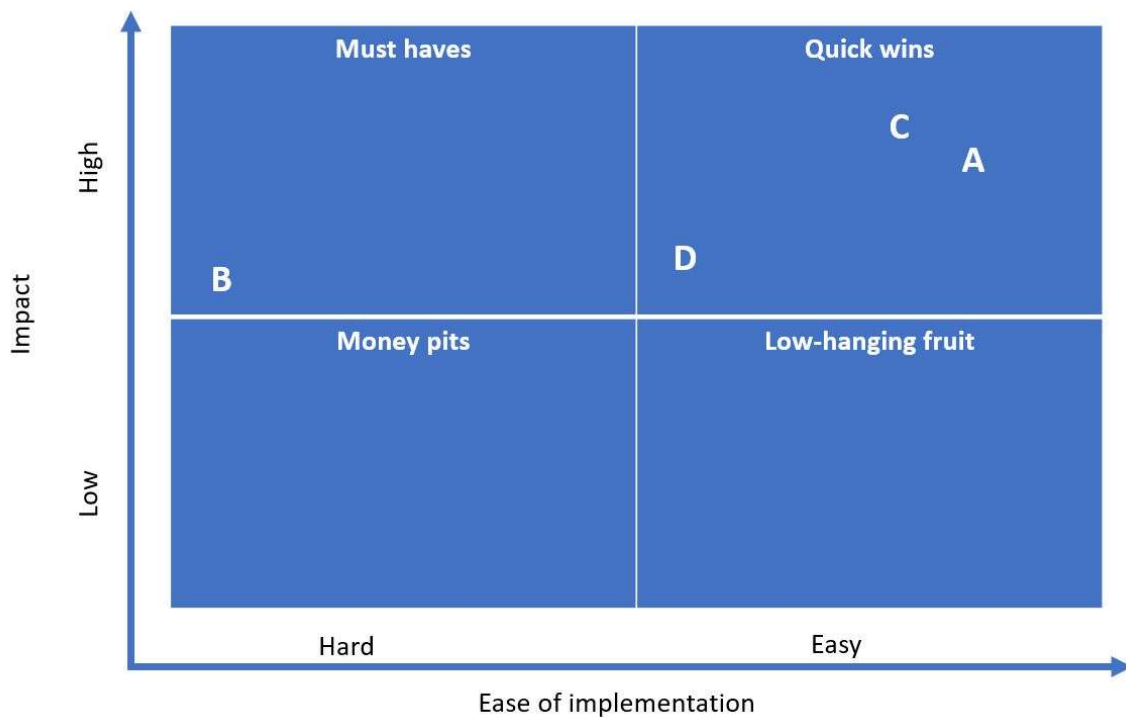


Figure 4 Prioritisation matrix

- A. Train employees in quality procedures and processes** will contribute to elevate the employees understanding and knowledge. An increased focus on training will likely reduce perceived complexity. Training is a “quick win” and is easy to

implement in Baker Hughes' training portal. The impact will be high as employees will understand the importance of quality, and this also helps drive continuous improvement within the organization. Employees will achieve a better understanding of how the procedure is intended to function. It is the management's responsibility together with the quality department to implement this action.

- B. Implementing an automated data system** will make it easier for the employees to view the status of their quality issues, CI and track & trend at any given time. This will likely increase the employees' awareness and reduce perceived complexity, and this can lead to increased functionality of the procedure. This measure can be placed under "must have", but due to the size of the company with many approval steps, it can be hard to implement although the impact can be high. The responsibility of this action is on the management.
- C. Raise communication internally regarding CI and track & trend** will increase knowledge and awareness. If management focuses on communication of continuous improvement and track and trend within the organization, the employee's knowledge will increase. This falls under the "quick win" as the impact and ease of implementation is high. The only action is to share what is already being discussed at management reviews. This action is the management's responsibility to communicate to the organization.
- D. Raise experience and knowledge by involving employees in forming organizational procedures,** will engage the employees to drive continuous improvement. Currently the quality department owns the procedures, and only senior management are involved in reviewing these. The actual users of the procedures are not involved. This method binds the procedure with no possibility to drive continuous improvement. If employees are involved in forming the procedure, they can take advantage of with their knowledge and experience from utilising it. Involving employees in forming procedures falls under "quick win", as this should be easy to implement. It is dependent of management changing their current mindset on the way procedures are created, and to use lean six sigma methodology by including all employees. The impact will be that quality within the organization will increase.

Based on these abovementioned suggested improvements this will increase the functionality of the quality procedure. The priority of the improvements is made based on the findings and arguments above in the following order:

1. A - Train employees in quality procedures & processes
2. C - Raise communication internally regarding CI and track & trend
3. D - Raise experience and knowledge by involving employees in forming organizational procedures
4. B - Implement automated data system

These suggestions are proposals and not a final answer, but based on the research performed it is believed that these measures will increase the functionality of the quality process.



## **5 Validity and reliability**

### **5.1 Internal validity**

Internal validity verifies that the cause and effect in research are trustworthy, and reflects if it is possible to eliminate alternative explanations or findings (Taylor, 2013). The collecting of data to answer the research questions were based on first-hand knowledge as an employee of the company being studied and conducting interviews with other employees working in Baker Hughes. The interview questions were formed based on the cost of quality procedure. The questions were formed open ended to minimize risk of influencing the answers, since I have a position within Baker Hughes. In addition to this, while conducting the interviews my focus was mainly on letting the respondents talk without giving too much additional information. The objective was to avoid leading the respondents in a certain direction. All the interviews were recorded, and the transcription can therefore be considered accurate. Although all the identified causes are difficult to measure, or quantify, there is reason to believe that there is a relationship between these causes and the perceived complexity of the procedure, as well as the knowledge the employees holds.

### **5.2 External validity**

External validity verifies if the results can be generalized beyond the context of the study in question (Taylor, 2013). Although it can be questioned whether eight respondents represent a large enough population to answer the research question, the interview objects all have a role within the cost of quality procedure, having either raised a quality issue before or been involved in the process. There are six departments with a role in the quality procedure, whereof four were represented in the interviews. Employees from the remaining two departments were asked to participate in this research, but either declined or were not able to. Even though this research is based on a limited number of interview objects, the topic being studied is likely transferrable to most companies concerned with quality management, as the causes identified are not company-specific, but rather quite general.

### **5.3 Reliability**

Reliability in qualitative research means collecting data consistently, and that the data is being measured in a thoughtful and consistent manner so it is dependable (Neuman, 2012).

The goal with a qualitative study with reliability is to capture social life in a manner that appears to be true to the experiences of the people who are being studied (ibid). In this thesis reliability has been sought by focusing on both acting the same in all interviews performed, as well as presenting the data in a consistent and true manner.

## 6 Conclusion

The purpose of this thesis was to explore if a quality procedure within Baker Hughes could be improved to increase functionality, by researching if increased knowledge and awareness to the procedure and reducing complexity of the procedure could be potential solutions to the problem. Through performing a qualitative case study using first-hand knowledge as an employee of Baker Hughes in addition to information from other employees, the data and problem was analysed using lean six sigma methodology. In the analysis three probable root causes to lack of knowledge and/or awareness to the procedure were suggested: lack of communication, lack of automated data system and lack of employee training. Three probable root causes to perceived complexity of the procedure were suggested. These were: lack of experience, lack of employee involvement in forming procedure and lack of automated data system. The root causes were analysed using an A3 process where four potential solutions to the research problems were suggested, which were: train employees in quality procedures and processes, raise communication internally, involve employees in forming organizational procedures and implementing an automated data system. Based on the analysis the author has reason to believe that these solutions can increase knowledge and awareness to the procedure, and that the perceived complexity can be mitigated.

The analysis was concluded by an action prioritisation matrix suggesting which of these solutions the company should prioritise first based on the level of impact and how easy or difficult it is to implement. In this matrix it was suggested that the first three solutions mentioned above are “quick wins”, and therefore the company should prioritise these first. Implementing an automated data system was suggested as a “must have” because of its high impact on solving the problem, even though this is considered more difficult to implement than the three other potential solutions.

The recommended prioritisations set aside, implementing these proposals will increase the functionality of the quality procedure. The functionality can be improved by increasing knowledge of the procedure through training the employees in quality management, increasing focus on raising communication in the organization, and by implementing a system that makes it easy for the employees to take ownership to quality. It is also believed that the employees will perceive a procedure less complex if they are involved in forming

the procedures, and if their experience is increased. In addition, the employees will likely find it easier to utilise the procedure if it is run in a data system, where they are guided through the entire process and can find relevant information about previous quality issues.

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# Appendix A

## 7.1 Transcription of the interviews

### 7.1.1 Interview one

1. **What is your title and what do you do?** Project manager. I follow up all the support functions and run the delivery through all steps from engineering, procurement, manufacturing and customer delivery.
2. **How would you define cost of poor quality?** Cost that we see because we have done something wrong in the chain. Sometimes because of errors in procedures, parts are designed incorrect or that we did not follow the drawing when the part was made.
3. Where would you place your knowledge about the cost of quality procedure?
  - a. No knowledge b. Heard about it c. aware of it d. Read it. c and d. **B.** Think I might have read it about five years ago.
4. Can you explain where to find it? Agility.
5. Can you please describe your understanding about the procedure? No.
6. Can you describe your role and responsibility within the procedure? I think I have a role approving the cost that is in our product group when it comes to cost of poor quality. If engineering needs to perform extra work, or we have to make a part over again then it is my role to approve the cost or the hours spent.
7. What is your role regarding a risen cost of quality issue? My role is to approve the cost.
8. How do you identify or know that an issue is a cost of quality concern? I don't have the definition on how we define cost of poor quality.



9. How are you involved in the process when a cost of quality concern arises?  
Partially involved in what we have identified within engineering. Extra hours that needs to be approved or else through the NCR system.
10. What happens after you have done your “task”? Can you please describe what happens next? Then it will be fixed. I have worked through the approval process and we get the cost on the project or the part that we need to move out later.
11. Have you raised any cost of quality issues earlier? Yes or No? Yes, on earlier projects in the old systems.
- a. How was your experience in the process after it was raised? I vaguely remember something about a 4-blocker, and registering in the ERP-system that probably went to the cost controller. It was rather simple in the old system, but I don't know how the new functions.
  - b. What was your level of involvement during the process? Relatively involved. Without remembering in detail, but my responsibility was to log it in the system and to sift it out.
  - c. How was the feedback when the issue was being handled? Did you know where it was, and who was doing what? I'm uncertain on how automatic that process is. As I remember there were a 4-blocker that was emailed, but I cannot say if that was correct. I don't think you could see in the system where it was and who was doing what.
  - d. Any feedback if it's closed or still open? It was probably closed four years ago. Think I got a feedback on that this was CoPQ and not margin erosion.
  - e. What were your overall experience about the process? I have little understanding about the process when it's ongoing.
12. Can you please explain where to find the outcomes of raised cost of quality issues?  
No, That I cannot do.

13. Based on your experience, how is your overall impression about learnings after cost of poor quality issues are resolved? Bad. We do have a tendency to fix it there and then and move on. We do not know if the person sitting next to you is going to do the same error that just occurred.
14. Any additional comment? No.

### 7.1.2 Interview two

1. What is your title and what do you do? I am the Balder Future Project quality manager. As quality manager for the project you are basically making sure that the quality aspects are as required or implemented and followed up.
2. How would you define cost of poor quality? COPQ is something that as a business we have encountered an additional cost. Maybe a quality miss has happened to a product or service, or it can be any form of additional cost of what it should be. Any cost related to that additional set of work due to a non-conformity that is spent to get the part to required function, or you need to replace the part due to scrapping. Any cost related to that will be cost of poor quality.
3. Where would you place your knowledge about the cost of quality procedure?
  - a. No knowledge b. Heard about it c. aware of it d. Read it. c and d. You need to read and be aware of it, and the content within it.
4. Can you explain where to find it? Our QMS database which is Agility.
5. Can you please describe your understanding about the procedure? No, I cannot.
6. Can you describe your role and responsibility within the procedure? There is a new procedure in creation stage. I would be involved in that, but I'm not there yet since it's a very new procedure. (old procedure) No, I don't remember that straight away.
7. What is your role regarding a risen cost of quality issue? Have we changed a certain routine from the moment a non-conformity has happened, we need to make sure that the additional cost is captured. As quality it would be like you revisit this with track and trend. From a quality aspect you follow up based on the track and trend. Then you get a picture on what is actually going wrong, and this gives you the opportunity to implement new measures, so that you can try to improve on

those figures (negatively) to bring down the cost that is costing the business. That is the quality role

8. How do you identify or know that an issue is a cost of quality concern? A non-conforming product/service is the basis. A negatively impacted product. A product that don't meet the quality requirements assigned to it. The additional work or cost to get that to an original requirement is a cost of poor quality concern.
9. How are you involved in the process when a cost of quality concern arises? As quality you are more focusing on the corrective actions and preventive action (CAPA) You focus and involvement as quality would be that the CAPA is implement and that there are enough preventative actions.
10. What happens after you have done your "task"? Can you please describe what happens next? The next task is when you have the CAPA action the case is closed, and they all contribute to the track and trend, and this will be further evaluated. The next stage to understand is the trend which will trigger your involvement on what needs to be changed and what needs to be implemented to improve on those figured.
11. Have you raised any cost of quality issues earlier? Yes or No? Raised no but Involved yes.
  - a. How was your experience in the process after it was raised? The procedure was not sufficient. It was up to individuals to decide if they wanted to move those cost out of the project. It was resting on the project managers.
  - b. What was your level of involvement during the process? Making sure that there were CAPA actions. You fix the part and make sure it is not happening again.
  - c. How was the feedback when the issue was being handled? Did you know where it was, and who was doing what? Yes
  - d. Any feedback if it's closed or still open? No, I did not get that information
  - e. What were your overall experience about the process? There is a need to improve the procedure or create a new one.
12. Can you please explain where to find the outcomes of raised cost of quality issues? Not within my role. I think that is with the project managers because that cost is finance related where the cost will be shown.

13. Based on your experience, how is your overall impression about learnings after cost of poor quality issues are resolved? We need to improve.
14. Any additional comment? Not really. I think everything is going back to the procedure. We need to improve the procedure. It cannot be up to individuals (OTR) to decide if this is COPQ. Right now, everything is getting an expensive part, and no one is taking action on why we ended up here. This is not currently showing in our current system.

### 7.1.3 Interview three

1. What is your title and what do you do? Finance project manager currently working as a cost controller and I control the cost and revenue.
2. How would you define cost of poor quality? I would say that it is cost that exceed budgeted cost on products due to defects, errors or unforeseen problems.
3. Where would you place your knowledge about the cost of quality procedure?
  - a. No knowledge b. Heard about it c. aware of it d. Read it. c and d. C.
4. Can you explain where to find it? No, but it depends on what viewpoint you look at it. If looking at it from a financial standpoint, I have the procedure that tells me where I shall lay the cost financially, but the process used in production I don't know. As I see it, I do not have that much to do with the analysis of this exceeding the budget or not. I am focusing on where it is to be placed financially. On Balder it is logged as period cost and treated as project management for instance. We don't calculate revenue on that cost, that is added later.
5. Can you please describe your understanding about the procedure? No, that will be a question on where the responsibility lay. If it is cost that exceed the budget, or the project managers or project director say we have identified cost we have not forecasted, it is on the cost controller to allocate correctly. It varies who decides what a CoPQ is.

6. Can you describe your role and responsibility within the procedure? Now I think that I should interpret according to my revenue recognition policy on handling cost, but I am uncertain if this is the right understanding.
7. What is your role regarding a risen cost of quality issue? Link the cost correctly, but I know everything is tagged to a code, and my understanding is that this is the project manager's responsibility that the cost is flagged as CoPQ and not regular cost.
8. How do you identify or know that an issue is a cost of quality concern? No, that I don't know.
9. How are you involved in the process when a cost of quality concern arises? No, until now it is to find cost or no, I have not been involved earlier.
10. What happens after you have done your "task"? Can you please describe what happens next? For my part the cost will be placed where it belongs, then there will be an analysis on how this affects margin and such.
11. Have you raised any cost of quality issues earlier? Yes or No? No.
  - a. How was your experience in the process after it was raised?
  - b. What was your level of involvement during the process?
  - c. How was the feedback when the issue was being handled? Did you know where it was, and who was doing what?
  - d. Any feedback if it's closed or still open?
  - e. What were your overall experience about the process?

12. Can you please explain where to find the outcomes of raised cost of quality issues?  
No, I guess that would be to check previous projects, eventually talking with the project managers or cost controllers.
13. Based on your experience, how is your overall impression about learnings after cost of poor quality issues are resolved? Do not know.
14. Any additional comment? No, this is a “blurry” area so it could be more on the agenda from my side with more input from project managers when something unsuspected happens. When I see more hours are used, I think we should have a talk if this should be CoPQ or not.

#### 7.1.4 Interview four

1. What is your title and what do you do? Project Manager and I run projects.
2. How would you define cost of poor quality? It is cost that happens because we have done something wrong.
3. Where would you place your knowledge about the cost of quality procedure?
  - a. No knowledge b. Heard about it c. aware of it d. Read it. c and d. **D.** I have read it.
4. Can you explain where to find it? Agility.
5. Can you please describe your understanding about the procedure? The procedure is there to explain us how the process is working. It works by us identifying a problem and capture it. Then we process the problem and log the costs.
6. Can you describe your role and responsibility within the procedure? My role is to identify where I have a possibility to do so. We also have a responsibility to verify that a WBS is logged in the ERP system and fill out the template for cost of poor quality. Evaluation of the cost and participate in the process to verify that it is cost of poor quality.

7. What is your role regarding a risen cost of quality issue? Supervisory responsibility
8. How do you identify or know that an issue is a cost of quality concern? I would say that it is based on the level of experience, but do you get rework or scrap in the doors, especially on the newbuild projects we are doing then I would say it is a cost of poor quality.
9. How are you involved in the process when a cost of quality concern arises? I am responsible in identification and to make a 4-blocker.
10. What happens after you have done your “task”? Can you please describe what happens next? After we have identified and logged the 4-blocker and it is approved, then we gather the costs we move it out of the project and track and trend.
11. Have you raised any cost of quality issues earlier? Yes or No? Yes.
  - a. How was your experience in the process after it was raised? I didn’t have a good experience that it was functioning. It was more a proforma and formality case you had to do. I can’t see that we learned or evolved the processes for that reason.
  - b. What was your level of involvement during the process? I was involved in the process to the point where the cost was collected.
  - c. How was the feedback when the issue was being handled? Did you know where it was, and who was doing what? I did.
  - d. Any feedback if it’s closed or still open? It is beginning to be a few years ago, but I cannot say if I got any feedback if it is closed or still open.
  - e. What were your overall experience about the process? The understanding is ok, but everything happens in a hurry to move the process forwards.

12. Can you please explain where to find the outcomes of raised cost of quality issues?  
No, I cannot.
13. Based on your experience, how is your overall impression about learnings after cost of poor quality issues are resolved? Not a good impression.
14. Any additional comment? No, we probably could update this process and focus more on outcomes, track and trend, also the results should be more highlighted.

### 7.1.5 Interview five

1. What is your title and what do you do? Project Manager. I run deliveries on newbuild equipment to our customers.
2. How would you define cost of poor quality? It is a way to allocate the cost or to define the cost that is linked to various errors in the supply chain. If it is extra hours for engineering, errors with a delivery or extra cost that we have not calculated for. That cost we need to tag and highlight within the company, so that we take steps to reduce the amount of CoPQ.
3. Where would you place your knowledge about the cost of quality procedure?
  - a. No knowledge b. Heard about it c. aware of it d. Read it. c and d. C.
4. Can you explain where to find it? Agility.
5. Can you please describe your understanding about the procedure? The understanding of the process is that it is how we are to relate to CoPQ. How the various functions shall adhere to it.
6. Can you describe your role and responsibility within the procedure? No, I cannot do that in detail. I have a clue on my responsibility and how to handle it when it happens on my projects, and that is to allocate the cost to the right place, or the correct activity on the project so that we can find it again.



7. What is your role regarding a risen cost of quality issue? It varies. Often when people find CopQ, they approach me with their findings, and it is up to me to decide on how we handle the issue as I am responsible for the project. If it is extra cost, we need to allocate it to the right place in the project and hand it over to the ones responsible for the error or possible correct the error.
8. How do you identify or know that an issue is a cost of quality concern? I know how it is defined, if not I look it up in the procedure.
9. How are you involved in the process when a cost of quality concern arises? I wonder if I answered that question earlier, but as I stated when they identify an error, they approach me, then I am the decision maker on how we handle this further. If it is a deviation towards engineering, engineering has to identify what needs to be done. If we need to action something, it usually goes through me and also when we need to make modifications or larger engineering activities. I am the decision maker since I own the cost and the budget on the job.
10. What happens after you have done your “task”? Can you please describe what happens next? Yes, or no, when a COPQ WBS is allocated to the project we only need to tag the cost, but I do not know who is doing the review of the CoPQ after the projects are closed. I take action to solve the activities that are related to my project and get the cost allocated correctly. After that I do not take any more responsibility.
11. Have you raised any cost of quality issues earlier? Yes or No? Yes.
  - a. How was your experience in the process after it was raised? I was mainly after finding a solution for my problem. I experience that not much happen after they are logged. We do what is necessary to find a solution, after that it seems like nothing is happening.
  - b. What was your level of involvement during the process? Highlight the issue and potential solutions is what I did.

- c. How was the feedback when the issue was being handled? Did you know where it was, and who was doing what? No.
  - d. Any feedback if it's closed or still open? In some cases.
  - e. What were your overall experience about the process? No, experience of the process is that I mainly focus on finding a solution, and I did not know what happened later with the issue.
12. Can you please explain where to find the outcomes of raised cost of quality issues?  
No.
13. Based on your experience, how is your overall impression about learnings after cost of poor quality issues are resolved? No, I don't think they are highlighted in much detail. What total cost is uncertain and what steps are taken to prevent it from happening again is also not highlighted. What is highlighted is that we have a lot of CoPQ in the company on an overall level.
14. Any additional comment? No, I do not have that.

### **7.1.6 Interview six**

1. What is your title and what do you do? I have two positions, I am the leader of the QC department and also PQE, specifically towards XT and tools department. On QC I am the leader planning day to day business and issue resolution and facilitate for the work we do. As PQE I have the responsibility for quality within the projects I am responsible for. Mainly ITP to customer, customer contact regarding quality deviations, Non-conformances and technical questions that arises. I am working in many fields.
2. How would you define cost of poor quality? CoPQ is something we have caused ourselves, that make our equipment not meet the requirements we have, or something we har inflicted or forgotten do to.

3. Where would you place your knowledge about the cost of quality procedure?
  - a. No knowledge b. Heard about it c. aware of it d. Read it. c and d. **D.** I have read it
4. Can you explain where to find it? Agility.
5. Can you please describe your understanding about the procedure? No.
6. Can you describe your role and responsibility within the procedure? I am not sure if I have a role and responsibility in the process since I read it a long time ago.
7. What is your role regarding a risen cost of quality issue? Not me specifically, but I do know that quality is involved, but uncertain if PQE's are involved.
8. How do you identify or know that an issue is a cost of quality concern? Not according to how the process is set up.
9. How are you involved in the process when a cost of quality concern arises? No.
10. What happens after you have done your "task"? Can you please describe what happens next? No.
11. Have you raised any cost of quality issues earlier? Yes or No? Yes, but it is starting to be a while ago.
  - a. How was your experience in the process after it was raised? Because this is so long ago, but I feel the CoPQ is too tied in with OTR and little input from the other functions. OTR ran the show and defined if it was CoPQ and had all the premises. I know it have been partially changed later, but my experience is that it was a badly controlled process.
  - b. What was your level of involvement during the process? We did everything.
  - c. How was the feedback when the issue was being handled? Did you know where it was, and who was doing what? No.

- d. Any feedback if it's closed or still open? No.
  - e. What were your overall experience about the process? Minimal.
12. Can you please explain where to find the outcomes of raised cost of quality issues?  
No.
  13. Based on your experience, how is your overall impression about learnings after cost of poor quality issues are resolved? Non existing.
  14. Any additional comment? The process and the entire scheme as I see is awful. The handling of CopQ in all chains are poor. No transfer of knowledge and no transparency. If a project has CoPQ on some bolts that is the wrong material, then this knowledge is not transferred to other projects.

### 7.1.7 Interview seven

1. What is your title and what do you do? As you probably know I currently work as a PQE, Project Quality Engineer. What I do is all kind of things like check documentation, non-conformances and pre-production meetings with client and suppliers.
2. How would you define cost of poor quality? CoPQ is cost that happens on a project that cannot be transferred to the client, and it's an internal error.
3. Where would you place your knowledge about the cost of quality procedure?
  - a. No knowledge b. Heard about it c. aware of it d. Read it. c and d. **B** might read it but don't remember.
4. Can you explain where to find it? Agility.
5. Can you please describe your understanding about the procedure? Per today not possible, A new procedure should be released soon.

6. Can you describe your role and responsibility within the procedure? No, that would be very difficult.
7. What is your role regarding a risen cost of quality issue? Don't know. If an issue occurs, I will ask the leaders in quality.
8. How do you identify or know that an issue is a cost of quality concern? If it happens internally, our error or something we do wrong that cost money to repair.
9. How are you involved in the process when a cost of quality concern arises? Don't know. Ask the leaders in quality.
10. What happens after you have done your "task"? Can you please describe what happens next? No.
11. Have you raised any cost of quality issues earlier? Yes or No? No.
  - a. How was your experience in the process after it was raised?
  - b. What was your level of involvement during the process?
  - c. How was the feedback when the issue was being handled? Did you know where it was, and who was doing what?
  - d. Any feedback if it's closed or still open?
  - e. What is your understanding about the process once it's running?
12. Can you please explain where to find the outcomes of raised cost of quality issues? No, I guess it is stored in a folder somewhere in the cloud.
13. Based on your experience, how is your overall impression about learnings after cost of poor quality issues are resolved? No good. If you mean if the problem is discussed I've might have seen some power point presentations in various

meetings, but we do not have an overview of how many we have, where they are or where we can find them. What I know have been presented in meetings.

14. Any additional comment? We get a new procedure at one point.

### 7.1.8 Interview eight

1. What is your title and what do you do? I am a supervisor and what I do is to make sure that the people on the shopfloor knows what to do when it comes to quality, and to work according to company procedures.
2. How would you define cost of poor quality? I would define it as a negative aspect. When we hear about CoPQ, I automatically think this is going to cost the company money because we done something wrong.
3. Where would you place your knowledge about the cost of quality procedure?
  - a. No knowledge b. Heard about it c. aware of it d. Read it. c and d. **C**
4. Can you explain where to find it? Agility
5. Can you please describe your understanding about the procedure? My understanding is that if we do something wrong, it needs to be reported and it is reported through the NCR system.
6. Can you describe your role and responsibility within the procedure? I am presuming but I think I am the one who is going to make a report that further will be sent to engineering or OTR.
7. What is your role regarding a risen cost of quality issue? If we can reduce a damage or outcome that has happened, we send a report to the person responsible for the job and further up the system.
8. How do you identify or know that an issue is a cost of quality concern? CoPQ is mainly about damage to equipment or property, but not people.

9. How are you involved in the process when a cost of quality concern arises? I am the person that needs to explain what happened, and if there are something in the procedures or system could do better, or if it is human error.
10. What happens after you have done your “task”? Can you please describe what happens next? You do have an investigation team, but that depends on how expensive it is to repair, then I think there are some interviews with the people involved to try and find out what exactly happened.
11. Have you raised any cost of quality issues earlier? Yes or No? Yes.
- a. How was your experience in the process after it was raised? Honestly, I am quite dissatisfied. I have logged two issues, but I do not hear anything. I am interested to hear what it eventually costed to fix. What I have logged is not anything great, but I do wonder what it costed to remedy.
  - b. What was your level of involvement during the process? Not so much, I logged the issue.
  - c. How was the feedback when the issue was being handled? Did you know where it was, and who was doing what? No, I know that OTR got the message and that we needed to give an estimate of the repair, but we never heard anything back. I think it is quality who handle these kinds of things
  - d. Any feedback if it’s closed or still open? No
  - e. What were your overall experience about the process? The understanding of the process is not that great, but the principle is that we are to prevent it from happening again and to communicate what happened.
12. Can you please explain where to find the outcomes of raised cost of quality issues? Sometimes we get outcomes in weekly emails, and then there are meetings that explains CAPA.

13. Based on your experience, how is your overall impression about learnings after cost of poor quality issues are resolved? Not so good, it could be better. When they have identified what went wrong, it is up to each supervisor to interpret and communicate this through toolbox talk, but I think we should gather all involved and discuss this for fifteen minutes to half an hour.
  
14. Any additional comment? I like better to fill out the old template than using the NCR system.