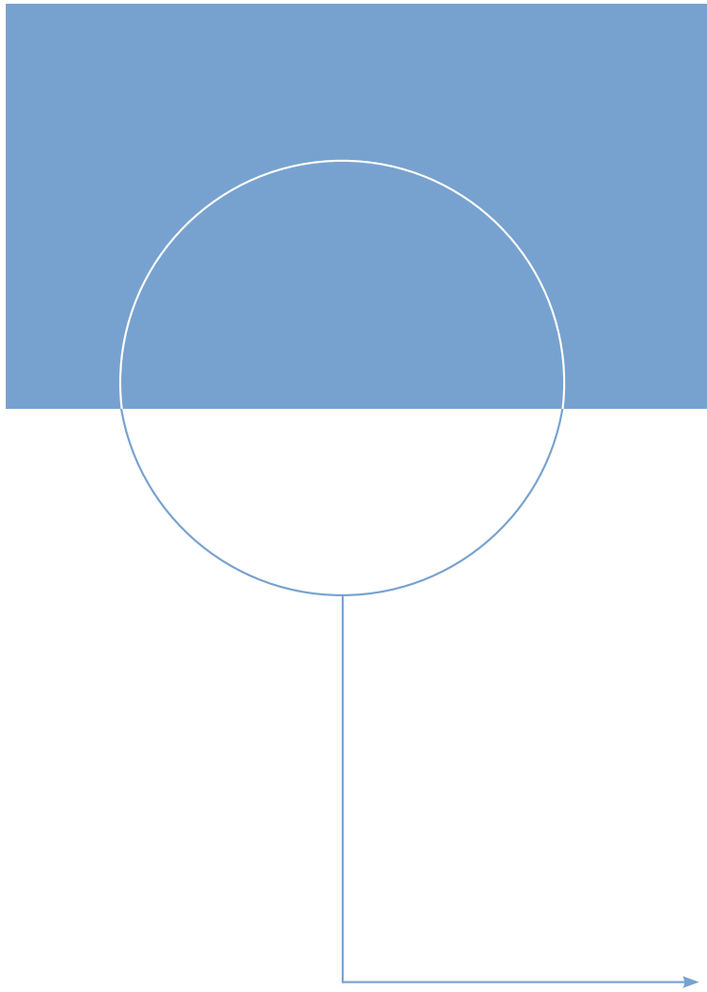


Master's thesis

2020

Preben Liland, Endre Eikeland Skaara

**NTNU**
Norwegian University of
Science and Technology
Faculty of Engineering
Department of Civil and Environmental Engineering

Master's thesis

Preben Liland
Endre Eikeland Skaara

# How to Achieve Improved Project Management

## A Study of Norwegian Road Clients

June 2020

NTNU
Norwegian University of
Science and Technology

NTNU
Norwegian University of
Science and Technology

NTNU
Norwegian University of
Science and Technology

# How to Achieve Improved Project Management

A Study of Norwegian Road Clients

**Preben Liland**
**Endre Eikeland Skaara**

MSc Project Management
Submission date: June 2020
Supervisor: Olav Torp

Norwegian University of Science and Technology
Department of Civil and Environmental Engineering

**NTNU- Norwegian University of Science and Technology**
Faculty of Engineering
**Department of Civil and Environmental Engineering**

| Accessibility |
|---|
| Open |

| | | | | |
|---|---|---|---|---|
| **Title**: How to Achieve Improved Project Management – A Study of Norwegian Road Clients | Date: 25.06.2020<br>Number of pages (incl. appendices): 256 | | | |
| **Authors:** Endre Eikeland Skaara and Preben Liland | Master´s thesis | X | Project report | - |
| **Internal supervisor:** Olav Torp, Associate Professor at the Department of Civil and Environmental Engineering at the Norwegian University of Science and Technology | | | | |
| **External supervisor:** | | | | |

**Abstract:**
Fewer projects are completed within budget and/or meeting original goals and business intent than previous years, creating significant monetary loss for the organizations. This has caused the field of project management to receive more attention from the industry and led to an acknowledgement that there exists a demand for professionalizing project management.

Considering the industry´s need for professionalizing project management, the aim of this master´s thesis is to explore how to achieve improved project management. To this end, the paper includes a study of the current project management practice that is performed by the road clients in the Norwegian construction industry, and a comparison with recognized project management theory. Furthermore, presents the master´s thesis a finalized representation of what the Norwegian road clients are preforming well, what they should improve on, and finally recommendations on how to improve the project management.

The paper utilizes the two methods of qualitative interview and literature review for obtaining data, in order to answer the inquiry of this paper. The method of qualitative interview consists of 13 interviews with professionals working in the Norwegian road construction industry, while the literature review is based on theory presented in recognized scientific journals, articles, and books.

The findings suggest that in order to achieve improved project management organizations must, execute project management in compliance with project management theory, utilize productivity management tools in order to improve the productivity, select the most appropriate project delivery method, diminish the organization's individual weakness by learning from other organizations in the industry, and realize the project management shortcomings in order to implement measures to solve these limitations. In addition to this, the findings reveal that the two Norwegian road clients share many similarities, but that they also have several differences in how they execute project management. The master´s thesis consequently provide recommendations on how to achieve improved project management that applies for both clients, and the individual client.

| **Key Words:** |
|---|
| 1. Project Management |
| 2. Productivity Management |
| 3. Tools and Strategies |
| 4. Project Delivery Method |
| 5. Norwegian Road Clients |

Preben Liland

Endre Eikeland Skaara

# Preface

This master´s thesis is written by Endre Eikeland Skaara and Preben Liland and marks the end of the two year-long study program MSc Project Management at the Norwegian University of Science and Technology. The authors have both completed their bachelor´s degree in civil engineering, which has served as a foundation for the expertise needed in the process of developing this paper.

The authors´ background of civil engineering and their profound interest of project management in the construction industry was an important motivation when selecting the thesis´ topic of how to achieve improved project management. The paper serves as a continuation to the results obtained in the specialization project written by the authors in the autumn of 2019.

The authors would like to express gratitude toward the three organizations that assisted the study in obtaining empirical data through interviews. This master´s thesis would not have been possible to create without their admirable willingness to contribute for the sake of research and development.

In addition to this, would the authors like acknowledge the Norwegian University of Science and Technology for providing all the necessary facilities. Finally, would the authors offer a special thank you to Olav Torp, an Associate Professor Department of Civil and Environmental Engineering, for being a valuable asset and supervisor throughout the whole process and development of this master´s thesis.

Trondheim, Norway 25th of June 2020

Preben Liland

Endre Eikeland Skaara

# Abstract

Fewer projects are completed within budget and/or meeting original goals and business intent than previous years, creating significant monetary loss for the organizations. This has caused the field of project management to receive more attention from the industry and led to an acknowledgement that there exists a demand for professionalizing project management.

Considering the industry´s need for professionalizing project management, the aim of this master´s thesis is to explore how to achieve improved project management. To this end, the paper includes a study of the current project management practice that is performed by the road clients in the Norwegian construction industry, and a comparison with recognized project management theory. Furthermore, presents the master´s thesis a finalized representation of what the Norwegian road clients are preforming well, what they should improve on, and finally recommendations on how to improve the project management.

The paper utilizes the two methods of qualitative interview and literature review for obtaining data, in order to answer the inquiry of this paper. The method of qualitative interview consists of 13 interviews with professionals working in the Norwegian road construction industry, while the literature review is based on theory presented in recognized scientific journals, articles, and books.

The findings suggest that in order to achieve improved project management organizations must, execute project management in compliance with project management theory, utilize productivity management tools in order to improve the productivity, select the most appropriate project delivery method, diminish the organization's individual weakness by learning from other organizations in the industry, and realize the project management shortcomings in order to implement measures to solve these limitations. In addition to this, the findings reveal that the two Norwegian road clients share many similarities, but that they also have several differences in how they execute project management. The master´s thesis consequently provide recommendations on how to achieve improved project management that applies for both clients, and the individual client.

# Sammendrag

Færre prosjekt har i løpet av de siste årene blitt ferdigstilt innenfor budsjett og/eller treffer de originale målene og forretningshensikten, noe som har ført til betydelige økonomiske tap for organisasjonene. Videre har dette ført til at prosjektledelse har mottatt større oppmerksomhet fra industrien og til en erkjennelse at det eksisterer et behov for profesjonalisering av prosjektledelse.

Med tanke på det økte behovet for profesjonalisering av prosjektledelse, er målet med denne masteroppgaven og utforske hvordan man kan oppnå forbedret prosjektledelse. Med dette som utgangspunkt inkluderer denne oppgaven et studie av dagens prosjektledelsespraksis av norske veiutbyggere og en sammenligning av dette opp mot anerkjent prosjektledelsesteori. I tillegg presenterer oppgaven en endelig beskrivelse av hva byggherrene utfører bra, bør forbedre, samt anbefalinger til hvordan byggherren kan oppnå forbedret prosjektledelse.

For å svare på oppgavens problemstilling er de to metodene strukturert litteratur søk og kvalitativt intervju for innsamlingen av data benyttet. De kvalitative intervjuene består av 13 intervjuer med profesjonelle kandidater fra den norske anleggsindustrien, mens litteratur søket baserer seg på teori fra anerkjente vitenskapelige journaler, artikler og bøker.

Funnene tilsier at for å oppnå forbedret prosjektledelse må organisasjoner utføre prosjektledelse i samsvar med prosjektledelsesteori, benytte produktivitetsledelsesverktøy for å forbedre produktiviteten, velge den mest passende gjennomføringsstrategien for prosjektet, redusere den individuelle organisasjonens svakhet ved å ta læring fra andre organisasjoner i bransjen, og innse begrensingene i prosjektledelsen slik at tiltak for å løse dem kan iverksettes. Funnene avdekker også at de to norske veiutbyggerne delte mange likheter, men også at det fantes flere forskjeller for hvordan de utfører prosjektledelse. Som følge av dette presenterer masteroppgaven anbefalinger til hvordan å oppnå forbedret prosjektledelse både for begge, men også for den individuelle byggherren.

# Table of Content

# List of Figures

# List of Tables

# Acronyms and Keywords

**AEC-industry** –The Architecture, Engineering, and Construction Industry

**BIM** – Building Information Model

**BVP** – Best Value Procurement

**CAD** – Computer Aided Design

**CD** – Competitive Dialogue

**CE** – Concurrent Engineering

**DBB** – Design- Bid- Build

**DBFO** – Design- Build- Transfer- Operate

**DfMA** – Design for Manufacturing and Assembly

**D&B** – Design & Build

**ECI** – Early Contractor Involvement

**EU** – European Union

**EQF** – European Qualification Framework

**HSE** – Health, Safety, and Environment

**IPD** – Integrated Project Delivery

**NPRA** – Norwegian Public Road Administration

**NSD** – Norwegian Center for Research Data

**OEDC** – Organization for Economic Cooperation and Development

**PDM** – Project Delivery Method

**PM** – Project Manager

**PMD** – Project Management Document

**PMI** – Project Management Institute

**POP** – Product, Organization and Process

**PUS** – Project Uncertainty Control (Praktisk usikkerhetsstyring)

**PRIME** – Project Integrated Mediation (Prosjektintegrert megling)

**QA** – Quality Assurance

**RM** – Risk Management

**TPM** – Total Production Maintenance

**TQM** – Total Quality Management

**UN** – United Nations

**VDC** – Virtual Design and Construction

**WHO** – World Health Organization

## Definitions

**Power Distance** – The degree of inequality in power between a less powerful individual and a more powerful individual, in which they both belong to the same social system. (Hofstede, 1884)

**Matrix Structure** – A matrix structure is a blend of a functional structure and a project structure. The main characteristics of matrix structures are that projects are executed with resources belonging to several departments, and that the coordination takes place at the project level, but with different levels of involvement of line managers (Bolman, 2013).

## Paper Specific Definitions

**Construction Manager -** Employee of the client who is responsible for managing the daily construction process

**Project Management Tasks** – The necessary work for the project management in order to reach the project objectives.

**Project Scope** – The specific Project´s goals, including cost, time, quality and deliverables.

**Project Work** – The contractual agreed-upon project scope between the client and the contractor.

**The Project Group** – The authors of this master´s thesis.

# 1. Introduction

This chapter will present the background and motivation for the selected topic, the problem statement and the relevant research questions, and a short explanation of the report´s limitations and structure.

## 1.1 Background

The field of project management has in the recent years received more attention from the industry, acknowledging that there exists a need for professionalization of project management. "Project management has become a critical function for managing the need for change and development in all types of businesses" (BI Norwegian Business School, 2019). This need for professionalizing project management was, furthermore, supported by the Project Management Institute, who claimed in their 2016 global "Pulse of the profession" report that fewer projects were completed within budget and/or meeting original goals and business intent than previous years. The fact that more projects fails creates significant monetary loss for the organizations, which emphasize the industry´s need for professionalized project management. "It's time to strengthen the conversation on the benefits of project management and its value in producing better business outcomes." (Project Management Institute, 2016).

This research paper serves as a continuation of the authors previous engagement in understanding how project management theory can contribute to better project deliveries in the construction industry (Skaara & Liland, 2019). In this previous engagement the authors studied a proclamation expressing that a main concern for the construction industry is that the productivity has been decreasing for the last 20 years (Statistisk Sentralbyrå, 2018). The study focused on the idea that a common perception of this decline in the productivity is connected to the uncertainty of time, quality and costs in the planning stage of the construction process (Samset, 2017). It was also considered that the reason to the decrease in productivity was caused by increased complexity, higher uncertainty, more variables, and stricter quality requirements (Byggeindustrien, 2018) (Ahmad, 2018). As a result, it was discovered that improving project management can improve the project delivery, and it was concluded that "The implementation of the right tools and strategies will contribute to a better execution of project management, facilitating for better planning, control, communication, trust, and human relations. Ultimately leading to better management of complexity, and higher efficiency due to less uncertainty of time, quality, and cost. Thereby, improving project delivery." (Skaara & Liland, 2019).

However, the understanding of what really is the "right tools and strategies" was not clearly defined. This research paper will therefore investigate which tools and strategies could be considered the "right" ones for achieving improved project management, and the interconnection between them. In respect to this investigation, the paper will include a study of the current project management practice that is performed by the road clients in the Norwegian construction industry and compare it with recognized project management theory. Thus, the inquiry of this paper will be to explore; **How to Achieve Improved Project Management – A Study of Norwegian Road Clients**

With the problem statement introduced, the objective of this paper will be to map and understand the current project management practice and discuss how this compare to project management theory. As a result, the final goal of the master´s thesis will be a finalized representation of what the Norwegian road clients are preforming well, what they should improve, and finally produce recommendations on how to improve the project management aspect of the road clients.

## 1.2 Topic Sentence and Research Questions

The presented problem statement is a very comprehensive and broad topic. In order to break down the topic sentence into more manageable areas of investigation, the project group have decided upon five research questions to restrict the research area. Following is a presentation and an explanation of the research questions and how they contribute to answering the problem statement.

1. How does recognized project management theory and the organization´s project management strategy correspond to the actual executed project management?
2. How does the clients utilize productivity management, and how does this affect the organizations' project management?
3. What parameters affect the project delivery method, and how does the project delivery method influence the project management?
4. How does the NPRA and Nye Veier compare regarding project management?
5. What recommendations for improving project management in the NPRA and Nye Veier exist based on the findings of this research?

The first and second research question "How does recognized project management theory and the organization´s project management strategy correspond to the actual executed

project management?" and "How does the clients utilize productivity management, and how does this affect the organizations' project management?" was chosen for its strong correlation with the overall objective of the problem statement. The third research question "What parameters affect the project delivery method, and how does the project delivery method influence the project management?" is about how project management is affected by the overall contract strategy of the project. Finally, the fourth and fifth research question "How does the NPRA and Nye Veier compare regarding the use and effect of project management strategies?" and "What recommendations for improving project management in the NPRA and Nye Veier exists based on the findings of this research?" were chosen with the intent of highlighting the difference in the project management practice conducted by the largest road clients in Norway in the industry today, as well as discovering and suggesting possible improvements that exist in the two organizations, in order to achieve improved project management.

## 1.3 Limitations of the Report

The research, and the report´s scope is limited to the following prerequisites:

- The report focuses on project management and maps vital tools and strategies in regard to project management.
- The thesis assesses project management tools and strategies in order to formulate methods to achieve enhanced planning and execution of construction projects.
- The research is focused on the Norwegian construction industry, although some of the used theory have its origin from other industries.
- The included roles in the research are the client and the contractor.
- The case study and presented theory are investigated in regard to the planning and execution phase of a construction project.

The presented limitations are made because of the timeframe and research questions of this master´s thesis. Additionally, the limitations are a result of the collected data and investigated theory. Despite the limitations, this thesis has a broad and comprehensive topic. However, the project group have decided that this scope is the best for acquiring the whole picture, although it might compromise on how detailed the specific element in the report are presented and discussed.

## 1.4 Structure of the Report

The report will follow a standardized structure for scientific research. Table 1 presents the chapters and the associated description that makes up the framework of the report.

Table 1 Structure of the Report

| Chapter | Description |
|---|---|
| **1. Introduction** | The introduction chapter presents the papers topic, problem statement and the connected research questions. This chapter also describe the background and motivation for the master´s thesis. |
| **2. Method** | The method chapter describes the process of creating this research paper. The methods used are presented, with reasons for why they were chosen. Finally, an explanation of how the method was executed is presented. |
| **3. Theory** | The theory chapter contains previously produced relevant literature on the topic of project management. This chapter will therefore include a general description of project management, productivity management, relevant tools and strategies, and contract strategies. |
| **4. NPRA and Nye Veier** | The chapter will present the two Norwegian road clients the NPRA and Nye Veier. Additionally, will internal documents and terminology used in chapter 6 and 7 be presented. Finally, will the chosen construction project that serves as this thesis' case study be presented. |
| **5. Result of the Interviews** | The result chapter presents the obtained empirical data and include a presentation of the findings from interviews conducted with employees from the NPRA, Nye Veier and a contractor. |
| **6. Discussion** | The discussion chapter connects and compare the findings in the result chapter to the theory chapter. Based on the comparison of the result and theory, the chapter the discuss the research questions in the pursuit for a conclusion. |
| **7. Conclusion** | The conclusion chapter answer the thesis' problem statement based on the answers and recommendations from the research questions. This chapter consist of tangible recommendations for improving project management in the Norwegian construction industry and suggested concepts for further research. |

# 2. Method

The research method chosen will affect the result, it is therefore imperative that all the possible methods are thoroughly evaluated before the most relevant ones are chosen. In this chapter, the different research methods found to be the most relevant to this project will be introduced, explained, and evaluated. The chosen methods will additionally be shaped and used in accordance with the purpose of this research paper in order to fit the scope of this thesis.

The most relevant methods in this master thesis were chosen to be a qualitative interview, an observational case study, and a broad quantitative literature review to gather the necessary information and data to answer the problem statement. It was furthermore concluded that for the thesis to gain credibility, the information needed to be evaluated and controlled by checking its reliability and validity.

The structure of this chapter will follow a logical framework, where the steps are presented chronologically. The first part of this chapter will feature a description of the research methods that were deemed the most important to this report. In the next part, the reasoning behind the choice and an evaluation of the research methods will be presented. The last part of this chapter will give a description of the research methodology, where the steps taken in the creation of this report will be presented.

## 2.1 Research Methods and Research Approach

This sub-chapter will give a general explanation of the most relevant research methods to this report, whereas the reasoning behind why these research methods were chosen, will be explained further in the next sub-chapter.

### 2.1.1 Quantitative and Qualitative Research

Gathering information is an important part of the research and considering that the origin of the information will have a large impact on the result, it is imperative to know if the data collected is qualitative, quantitative, or if it is a combination of the two.

The qualitative method is a research methodology that uses an in-depth analysis to understand the information and the correlative connection of the research material. The qualitative method is therefore often associated with text-based research like opinionative and behavioral information that is not possible to quantify. Furthermore, qualitative research emphasizes on an inductive approach to the relationship between theory and research where the goal is to generate theory, rather than testing it (Bryman, 2016).

Quantitative method on the other hand, is a research methodology that collects large samples of data and emphasizes on quantification and analyzing of it in a numerical sense, with the purpose to test a hypothesis. This method is therefore often used and associated with mathematical or statistical research (Engebø, Research Methodology, 2019). Quantitative research is a deductive approach of the relation between theory and research, unlike qualitative research which focuses on generation of theory, qualitative focuses on testing the theory (Bryman, 2016).

A combination of the two research methods is often the most preferred option, because it makes it possible to get a broad view of your research topic (quantitative), but also an in-depth understanding of the topic (qualitative). It is however important to distinguish the difference of using a combination of the strategies, and with using an intertwined combination of the strategies. The intertwined combination of the two strategies, also called the mixed research methodology, is very complex and can be quite difficult to perform correctly. One should therefore thoroughly investigate which of these research approaches is the most beneficial to the project (Bryman, 2016).

### 2.1.2 Reliability and Validity

When considering sources, it is important to know if the information is relevant and if the quality of the information is legitimate. It can therefore be useful to consider if the source is reliable and if it can be validated.

If a source is reliable, then the information presented can be considered credible. In other words, the term reliability describes the sources trustworthiness. Validity is on the other hand a description of the source's relevance, which describes the information´s usefulness of the research and if it is within reason and in accordance with reality (Samset, 2017).

### 2.1.3 Literature Review

A literature review is a method used to collect and evaluate sources related to a topic of choice for further research. The sources collected for a literature review should be thoroughly investigated and evaluated in order to find the best and most relevant sources.

Thus, a literature review has four main objectives, which is to survey the literature, to synthesize the information into a summary, critically analyze the information by identifying gaps and limitations of current theories to be researched in future studies, and finally present the literature in an organized way (Royal Literary Fund, Unknown).

### 2.1.4 Investigation Techniques used in the Literature Review

When investigating literature, it is important to understand the difference between a reliable source and an unreliable source. The wrong choice of sources will make the scientific paper seem unprofessional and might even result in the production of false information. It is therefore crucial that the literature chosen comes from trustworthy sources that can be scientifically tested and proven for the research paper to gain credibility. Two of the techniques found to be the most useful to evaluate the sources' integrity was the ANTS method (Accessible, Neutral, Trustworthy, and Suitable) and the snowball technique. These techniques will be explained more thoroughly in section 2.2.2 Evaluation of Chosen Method.

### 2.1.5 Interview

Bryman (2016) explains that there are many different types of interviews, but considering the restraints of this report the project group has decided to focus on research interviews. Bryman (2016) continues by explaining that there also exist several types of research interviews, such as structured, unstructured, semi-structured, intensive, focused, and group interview. There are, however, some similarities between these different types of interviews. "The different kind of research interviews share some common features, such as the eliciting of information, by the

interviewer from the interviewee and the operation of rules of varying degrees of formality or explicitness concerning the conduct of the interview" (Bryman, 2016). In this section, the focus will be on the three research interviews namely structured-, unstructured- and semi-structured interviews.

Structured interviews entail the administration of an interview, which means that it is the interviewer's task to design questions to ask the interviewee. The goal of this interview is therefore to give exactly the same question to each interview candidate, in order to ensure that the answers are compatible and simple to compare (Bryman, 2016).

An unstructured interview is the opposite of a structured interview. The interviewer does in this form of interview usually only have a list of topics or issues that should be covered during the conversation. The interview candidate is thereby left to interpret the topic themselves, and as a result, the answers gained from these types of interviews might vary and be difficult to compare (Bryman, 2016).

A semi-structured interview is to a certain extent a combination of structured and unstructured interviews. This means that like the structured interviews, the interviewer has a range of questions prepared for the interview subject, but like in the unstructured interview, the interviewer lets the candidate talk more freely around the question. What is unique about the semi-structured interview is that the interviewer also has the ability to ask follow-up questions, if the interviewee says something of particular interest (Bryman, 2016). This will hopefully provide the interviewer with comparable answers between the different interview subjects, but also contain a broader perspective from these responses that the interviewer can use for further research.

### 2.1.6 Case Study

An observational study is about collecting relevant data as a project or case is developing by observing the events and activities as they are unfolding (Zelkowitz & Wallace, 1997). This can either be done in an indirect setting where the researchers are present but not participating in the case studied, or in a direct setting where the researchers themselves engage in the case by having the ability to affect the case directly (Engebø, Research Methodology, 2019). Furthermore are "Observational studies either case studies or field studies." (Mohagheghi & Conradi, 2007).

A case study can be defined as a study that entail an in-depth research of one specific case or object of interest, where the researchers aims to provide an explanation of an hypothesis from

a single case (Bryman, 2016). This is supported by Yin (2003), who defines a case study as "[…] an empirical inquiry that investigates a contemporary phenomenon within its real-life context,[...]." and (Zelkowitz & Wallace, 1997) who defined it as "A project is monitored and specific data collected over time in order to collect information about some specific attribute under study." Even though a case study only focuses on a single case, it is often, according to the Norwegian Encyclopedia, used as a research method to map or identify important trends and phenomena about the bigger picture, from the study of this single case. (Wæhle & Dahlum, 2018). Thus, a case study is about conducting an in-depth investigation of a single study in order to prove or disprove a given hypothesis.

In comparison, a field study is another observational research method where one studies multiple cases when it is desirable to compare several projects simultaneously in order to find a connection between independent cases in a mutual industry or field. The method shares multiple similarities with a case study, but two factors that separates them from one another is that a field study carries a lower level of details with less in-depth research, and that the opportunity to affect the cases studied can be reduced as it less intrusive on the case, compared to a case study (Zelkowitz & Wallace, 1997).

### 2.1.7 Questionnaire

"A questionnaire is a method for collecting quantitative data where the communication between the interviewer and the respondents is standardized" (Gripsrud, Olson, & Silkoset, 2016). Gripsrud (2016) further explains that all the respondents in a questionnaire are asked the same questions in the same order. The use of a questionnaire requires that the analyst have conducted a thorough analysis on which questions that should be asked, and how they should be asked. The analyst should also decide how the communication in the questionnaire should take place (Gripsrud, Olson, & Silkoset, 2016).

## 2.2 Choice of Research Methodology

This sub-chapter serve as an explanatory part, where the purpose is to clarify the motivation behind the choice of research methods, as well as give an evaluation of these research methods. The next sub-chapter will present a description of why the research methods were chosen, and how they were executed.

### 2.2.1 Motivation and Reason Behind the Selected Methods

A scientific report requires trustworthy sources as a baseline to the information studied or reviewed. It is therefore not only necessary to find methods which are in line with what the report is investigating, but also work well with one another.

In this thesis, the methods of literature review, case study, and interviews were chosen as the principle research methods for pursuing the paper´s inquiry. A literature review was chosen because it can be used to amess the necessary knowledge needed to answer the research questions about project management theory. In the same way, interviews were chosen because it can be used to collect information from professionals and experts that have firsthand knowledge about how project management is executed by Norwegian Road clients. Lastly. a case study was chosen because it allows the project group to investigate and observe the executed project management from another perspective than what interviews provides. By using these methods, the project group aim to strengthen the validity of the answers of which parameters that affect the choice of contract strategy, how the theory of project management corresponds to the actual executed project management, in addition to compare how the NPRA and Nye Veier execute project management and provide recommendations on how to achieve improved project management for Norwegian road clients.

### 2.2.2 Evaluation of the Chosen Method

**Literature Review**

A well conducted literature review can provide a good foundation of a topic and identify areas of prior research to prevent duplication. Moreover, a literature review gives the possibility to identify gaps in research, and therefore identifying the need for additional research, ultimately justifying the need for the current research (University of South Carolina, 2019).

Although a literature review can provide the benefits listed above, it is crucial to be aware of the limitations and problems that can occur when conducting a literature review. Common problems are that the authors are not being sufficiently critical, not discriminating between

relevant and irrelevant materials, and relying on material that is out-of-date (The University of Queensland, 2019).

To overcome the challenge connected to a literature review, the project group will utilize several methods. The most important being ANTS, which evaluates the source's accuracy, neutrality, trustworthiness, and suitability (NDLA, 2018). This method assists the selection of relevant literature by checking the article´s authors, publisher, and number of citations.

Using snowballing for extending the systematic literature review, especially in a literature review involving such a broad topic as this, is seen as beneficial because it is a high probability that the "snowballed" sources are relevant. However, when using snowballing, the project group takes the responsibility of the assumption that the source used has given a sufficient coverage of the topic (Badampudi, Wohlin, & Petersen, 2015).

**Qualitative Interview**

The semi-structured qualitative interview used in this research is a great tool for gathering information that can be compared with the material from the literature review (asae, 2009). The benefit of a semi-structured interview is that it gives the opportunity for the person being interviewed to talk about the topic in detail and depth. It also gives the possibility for the interviewer to add follow-up questions on topics that are considered relevant for the research (Scociology Central, Unknown). There are, however, some limitations with this kind of interview. For example, the findings can be difficult to generalize because respondents might interpret the questions differently, which can furthermore lead to some unreliable results. Another challenge regarding the reliability of the result is to conduct enough interviews. In many cases the number of interviews tend to be too small for the result to be considered reliable (Scociology Central, Unknown).

**Case Study**

An observational study is a "method used to collect relevant data as a project develops." (Zelkowitz & Wallace, 1997), and a case study is an observational study where a single project is studied in depth. Thus, some of the advantages of a case study is its ability to get strong and detailed data from the phenomenon studied, it can simplify complex concepts, researchers get exposure to real life situations, it helps participants learn from their own work, better overview of the project, and a project that can work as a reference for later work. (Simplify My Training, 2014). However, what could be considered the greatest advantageous to the "method is that the development is going to happen regardless of the needs to collect experimental data, so the only

additional cost is the price of measuring the development for specified attributes and collecting this data" (Cantone, 1998), which makes it a reasonable option for students and researchers with limited funding.

The largest disadvantage a case study has is "that each development is relatively unique, so it is not always possible to compare one development profile with another. Determining trends and statistical validity becomes difficult" (Cantone, 1998). Other disadvantages include the difficulty of finding case studies that suit all subjects, overcoming researchers' cognitive biases, time consumption, and the challenge of validation due to the difficulty of retesting the results (Simplify My Training, 2014).

### 2.2.3 Evaluation of the Discarded Method

**Questionnaire**

As presented in section 2.1.6, questionnaires serve as a useful method to collect quantitative data by using standardized communication. However, this method was discarded to the benefit of conducting a case-study and qualitative interviews instead. The project group does acknowledge that a questionnaire could be advantageous for the research, because it would provide the master´s thesis with quantitative data, ultimately increasing the research validity. This is substantiated considering that a challenge with a qualitative interview is to conduct enough interviews in order to produce reliable answers, as presented in section 2.2.2. Although a questionnaire provide more reliability to the data, the project group decided to focus on qualitative interviews, considering Gripsrud (2016)´s statement that **"**One must always assess if one has enough knowledge about the research questions in order to develop meaningful questions and multiple answers that makes it reasonable to conduct the questionnaire". The project group believed that the comprehensiveness of the problem statement would make it hard to generate a standardized research. In addition, during the pre-study, it was discovered that there exists a confusion in different project management terminology, strengthening the belief that trying to generalize questions in a questionnaire was not the optimal research method.

## 2.3 Description of Chosen Research Methodology

The purpose of this sub-chapter is to explain in detail how the project group worked with this report and give a detailed description of the tasks performed in relation to the methodologies chosen. The first section will start off with a pre-study, where the authors discussed the overall topic of the project. Followed by a description of the research questions, actors involved, the timeline of the project, and a description of the report´s structure. Whereas the next sections will feature the execution of the literature review, Specialization project, the interviews, and the case study, respectively. The final four sections will present how the data was analyzed, challenges and uncertainties with the report, the projects limitations, and the challenges the project faced during the Covid-19 outbreak.

### 2.3.1 Pre-Study

As introduced in the beginning of this paper, the purpose of this report is to study the current project management practice and compare the findings against project management theory with the intention of discovering how one can achieve improved project management. In order to complete this objective, the project group found it imperative that the project underwent a thorough pre-study where the topic sentence, research questions, actors involved, project timeline, and possible methods were discussed. The thoughts and ideas established during this phase of the project were then formed into a report, with the purpose of guiding the authors towards this final thesis.

One part of the Pre-Study involved gathering information about the use of Lean in the Norwegian construction industry. Lean is important because the strategy can be used to eliminate wasteful activities and improving the productivity in the construction industry. Lean will be thoroughly presented in section 3.5.2 Lean. However, the strategy involves many tools, and it can be difficult to select which tool that is the most relevant for this research. In order develop an interview guide that included the most relevant Lean tools for the Norwegian construction industry, the project group conducted two pre-study interviews with Lean consultants, who each represented a company that specialized in Lean consulting. This pre-study interview guide can be found in appendix 1.

### 2.3.2 Norwegian Centre For Research Data (NSD)

The Norwegian Centre for Research Data is a national archive and center for research data. The organization´s aim is to ensure open and easy access to research data, and to improve opportunities for empirical research through a wide range of information and support services

(Norsk senter for forksningsdata, n.d.). For this master´s thesis, NSD was used as a method for approving that the research through observations and interviews was conducted in lines with the EU personal data protection law. “NSD has one of the largest professional communities in Europe with competency in the field of personal data protection in research. We assess whether research project which will process personal data meet the requirements of data protection legislation, and offer guidance and courses on personal data protection, for researchers and students” (Norsk senter for forksningsdata, n.d.).

The project group specified to NSD what the research was about, which research methods that were going to be used, which data that were being acquired, how the data should be secured, and when the data were to be deleted. The project then got an approval and could start the gathering of empirical data. This approval can be found in appendix 2. The NSD also imposed the project group to develop a declaration of consent that all the people interviewed or observed had to sign. This declaration can be found in appendix 3.

### 2.3.3 Research Questions and Topic Sentence

Finding the most appropriate research topic can be a turbulent process with many discussions on what the researchers actually want to study. Thus, in preparation of creating this thesis, the project group used brainstorming in order to find possible topics of interest, and of relevance to the construction industry.

The first thing that needed to be decided upon, was if this master’s thesis was going to continue in the same route as the specialization project that the authors had previously conducted. After some discussion the authors, in collaboration with the project group´s supervisor, agreed on continuing the work from the specialization project.

In the specialization project it was concluded that improved project management can lead to a better project delivery. Nevertheless, the authors agreed that the explanation of what improved project management actually is was a bit vague, and that it could be beneficial to take a closer look at this. As a result, the project group decided that the topic of this master thesis would be to research what improved project management is, and how to achieve it. In addition to this, the authors agreed that a study of current practice in comparison with project theory, would be the most fitting method used in order to accomplish this.

The project group did however quickly realize that the substantiality of the chosen topic meant that it could be difficult to research to its full extent. The project group therefore decided on creating some research questions in order to limit the scope of the research. After much

discussion and some brainstorming, the authors finally agreed upon the research questions presented in this report.

### 2.3.4 Actors Involved

One area of the report's investigation is to look at how project management is executed by professionals in some of the major construction clients in the industry. One of the most important actors investigated in connection with this report is the Norwegian public roads administration, which is the largest road management organization in Norway. The organization has been given the responsibility for the planning, construction and maintenance for most of the roads in Norway (Statens vegvesen, 2017). Furthermore, the NPRA is a well-established construction client organization, which means that involving the NPRA in this project can be seen as favorable in order to collect data-input to the report.

Another important construction client that the project group considers highly relevant when reviewing project management in the road construction industry, is the organization Nye Veier AS. The road client´s activities include planning, construction, and operation and maintenance of major highways that bind Norway together and connect the country to major highways abroad (Norwegian Government, n.d.).

The last important actor to introduce is the academic community at The Norwegian University of Science and Technology. With the project group´s supervisor´s support, NTNU was a great resource for gathering relevant information concerning the topic of the report, in addition to guidance on how to enhance data and how to structure the project report in a reasonable manner.

### 2.3.5 Project Timeline

It is thoroughly explained in project theory that a well-defined timeline is necessary for a project to be completed within time, cost and quality (Kerzner H. R., 2013). The authors of this project therefore found it essential to create a simple timeline at the start of this specialization project. This timeline was later found to be a great tool, regarding deadlines and the overall efficiency of the project. It was however, discovered that the original timeline had to be modified in order to deal with unexpected events of Covid-19.

In the original timeline, the case study had been allocated a considerable amount of time with respect on execution and planning. Unfortunately, as the master thesis advanced and the Covid-19 outbreak progressed, the project group released that changes had to be made. The new timeline would therefore be changed in order to fit the new project outline with more interviews and less observational studies. As a consequence, it was also found necessary to revise the

timeline with respect on changing the durations of some of the different activities. The original and the revised timeline are available for perusal at appendix 12.

### 2.3.6 Structure of the Report

The structure of this report follows the general template of a scientific report, with additional project specific chapters. The first chapter is an introduction, the second an explanation of the chosen method, the third an elaboration of the theory, the fourth a presentation of the two road clients, connecting internal documents, and the case study, the fifth an presentation of the research conducted, the sixth a discussion of the findings, and finally the seventh a conclusion to the paper´s problem statement.

The authors chose this way of presenting the report because it has strong ties with how the project group worked during the development of the paper, and because this structure was believed to be the best way for the reader to experience the content of the report. The project group also believed that the result- and discussion chapter should follow the same logical framework as the theory was presented. This should enable the reader to experience a strong connection between the three chapters, making it easier for reading and comprehension.

### 2.3.7 Literature Review

The purpose of this section of the report is to identify and evaluate necessary literature and explore empiricism that can be used as valuable sources in this master´s thesis. One of the chosen methods to collect scientific research and material was therefore a literature review, where the sources were thoroughly evaluated and appraised.

In order to find relevant information and literature, a thorough and precise plan was created with the purpose of only selecting the best and most appropriate sources. This can however be a challenging task, and the project group chose to use the method described in the article “Collaborative Project Delivery Methods: A Scoping Review” written by Engebø, et. al. (2020) as an inspirational source. In this article the initial stage of the research methodology was to find original studies published in peer-reviewed journals in a defined time period. The journals were furthermore selected unbiasedly from key publishers related to the field researched, based on relevant search words. If standard keywords were not enough, a combination of relevant search words were used. The next step was to combine the keywords into search queries, where different methods were used to narrow down the results. The refining stage was about filtering out articles by reading the abstracts and further narrow them down based on additional exclusion and inclusion criteria. Finally, the whole article was read if found necessary (Engebø, et al., 2020).

In this master thesis, search engines such as Google Scholar, ASCE and Oria were used to find the most relevant articles and filter out irrelevant sources. However, considering the amount of research papers on this subject, a few evaluation criteria had to be set. The number of results for the specific search topic is presented in table 2.

Table 2 Number of Results from the Literature Review

| Search words | Filter | Oria | Elsivier | ASCE |
|---|---|---|---|---|
| Project Management, Construction Industry | All Fields | 757 343 | 25 791 | 26 728 |
| | Books | 20 607 | 18 377 | - |
| | Journals | 92 | 809 | - |
| | Articles | 294 880 | - | - |
| Trust, Construction Industry | All Fields | 69 694 | 14 422 | 2 861 |
| | Books | 2 692 | 10 870 | - |
| | Journals | 5 | 358 | - |
| | Articles | 161 831 | - | - |
| Communication, Construction Industry | All Fields | 445 594 | 21 104 | 10 039 |
| | Books | 21 719 | 14 436 | - |
| | Journals | 1 | 993 | - |
| | Articles | 252 470 | - | - |
| Lean Construction | All Fields | 141 035 | 3 856 | 3426 |
| | Books | 6 075 | 3 340 | - |
| | Journals | 10 | 62 | - |
| | Articles | 12 151 | - | - |
| Risk Management | All Fields | 10 317 357 | 17 754 | 45 673 |
| | Books | 55 678 | 11 412 | - |
| | Journals | 4 097 | 606 | - |
| | Articles | 3 682 357 | - | - |
| Supply Chain Management | All Fields | 1 356 730 | 17 834 | 5 946 |
| | Books | 5 374 | 12 524 | - |
| | Journals | 2 645 | 583 | - |
| | Articles | 477 165 | - | - |
| Six Sigma | All Fields | 383 096 | 3 026 | 5 745 |
| | Books | 7 147 | 2 166 | - |
| | Journals | 469 | 35 | - |
| | Articles | 1 794 297 | - | - |
| BIM | All Fields | 166 437 | 25 | 2 050 |
| | Books | 1 023 | 17 | - |
| | Journals | 24 | 1 | - |
| | Articles | 91 471 | - | - |
| VDC | All Fields | 48 681 | 2 | 232 |
| | Books | 318 | 2 | - |
| | Journals | 1 | 0 | - |
| | Articles | 30 344 | - | - |
| Conflict Management, Construction Industry | All Fields | 180 772 | 24 682 | 5 997 |
| | Books | 13 979 | 17 827 | - |
| | Journals | 19 | 792 | - |
| | Articles | 116 323 | - | - |

The first evaluation criterion determined that the more specific the key words were, the more precise the research would become. The second criterion was that the title of the article needed to be close or highly relevant to what the authors deemed within the project scope. The third criterion was that the articles should have as many citations as possible, as this would increase the scientific papers reliability. The fourth criterion was that the article should not be too old. The fifth evaluation criterion was to read the abstract of the article. The sixth evaluation criterion was to check if the article was published by an internationally accepted publisher, in order to increase the papers credibility. If all these six preliminary steps were approved, the article could be investigated further.

The next step in the evaluation process was to read the articles. Considering the amount of research papers needed to create a strong report, a plan to sort the different sources was made.

The solution was the creation of a shared online web-hotel with an excel sheet, created for showing which key words were used, the name of the scientific paper, who read it, and if the article was recommended. The overview of some of the articles studied are presented in appendix 4.

After reading the article, the reader would then make a short evaluation of the most relevant articles, through the use of the ANTS method, and decide if it should be considered for further research. Some articles which were considered highly relevant to the problem statement, would also undergo a snowballing exercise, where the author went through the sources to find other relevant papers.

After the literature had been reviewed, the project group had discovered several reliable articles that could be used in the creation of this master's thesis.

### 2.3.8 Specialization Project

Research is according to the Norwegian Encyclopedia, about using systematic efforts to bring about new knowledge and understanding about what is being studied (Skoie, 2020). The results found in these studies are often shared with the world through publications through universities or journals, because of the benefits the information can have on the scientific community (Boeard of Life Science Division on Earth and Life Studies, 2003). In addition to the amount of time and effort put into the creation of these scientific reports, the publications also need to be peer reviewed by professionals in order to increase the reports reliability and trustworthiness. Thus, the function of these reports is to give information on the work performed, the observed results and present a conclusion about the research (Mørsh, 2010). It can therefore in many cases be advantageous to conduct a pre-project, or a specialization project, about a research topic, in order to find the most relevant research material and to substantiate the findings in order to strengthen the conclusions in a later more in-depth report.

The main advantageous of conducting a specialization project is that the researchers can gather relevant data and test their original hypothesis and see if the research assumptions needs to be reassessed. This identification process might be used in order to recognize critical holes in the research and serve as a guide for the researchers in a more limited future study.

In connection with the creation of a scientific report, a new and inexperienced researcher might be unfamiliar with how to properly present the research in a publication. In these cases, a specialization project could serve as an experiment or test, where the researcher learns how to properly present the research methodology, theory, sources used, conclusion, etc. (NTNU,

2020) (Mørsh, 2010). Failing to present the findings in a respectable manner, could in the worst-case scenario render the research useless, as people might have a problem reading or understanding it. “There are a countless number of important scientific discoveries that never realize their potential impact because they are buried within poorly written manuscripts.” (Ibrahim & Dimick, 2018).

The disadvantageous of conducting a specialization project could be that it is time consuming. This is especially true in consideration that a specialization project might be unnecessary if the researchers already have a lot of experiences and knows how to structure a report, or if the researchers are deep into a study and the use of a pre-project would lead to writing the same report twice.

As a part of the student’s evaluation criteria and introduction to writing a master thesis, the Norwegian University of Science and Technology required the authors to conduct a pre-project. In relation to this pre-project the authors were required to specialize in a subject that the authors themselves were interested in, and the university deemed relevant as a research topic in the year of 2019. The authors were furthermore required to follow lectures, conduct a literature review, create a pre-study, have follow up meetings with a supervisor, and conduct assignments in relation to this project. The ultimate goal of this project was that the authors were to learn about how to collect information and write a master thesis.

The first part of the specialization project conducted in preparation to this master thesis, was about the background information of the report. This part started out with a short pre-study report, where the projects timeline, the actors involved, and the projects topic were to be decided. After this, the project group conducted a thorough literature review following the procedure described in section 2.3.7 Literature Review. The next step in the specialization project was about how to use the literature in a theory chapter and decide what was important information in relation to the inquiry, and what was unnecessary. Once the theory chapter had been created, the introduction chapter was written, and the research questions were finalized.

The second part of the specialization report was about the research conducted. In this part the project group created an interview guide and conducted interviews with professionals in connection with the topic of the report. After the interview were completed the result part of the report was written based on the answers collected during the interviews.

The third part of the specialization project was about connecting the dots from part one and two. This was mostly done in a discussion part where observations gathered from the interviews

were compared and evaluated against the theory found in part one of the project. When the discussion part was completed, the conclusion of the paper was created with respect on the findings from the discussion part. Then finally a presentation of the selected research concepts that could be further investigated were created.

### 2.3.9 Interviews

Another research method chosen to gather information was a semi-structured qualitative interview. By using this method, the project group hoped to get an insight into how project management theory is practiced by professionals in the construction industry and compare the data with the recognized project management literature presented in the theory chapter. The interviews would therefore either serve as a support to the presented literature or show that the project management practice conducted by Norwegian road clients differ from the "best practice" described in the literature. The ultimate goal of the interviews was therefore to collect data that would be able to give, together with the investigated literature, answers to the papers research questions and problem statement.

Even though a semi-structured qualitative interview is about giving the interview candidates space to talk about the subject, the method does, however, require the interviewer to prepare a set of questions to initiate a conversation-topic. In consideration to this master thesis, the questions had to be in line with project management, productivity management, tools and strategies, and project delivery method for the interview to be relevant to the inquiry of this paper. Moreover, the questions chosen needed to be reasonable and accurately asked in order for the information to be relevant for the paper´s topic. The questions chosen were therefore created with respect on the topic sentence, the research questions, the literature reviewed, the opinions of the supervisor and the project groups own experience. This resulted in a general content plan that included three main sections.

The first section included the topic of project delivery methods, with questions around procurement methods and contract structures in the respective organization. The second part of the interview guide embraced project management and its tools and strategies. This part included communication, trust, project planning, project monitoring and control, risk and uncertainty management, and conflict management. The third part of the interview guide contained the subject of productivity management. In this part supply chain management, Lean, Lean Six Sigma, Building Information Modeling, and Virtual Design and Construction was included. It is important to notice that some minor variances of the interview guides did occur,

depending on what organization that was interviewed. The full interview guides can be viewed in its entirety in appendix 5, 6 and 7.

The reader should notice that the use of interviews as a method was in the original thesis plan meant to be a supplementary to the case study. It was therefore planned around 3-5 interviews. However, due to the Covid-19 situation explained in section 2.3.14, the case-study was crippled. This meant that interviews had to be used for gathering empirical data, instead of observations. Because of this, the intended number of interviewed was set to be 12 interviews. The number 12 was chosen because the project group considered this as a reasonable number of interviews that would provide reliable and valid information that covered the topic and research questions of this master´s thesis. The final conducted number of interviews turned out to be 13. The distribution of the interview candidates by organization can be viewed in table 3.

Table 3 Distribution of interview candidates

| Organization | Number of interview candidates |
|---|---|
| NPRA | 7 |
| Nye Veier | 5 |
| Contractor | 1 |

The interviews were conducted with both of the authors and with the interview subject present. The project group believed that by having both of the authors present, one would be able to divide tasks and mitigate the likelihood of missing out on valuable information. One would serve as the interviewer while the other listened and transcribed important information. This was done in order to generate a structure with little confusion of who the interview subject would get the questions from.

Before the interview, the project group asked the interviewee if it would be okay for the interviews subjects that the interview would be recorded. This was executed by emailing an informative document with a description of the projects purpose and how the recording would be used, to be signed by the interview subjects. This practice is a requirement given by the "NSD" or Norwegian Center for Research Data" in order to protect the privacy of the individuals involved in the project. All of the interview subject agreed to this, as they understood that it would be easier for the authors to remember the content when transcribing the interviews.

The questions were structured with a chronological shape with the purpose of making it simple to follow for both the interviewee and the interviewer. It was made in this chronological structure, because it would according to the plan, lead the interview subject onto a certain pattern and thereby elaborating on the question and sink into the next question automatically, instead of giving answers that would be of topic. The interviews lasted for roughly an hour each.

### 2.3.10 Case Study

The Case study was selected as a method in order to inquire information of how project management is executed within the road client organization NPRA. The project group considered an observational study as a great tool to use in order to obtain data and information from another perspective than what interviews might provide. In order to acquire a project, the project group got in contact with the project manager of a NPRA project, presented in sub-chapter 4.3, who accepted the proposal of using this project in the case study. The project group planned to visit the project´s construction site in a total of 12 days because of the timeframe limitations of this thesis. The project group also perceived 12 days as being sufficient when considering the scope of the case study. The plan for project visit days can be found in appendix 8.

The project group also tried to arrange a case study with Nye Veier. However, Nye Veier had experienced delays with their ongoing projects and could therfore not provide a project for the project group to follow in a case study.

The use of case study as a method had mainly two purposes. These were to investigate and to observe, in order for the project group to compare and discuss the findings. The investigation part of the case was to study project properties and what these meant for the project. One important segment of this investigation was to explore what project delivery method that was used, why it was chosen, and finally in what way the selected project delivery method affected the project, and its project management.

The second part of the case-study entailed observing the client both internally and externally when interacting with the contractor on the project. To do this, the project group planned to take part and observe in various meetings with different disciplines. Such meetings included construction meetings, discipline meetings, and work-meetings. The purpose of observing the internal and external interaction of the NPRA was to map the use of project management tools and strategies including communication, trust, project planning, project monitor and control,

risk and uncertainty management, and conflict management. The observation plan also included productivity management tools and strategies including supply chain management, Lean, Lean Six Sigma, Building information modeling, and Virtual design and construction. The framework for mapping information through observations and the case guide can be found in appendix 9 and 10, respectively.

The case study was designed, as previous mentioned, to investigate and observe how project management is executed within a NPRA project. The intention of investigating and observing the project was that this could be used as a basis when comparing the results with existing project management theory and the results from the interviews. Additionally, this serves as great input when discussing the thesis' research questions in the pursuit for recommendations for how to achieve improved project management.

As previous mentioned in section 2.3.9 Interviews, and further explained in section 2.3.14 Covid-19, the Covid-19 outbreak caused severe challenges regarding the execution of the planned case study. The NPRA followed the national guidelines, meaning that everyone who could stay at home, should stay at home. This caused the activity on the project to drop dramatically, leaving the project group with little to observe. As a result, the project group only managed to visit the project two times. The first day of visit the project group got a general presentation about the project, in addition to meeting the project management group. In the next visit in the following week, Covid-19 had already started to show an impact on the construction site with less workers. Later that day, the Norwegian government decided to put the country on a lock-down, meaning that this was the last day the project group got to visit the construction site. As a result, the case-study did not provide the project group with any valuable and relevant result data.

### 2.3.11 Data Analysis

Data analysis can mean the application of statistical techniques in relation to the data collected (Bryman, 2016). In relation to this report, the data collected is almost entirely reliant on theory and text-based data, which means using software's and statistical techniques, are not the best suited method to analyze the data. It is on the other hand, the handling or management of the data collected which is important in this report (Bryman, 2016). This section will therefore convey how the data collected in this report was managed, compared, and evaluated.

After the data from the literature review was collected, it first needed to be evaluated. Thus, the literature reviewed, was evaluated as explained in section 2.3.7 Literature Review. After the

literature was evaluated, the project group started to compare it against other literature, to investigate if the information was similar and compatible. The data was thereafter managed into a theory section with the purpose of presenting the findings in a systematic and structured manner. The information was, furthermore, controlled and checked in order to eliminate obvious flaws and discrepancies between the different literatures.

The data collected from the interviews were transcribed and furthermore presented in the result chapter in a summarized paragraph based on what the interview subjects answered, and the relevance the information had to the inquiry of this project. The information presented in the result chapter was therefore not tempered with in any way, and the opinions and examples transcribed into the result chapter were all gained from the interviews.

In the discussion chapter the data from both the theory chapter and the result chapter were compared and discussed against one another. The data was thereby, managed in accordance with the problem statement of this report, in order to generate reliable result comprised from professionals and theory.

### 2.3.12 Challenges and Uncertainties

Choosing relevant literature can be challenging, and it is therefore important that the project group have a common understanding of the project goal. Good communication, trust and commitment between the participants were therefore recognized and understood as important factors needed not only in the beginning of the project work, but also continuously during the report-writing process.

Another challenge identified was how to involve the right organizations to cooperate with. The choice depended on factors like time restraint, connections, and available resources at the specific organization. In an attempt to avoid these challenges, the project group was conscious about the challenges and engaged different organizations early in the project process. Nevertheless, Nye Veier proved to be a challenge as they could not be a part of a case study, as originally planned.

Another uncertainty, as the project group sees it, is the accessibility of relevant data in order to answer the inquiry of the project. Does the statistical data exist? Is the project scope detailed enough? Is there enough time to complete the study? It was therefore important that the research material was explored from other sources such as NTNU teachers, the supervisor, and classmates, to make sure that the project inquiry was investigated from all possible angles.

### 2.3.13 Limitations

The chosen methods each has its positive and negative properties, as described in section 2.2.2. However, when one integrates the methods to the natural framework and prerequisites for this master thesis, involving time, scope, and field of investigation, one will discover that each method chosen has its limitations and constraints. This section will provide an explanation of how the method of literature review, interviews, and case study is limited in this master´s thesis.

The literature review´s first limitation is connected to the size and the topic of the report. Given that project management is a broad topic, and that master theses have a certain degree of size constraints, the authors are enforced with a choice to whether exclude important theory to the benefit of more detailed description of other theory, or to include all relevant theory, tough on a more general level. As mentioned in sub-chapter 1.3 Limitations of the report, the authors chose to match the literature review to the nature of this report, meaning that a broad topic should have a broad literature review, even though it implies that the level of detail will be affected by this. Another limitation to the literature review is the number of sources included. Because of the report's timeframe, the authors cannot possibly include all relevant sources to every topic, meaning that there is a chance for relevant theory and previous research to be unconsciously omitted. This limitation is however, tried to be mitigated as much as possible by using the ANTS method described in section 2.1.4 Investigation Techniques used in the Literature Review. The last limitation for the literature review is the accessibility of physical and online libraries. Due to the Covid-19 outbreak, students could not detain themselves at the campus of NTNU, meaning that the authors did not have the possibility for using the university´s libraries, nor downloading some of the restricted online literature due to the loss of NTNU network access.

The limitations for the interviews are mainly connected to the nature of the thesis, meaning the timeframe and topic. Qualitative semi-structured interviews were chosen, as described in section 2.2.2 Evaluation of the chosen methods, because its well suited for comparing them to theory (asae, 2009), and because of the possibility to investigate in-depth on topics during the interviews. However, these strengths of the qualitative semi-structured interview provide some limitations. The interviews are difficult to generalize and therefore also time consuming. This will cause a ripple effect that affect the number of interviews, threatening the interview result´s validity. Another limitation is the organizations interviewed. The project group interviewed 13 employees from three organizations, meaning that the diversity of the conducted interviews is low. However, the project group does not consider this to be a severe challenge as the conducted

interviews are well within the limitations established in chapter 1.3 Limitations of the report. An unforeseen limitation to the interviews were caused by the mentioned Covid-19 forcing the interviews to be conducted digitally. As it turns out, executing interviews virtually caused some of the human elements, such as gestures, to faint or disappear, meaning that the flow of the interviews is harmed, making it harder to for example ask follow-up questions. The last limitation to the interviews is connected to the people interpreting and evaluating the interviews, i.e. the authors of this thesis. With non, or very limited working experience within the construction industry and possible a more theoretical background and way of interpreting matters can cause some of the elements that are brought to light through interviews to be evaluated wrong and misinterpreted.

The method of case-study has the timeframe as its most challenging limitation. The thesis timeframe of 21 weeks caused the project group to decide on eight weeks of observation. These eight weeks were considered to be sufficient in order to observe and meet the thesis acquirement and give the authors enough data to compare and evaluate the observational result to interviews and existing project management theory. However, this timeframe was dramatically reduced by the Covid-19 outbreak, crippling the observation period to two weeks. A number that low threatens the case-study´s validity and can in that way only act as a supplementary to the interviews and theory. Another limitation is that the case-study only included one project. Every project is unique, meaning that the observed findings cannot be generalized without including more projects to the case-study. The last limitation is associated with the project group, which are the ones observing and evaluating the case-study. Due to the project group´s lack of practical experience in the construction industry, there is a chance for some of the observations to be misunderstood and thereby threatening the result of the observations.

All in all, there exist several constraints and limitations to the chosen methods in this report. However, the project group believes that these limitations are not preventing the project group to investigate how to achieve improved project management. The authors do instead believe that realizing these limitations can be a strength to this report.

### 2.3.14 Covid-19

In January 2020, China reported to the WHO that a new influenza virus was spreading throughout the country (World Health Organization, 2020). It was furthermore discovered that this virus, commonly known as the Coronavirus, had a fast spreading rate and did in just a few weeks spread across the whole of China. Many scientists and health organizations warned the world about the hazardous potential this virus could have on the world, but no one knew for sure how much the pandemic virus, renamed to the medical name Covid-19, would cripple the world's industries and economy (Norwegian Institute of Public Health, 2020) (Klein, 2020).

By the time Covid-19 became a serious threat to the Norwegian way of life in late February 2020, this master thesis had already undergone a significantly amount of planning and work. In the original plan the master thesis was supposed to be mostly based on a case study, and the authors had therefore made arrangements with the NPRA to conduct an observational study of a selected project. In the early phase of the case study the authors experienced lots of uncertainty related to the different governmental messages and quarantine rules, and the future of the case study started to become uncertain. As a result of the rules sat by the government on the 12.03.2020 the whole country was put on lockdown, and the case study was put on hold to the benefit of interviews which could be conducted through digital platforms, such as Skype, instead of in person.

This change in the thesis had a large effect on the projects structure and execution as the research purpose was challenged by these events. The project group therefore had to make serious changes to the report, knowing that the deadline of the report would stay the same. However, while this served as a profound challenge to the execution of the thesis, the diligent work of the authors quickly shifted the focus and reduced the repercussions as much as one could possibly hope for in a situation like this.

# 3. Theory

Chapter three will serve as the paper's theory chapter, making it the foundation for developing observational plans for the case study and interview guides. The theory chapter will also act as a support and reference point when discussing the papers findings from the case study and interviews.

The general terms of a project, project delivery, project management, productivity management, and the project manager role will be presented. An introduction to critical success- criteria and factors for project management will follow. Key competences that a project manager must possess in order to succeed with project management will also be presented in this chapter.

Chapter three will in addition present what improved project management is, major project- and productivity management tools and strategies that exist, before finally presenting project delivery methods used in the Norwegian construction industry. This framework was chosen in order to thoroughly explain what project management is before presenting essential elements that affect the project management.

## 3.1 What is a Project?

In order to reach the papers goal, it is fundamental to understand what a project is. A project is by nature, a temporary endeavor undertaken to create a unique product, service or result (Project Management Institute, 2017). This involves that the project is temporary with a defined beginning and end, with a defined scope and resources. Furthermore, a project is unique, meaning that it is not a routine operation, but a specific set of operations designed to accomplish a singular goal. The fact that a project is unique means that project teams often includes people that are not necessarily used to working together (Project Management Institute, 2017). Projects are in fact multifunctional, meaning it involves several different functional lines (Kerzner H. R., 2017). Since project members often are unfamiliar with each other's way of working and communicating, the importance of a person to facilitate good working conditions is high. The project manager will usually act as this facilitator (Wheelan, 2010).

## 3.2 Project Delivery

In the previous sub-chapter, this paper's understanding of a project was introduced as a prologue to answer the paper's topic sentence and research questions. This sub-chapter will act as a next step, by clarifying what is meant by project delivery, and what project success is.

Project delivery can be explained as the deliverables or the output of the project. This means that the project delivery describes what the project should result in, and may include project requirements, project designs, necessary documentation, description of components, the work process, models, concepts etc. (Hussein, 2018). Well performed project management is critical in order for the project delivery to be successful (Kerzner H. R., 2013). Skaara & Liland (2019) furthermore claims that that the correct implementation of project management tools and strategies will lead to a better project delivery.

Successful project delivery depends on the project´s purpose and goal, and will therefore vary depending on who is asked, and what is asked when evaluating success. "Traditionally, the project management metrics of time, cost, scope and quality have been the most important factors in defining the success of a project" (Project Management Institute, 2017). More recently, project success has been modified to include completion of project objectives (Kerzner H. R., 2017). This has led to that "project stakeholders may have different ideas to what the successful completion of a project will look, and which factors are the most important." (Project Management Institute, 2017).

This change in the understanding of project success have divided the term into different categories depending on the criteria being evaluated. One category is the strategic evaluation which concerns the project´s sustainability and relevance throughout its lifetime. Another category is called a tactical evaluation and is about the successfulness of the project execution phase. (Samset, 2017). A third category is the process success which "is about how the stakeholders perceived or experienced the project implementation. The process success is therefore more about the emotions, rather than reason" (Hussein, 2018).

In a strategic evaluation, one will assess the success of the long-term project delivery. The projects execution is therefore of less relevance than the reasoning and end result of the project. An example is that a project in a societal context will be seen as successful if it is relevant, sustainable and effective, but on the other hand be viewed as a failure if the project doesn't give any value to the society, no matter how well executed the project was. It is therefore in the

client´s and the user's best interest that the strategic evaluation criteria are thoroughly investigated and analyzed prior to the start of the project (Samset, 2017). The strategic criteria can therefore be viewed in the construction industry as the value generated by the road or building after its completion. If the user finds the building faulty and hard to use, the building might not serve its purpose and result in a project delivery failure. Successful project delivery may therefore be achieved if the purpose, the user satisfaction, the customer satisfaction, the strategic goal, etc. are attained (Hussein, 2018).

A tactical evaluation is on the other hand, an evaluation of the execution of the project. The goal of this process is therefore to assess the degree of which the project has managed to satisfy time constraints, stay within the cost, deliver the product according to the specifications and comply with internal and external constraints and expectations during the implementation. (Hussein, 2018). This category is therefore subjected to project management success and is achieved if the project is completed efficiently with minimal usage of resources. This is supported by Samset (2017) who explains that the general way of measuring efficiency is to measure the parameter of time, cost, and quality. It is therefore in the best interest of the contractors, and the suppliers to successfully plan and evaluate how to perform these tactical criteria.

The tactical and strategical evaluation of a project can therefore be summed up in five success criteria given by UN, OECD and EU and are as followed: Efficiency, Relevance, Impact, Effect, and Sustainability (Samset, 2017). The process success criteria are on the other hand more diffuse, considering that they are derived from the human emotions.

As previously mentioned, this thesis sets out to answer how to achieve improved project management. The thesis will focus on how to improve the project management process in the planning and execution phase of a project, i.e. the tactical aspects. This limitation is set because project management seen from the tactical aspect versus the strategical aspect is quite different. This limitation is also set because of the project manager´s direct influence on the tactical aspects of a project. It is, however, important to mention that the strategical and process success criteria are highly relevant when looking at the whole project, and they can therefore not be excluded entirely when exploring how to improve project management.

## 3.3 Project Management

In order to inquire the thesis problem statement, that is how to achieve improved project management, one need to know exactly what project management means, and what it consists of. Project management is by the Project Management Institute (PMI) defined as "The application of knowledge, skills, tools, and techniques to project activities to meet the project requirements" Furthermore, in the previous research conducted by the project group, it was discovered "that the factors affecting improved project management are related to the project managers competence, such as leadership-, business-, and project management technical skills, in addition to the project management success factors, including, a clear project charter, sufficient resources, and efficient decision making." (Skaara & Liland, 2019). In addition to this describes Harald R. Kerzner (2017) the term project management in his "Project Management" book, often referred to as the "bible" for project management, by using five process groups presented in table 4.

Table 4 Project Management Processes (Kerzner H. R., 2013).

| Process Group | Description of Processes |
|---|---|
| **Project initiation** | Selection of the best project given resource limits.<br>Recognizing the benefits of the project.<br>Preparation of the documents to sanction the project.<br>Assigning of the project manager. |
| **Project planning** | Definition of the work requirements.<br>Definition of the quality and quantity of work.<br>Definition of the resources needed.<br>Scheduling the activities.<br>Evaluation of the various risks. |
| **Project execution** | Negotiating for the project team members.<br>Directing and managing the work.<br>Working with the team members to help them improve. |
| **Project monitoring and control** | Tracking progress.<br>Comparing actual outcome to predicted outcome.<br>Analyzing variance and impacts. |
| **Project closure** | Verifying that all of the work has been accomplished.<br>Contractual closure of the contract.<br>Financial closure of the charge numbers.<br>Administrative closure of the paperwork. |

The presented project management processes describe what project management is. This is however not sufficient in order to fully understand the term project management. There exist several critical successes- criteria and factors for project management. Furthermore, project management involves productivity management and numerous tools and strategies linked to the execution of both the management of the productivity and the overall project. The following sections will present such project management elements.

### 3.3.1 Critical Success- Criteria and Factors for Project Management

An important element of project management is to acknowledge the importance of critical success- criteria and factors that affect the project. Kerzner (2017) defines critical success criteria as conditions that have to be achieved in order to reach the project objectives. These objectives usually require that the project is finished on time and within the budget, but also that the project achieves the desired performance, utilizing the assigned resources effectively and efficiently, and that the project is accepted by the customer (Kerzner H. R., 2017). Project management tasks is in this paper defined as the necessary work that must be complied with, in order to reach the project objectives.

Success factors on the other hand is defined as a set of factors that the project must comply with, in order to increase its likelihood of success (Turner, 2009). Because of this definition, and the definition of project success criteria, one could suggest that critical success factors are factors that must be fulfilled, in order to achieve the critical success criteria. Some example of key success factors that are found to be predictive of project success are good coordination with stakeholders, adequate project planning, proper choice of projects, agreed success criteria, realistic estimates, and good project start-up process (Murphy, et al., 1974).

Chan (2004) support this by stating that one of the critical success factors affecting project success is good planning. It is therefore up to the project managers to utilize the management tools to develop excellent plans and execute projects properly. Additionally, adequate communication, use of control mechanism, feedback capabilities, effective coordination, effective decision making, monitoring, and project organization structure are all examples of critical success factors that need to be handled, in order to maximize the possibility of project success (Chan, et al., 2004).

In order to understand the origin of where success factors come from, Hussein (2018) suggests that success factors can be distinguish into three categories:

1. *Case-specific factors*

These are factors that are only relevant to a specific situation and cannot be generalized to other contexts. Examples includes the relationship to vendors, execution style, type of contract and use of specific methods.

2. *Structural factors*

Structural factors include factors that are related to project organization, communication and information flow, planning, risk assessment and project manager.

3. *Cultural factors*

The cultural factors represent shared values that must be complied with in order to be able to create encouraging and positive working conditions for the involved persons/parties in the project. Such factors are trust, openness, respect, loyalty, and commitment.

### 3.3.2 The Project Manager Role and Key Competences

Project management involves many elements and different roles, with the most substantial role being the project manager. This role is described as the person being responsible for coordinating and integrating activities across multiple, functional lines. These integrated activities include activities necessary to develop a project plan, execute the plan, and make changes to the plan (Kerzner H. R., 2013).

Project managers can be described as change agents, who use their own skills and expertise to inspire a sense of shared purpose within the project team. Project managers also cultivate people skills in order to develop trust and communication among all other project participants. Additionally, they have a broad and flexible toolkit of techniques in order to adapt complex activities into manageable tasks that are documented, monitored and controlled (Project Management Institute, 2017).

Project Management Institute (2017) describes the project manager competence by dividing the key competences into the three categories: Technical project management skills, Strategic and business management skills, and Leadership skills.

**Technical Project Management**

The technical project management skills are defined as the skills needed to effectively apply project management knowledge to deliver the desired outcomes for programs or projects. Furthermore, does the Project Management Institute (2017) presents several key skills that superior project managers consistently demonstrate:

- Focus on critical technical project management elements, meaning that the project managers have the right artifacts of critical success factors, project schedule, financial reports, and deviation journal, readily available.
- Utilizes both traditional and agile tools, techniques, and methods for each project.
- Make time to plan thoroughly and prioritize diligently.

- Manage project element, including, but not limited to, schedule, cost, resources, and risks.

**Strategic and Business Management**

Strategic and business management skills involve the ability to have a high-level overview of the organization and effectively negotiate and implement decisions and actions that support strategic alignment and innovation. This requires that the project manager has adequate knowledge about the base organization's strategy, mission, goals and objective, and products and services. The project manager must then align these base organization properties to the specific project.

**Leadership**

Leaderships skills involve the ability to guide, motivate, and direct a team. Such skills can be the project manager´s ability to negotiate and act resilience when necessary, communicate, solve problems, and think critically. Project Management Institute (2017) presents several qualities and skills of a good leader:

- Being a visionary.
- Being optimistic and positive.
- Being collaborative.
- Managing relationships and conflicts by building trust, satisfying concerns, and balancing competing and competitive goals.
- Communicating by spending sufficient time on communication, managing expectations, receive and give feedback, and asking and listening.
- Being respectful, trustworthy, and ethical.
- Exhibiting integrity and being culturally sensitive, courageous, a problem solver, and decisive.
- Giving credits to others where due.
- Being a life-long learner who is result- and action-oriented.

### 3.3.3 Productivity Management

Project management consists, as previously mentioned, of several different elements. One of these underlying elements of project management is the administration of productivity. Productivity management is in this paper considered to be a vital project management element that must be correctly comprehended and executed in order to reach the intended project delivery and achieve project success, seen from a tactical point of view.

**Productivity**

Productivity is defined by the Norwegian encyclopedic dictionary as production in comparison to the effort given (Store Norske Leksikon, 2017). This means that productivity is a relationship between goods produced, and goods used in the creation of the product. Another way of defining productivity is to explain it in mathematical terms, where productivity is the result of outputs divided by inputs (Johnsson, 1996). Based on these definitions, productivity in the construction industry is a measurement of the resources used in the creation of the product, compared to the value of the final product.

A key source to evaluate a country`s economy is to assess its productivity level. If the productivity level is improving, it signifies that the output is increasing, which is also an indication that the economy is growing. If on the other hand the productivity level is decreasing, it would mean that the input is growing, which signify a decline in the economy (Investopedia, 2019). Considering that the productivity level is important to a country's economic growth, one might wonder why the productivity level in the construction industry is decreasing.

There are arguably several different factors influencing this decline in productivity. Some research is criticizing the supply chain, rework, poor planning or poor execution of the construction project as the reason for poor productivity (Josephson & Hammarlund, 1999) (Burati Jr, et al., 1992) (Love, et al., 1999). Others argue that the productivity is not that low, and that this would have been more apparent if the comparison criteria had been different (Ahmad, 2018). "Practitioners and researchers have noted that the industry has been building items of greater complexity and higher quality than in the past and is doing so in shorter periods of time. […] Hence, it may not be a fair nor accurate statement that productivity is declining across the board in the construction industry." (Dr. Yeoh Ker-Wei, 2019).

**Productivity Management**

In section 3.3.1, project management was thoroughly explained as necessary for a project to succeed. Knowing how to manage the overall project, might not necessarily be enough if one wishes to improve the productivity. It is therefore imperative that one also understand what productivity management is, and why it is necessary.

Productivity management and project management are two professions that share numerous similarities between one another and is one of the reasons why professionals often mistake one for the other. There is, however, a very clear distinction between these two roles, which is that productivity management is an underlying element of project management. In other words, the

difference between them is that project management is about the whole process of the project and consists of strategies and techniques used to manage the project activities in order to reach the overall goal of the project. While productivity management on the other hand, is about how to use different strategies and tools to analyze and improve these project activities in order to increase the productivity of the project (Moore, 2007).

Productivity management is thus a method used to analyze and understand where the production is slow, why it is slow, and how to make it more productive. In order to accomplish this, a productivity manager must first collect necessary output data, which often focuses on physical-quantity and resources, and the financial values (Phusavat, 2013). The next step in the process is to analyze the information and utilize the findings in order to make efficiency improvements where necessary. Finally, if the problem is reoccurring in different and independent projects, tools and strategies are created to deal with this inefficiency (Phusavat, 2013). Summarized, productivity management is used to increase awareness of inefficiency, and implement solutions in a structured way in order for the organization to improve the overall productivity and competitiveness.

### 3.3.4 Improved Project Management

The aim of this master´s thesis is to investigate and answer how improved project management can be achieved for large Norwegian road clients. The rationale of selecting this problem statement is that it continues where the specialization project, described in section 2.3.8, stopped. The specialization project investigated how improved project management can contribute to a better project delivery. However, the question on how to achieve this improved project management was not fully laid to rest. The term improved project management was on the other hand defined and is extended to this paper. “Improved project management is to understand and perform the elements of project management better than what is practiced today” (Skaara & Liland, 2019).

Furthermore, is the competence a project manager possesses, regarding to leadership, business, and project management technical skills, directly connected to the project management performance. Improving this competence will therefore improve project management (Skaara & Liland, 2019). Other elements affecting improved project management are the project management success factors. Skaara & Liland (2019) claims that good communication, effective coordination, effective decision making, good coordination with stakeholders, and adequate project planning are all vital factors that affect improved project management.

## 3.4 Project Management Tools and Strategies

In this sub-chapter various project management tools and strategies will be presented. A project management tool can be defined as "a document, framework, procedure, system or method that enables a company to achieve or clarify an objective" (Brady, et al., 1997). Project management strategies and tools can therefore be used to achieve the project´s success factors, and ultimately leading to project success. Project success in this report does, as previously mentioned, focus on the tactical aspect. This implies that the project- success and delivery is connected to the projects output and the process of executing the project.

### 3.4.1 Communication

Communication is by the Oxford Dictionary defined as "the imparting or exchanging of information by speaking, writing, or using some other medium." (Oxford Dictionary, 2020) Moreover, the art of communication in project management is seen as the "Project´s life blood", as everything in a project is based on how efficient the communication is carried out. (Rajkumar, 2010). This is also supported by Kerzner (2013) who states that "Effective project communications ensure that we get the right information to the right person at the right time and in a cost-effective manner. Proper communication is vital to the success of a project" (Kerzner H. R., 2013). It is therefore clear that good communication among the project participants is highly needed if the project is to reach its objectives, and it is consequently seen as an important tool and technique that the project manager must master. Kerzner (2013) provides nine techniques that can be used to improve communication:

- Obtaining feedback, possibly in more than one form.
- Establishing multiple communications channels.
- Using face-to-face communications if possible.
- Determining how sensitive the receiver is to your communications.
- Being aware of symbolic meaning, such as expressions on people´s face.
- Communicating at the proper time.
- Reinforcing words with action.
- Using a simple language.
- Using redundancy (i.e., saying it two different ways) whenever possible.

Additionally, Kerzner (2013) underlines that one should never assume that the message you sent will be received in the form you sent it. This is also supported by Rajkumar (2010) who claims that one can never take for granted that the receiver will interpret the message the same way as the sender intended it. Kerzner (2013) also conclude that the most effective communication take place among people with a common point of view. It can therefore be understood that a manager who foster good relationships with other project participants will have a great possibility of good communication. Communication must also be established early in the project since it is a vital factor for achieving project success.

Managing communications effectively and efficiently requires planning. Abudi (2013) claims that planning of communication in a project will enable for improving the effectiveness of communication overall, including frequency and quality. The planning will also enable for keeping individual project participants engaged in the initiative through open communications. Finally, stakeholders will get involved in communications through enabling for more effective two-way conservation. On the other hand, poor communication in a project presents a tremendous negative impact, as presented in table 5, on the project.

Table 5 Impact on Projects due to Poor Communications (Abudi, 2013)

| **Poor Team Communications** | **Poor Stakeholder Communications** |
|---|---|
| Misunderstanding around project goals and objectives | Lack of or limited buy-in and commitment to the project |
| Missed deadlines | Misunderstanding around stakeholder expectations on what is considered project success |
| Conflicts between team members | Conflicts between the project team and stakeholders, or between stakeholder groups |
| Individual team members moving in different directions | Stakeholders who may actively work against the project the project being accomplished |
| Decreased productivity on the project leading to increased timelines and going over budget | Failed projects |
| Lack of commitment on the part of project team members in accomplishing the work of the project | |

When developing a communication plan the goal is to establish communication with stakeholders that manage their perceptions of the project in a way that will support the project. A communication plan can be obtained by identifying the 5Ws (Why, What, When, Where, Who) and 1H (How).

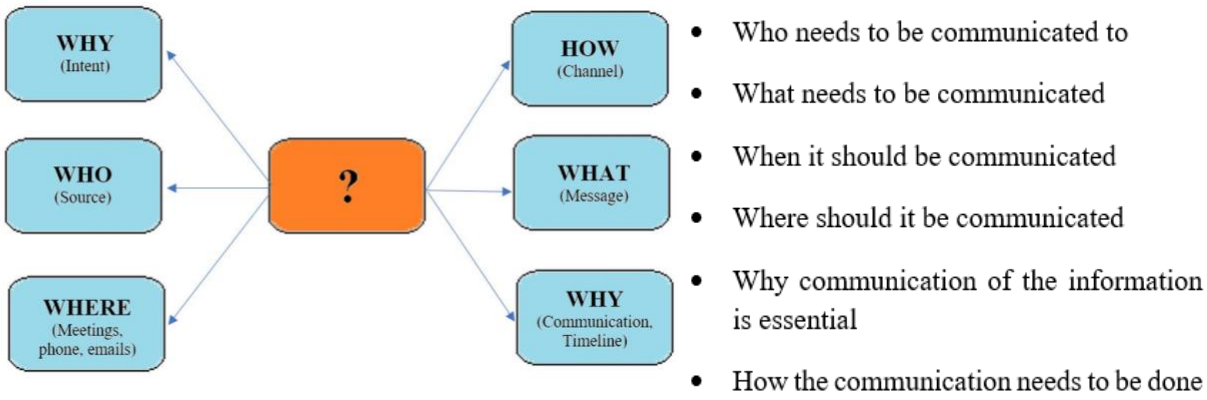



Figure 1 The 5Ws and 1 H (Rajkumar, 2010)

### 3.4.2 Trust

Trust is defined in the Cambridge Dictionary as "to believe that someone is good and honest and will not harm you, or that something is safe and reliable" (Cambridge dictionary, 2019). Maurer 2010 support this definition by highlighting that "most researchers agree that at its core, trust is an expectation concerning the initiation or behavior of others".

In consideration of project management, trust is a vital tool for the collaboration between the project participants (Kerzner H. R., 2017). Kerzner (2017) further claims that all parties benefit when trust occur in a project. For example, will trust facilitate long-term contracts, repeated business, less documentation and need for project team meetings. This is supported by Kadefors (2004) who argues that "if trust is present, people can spontaneously engage in constructive interactions without pondering what hidden motives the exchange partners might have"

Trust will also contribute to a greater acknowledgement of responsibility when problems occur, and willingness to solve the problem in a reasonable matter (Kerzner H. R., 2017). This is supported by Lencioni (2002) who mention several properties that a project team with a high level of trust possess presented in table 6. Another way to illustrate the level of trust one might have towards one another, is by making use of the five-step pyramid presented in figure 2.

Table 6 Properties of a Team with a High Level of Trust (Lencioni, 2002).

| **Properties of a Team with a High Level of Trust** |
|---|
| Admit weakness and mistakes |
| Ask for help |
| Accept questions and input about their areas of responsibility |
| Give one another the benefit of the doubt before arriving at a negative conclusion |
| Take risks in offering feedback and assistance |
| Focus time and energy on important issues |
| Offer and accept apologies without hesitation |
| Look forward to meetings and their opportunities to work as a group |

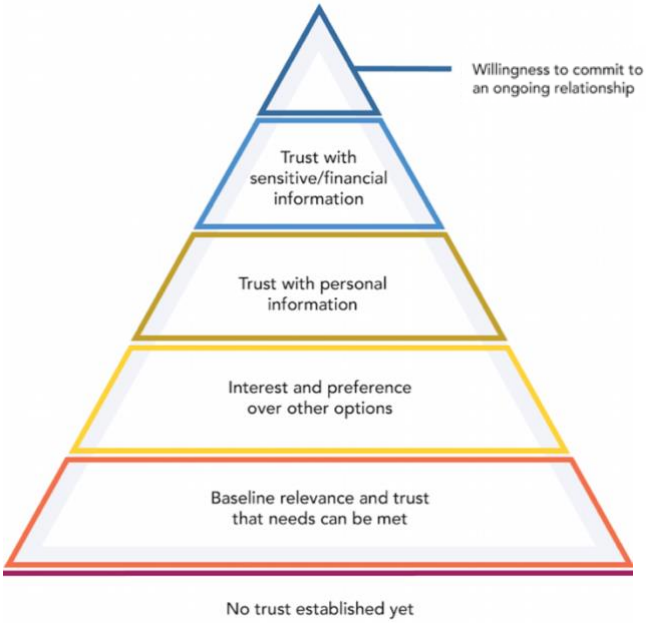



Figure 2 Pyramid of Trust (Nilsen Norman Group, 2016)

### 3.6.3 Project Planning

The general perception in the society is that a project manger´s task is to make plans; and this is not far from the truth, because the difference between a good project manager and the poor project manager often is described in one word: planning (Kerzner H. R., 2013).

According to Kerzner (2013) involves project planning many elements but can be divided into five main focus areas. The first area concerns the development of schedules, while the second involves the development of budgets. These two areas contain the quantitative aspects of planning. The third area is about planning the project administration, which mainly includes choosing the right competence for the project. The fourth area of planning is leadership styles. Additionally, explains Kerzner (2013) that the leadership styles are impacted by the importance of the shared values in an organization. It is observed that the values in organizations now are shifting from traditional values such as power and authority, internal focus, reactive management, bureaucracy, and tactical thinking, to more "effective" values. Such values include more focus on trust, teamwork, stakeholders, proactive management, and strategical thinking. Planning regarding leadership styles must therefore be derived from the organization's values, preferably toward the "effective" values (Kerzner H. R., 2013). The fifth and last area is conflict management. The project manager has often been described as a conflict manager, who continually fights fires and crisis evolving from conflicts (Kerzner H. R., 2013). Handling conflicts requires much resources, making a plan for how to prevent or mitigate the

probability for conflicts is therefore vital. The project manager should therefore make a contingency plan for measures to implement if a conflict occurs. Further elaboration of conflict management will be presented in section 3.4.7 Conflict Management.

### 3.4.4 Stakeholder Management

A project stakeholder is by the Project Management Institute (2017) defined as "an individual group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project". Hussein (2018) explains that one source of uncertainty in projects are connected to the stakeholders´ willingness, capacity, and ability to perform as required in order to achieve the project objectives. Being able to map and understand the stakeholders´ influence and interest in a project is therefore vital for a project manager.

A stakeholder analysis classifies the different stakeholders into four groups depending on the specific stakeholders´ influence and interest of the project. This classification can be done by using the matrix in table 7.

Table 7 Stakeholder Analysis (Hussein, 2018)

| | | **Interest** | |
|---|---|---|---|
| | | **Small** | **Large** |
| **Influence** | **Critical** | Group 2: The stakeholders' contribution to the project is critical, however they do not have a large interest in the project's requirements. | Group 1: Stakeholders that the project is critical depending on. The stakeholders also have a large interest in the project or its outcome. |
| | **Marginal** | Group 4: Stakeholders in this group have little expectations and influence on the project. | Group 3: This group of stakeholders have significant requirements and expectations for the for the project outcome, however they have little power to influence this outcome. |

After analyzing the project stakeholders, one need to identify how to satisfy them. Hussein (2018) presents how to manage the different groups in the following way: Group 1 has both large interest and influence, which means that collaboration with this group is vital for the project to succeed. Group 2 on the other hand, have a small interest, but high influence. This means that dealing with this group should be based on maintaining their support and satisfying their minimal expectations. Group 3 has large interest, but marginal influence. Which means that they should be informed continuously, and that their concerns should be considered, as this group normally consist of the project´s end-users. Finally, group 4, which consist of

stakeholders with minimal interest and influence, should be monitored and observed in case their position will change during the project lifetime.

### 3.4.5 Monitor and Control of Project Work

"Monitor and control of project work is the process of tracking, reviewing, and reporting the overall progress to meet the performance objectives defined in the project management plan" (Project Management Institute, 2017). The key benefits of the monitor and control process is that it allows stakeholders to understand the current progress of a project, why actions are made regarding performance issues, and to foresee future project status with cost and schedule forecast.

The Monitor- and Control Project Work- process is by the Project Management Institute (2017) described as concerning the following elements:

- Comparing actual project performance against the project management plan.
- Assessing performance periodically to determine whether any corrective or preventive actions are indicated.
- Checking status of individual project risks.
- Maintaining an accurate, timely information base concerning the project´s products and their associated documentation through project completion.
- Providing information to support status reporting, progress measurement, and forecasting.
- Monitoring implementation of approved changes as they occur.
- Providing appropriate reporting on project progress, and status to program management when the project is part of an overall program.
- Ensuring that the project stays aligned with the business needs.

### 3.4.6 Risk Management

Risk has two primary components for a given event. The first includes the probability of occurrence of an event, while the second component is how large the impact/consequence of that event occurring is (Kerzner H. R., 2013). Risk can in other words be measured by multiplying the consequence and the likelihood, the result can be viewed in figure 3.

| | Consequence | | | | |
|---|---|---|---|---|---|
| **Likelihood** | **Insignificant** | **Minor** | **Moderate** | **Major** | **Severe** |
| **Almost Certain** | Medium | High | High | Extreme | Extreme |
| **Likely** | Medium | Medium | High | Extreme | Extreme |
| **Possible** | Medium | Medium | High | High | Extreme |
| **Unlikely** | Low | Medium | Medium | High | High |
| **Rare** | Low | Low | Medium | High | High |

Figure 3 Risk Matrix (Hussein, 2018)

"Project Risk Management includes the processes of conducting risk management planning, identification, analysis, response planning, response implementation, and monitoring risk on a project. The objectives of project risk management are to increase the probability and/or impact of positive risks and to decrease the probability and/or impact of negative risks, in order to optimize the chances of project success" (Project Management Institute, 2017). The project risk management processes are described in seven steps, presented by PMI (2017):

- Plan Risk Management – Defining how to conduct risk management activities for a project.
- Identify Risks – Identifying individual project risks and general overall project risks.
- Perform Qualitative Risk Analysis – Prioritize individual project risks for further analysis based on their probability of occurrence and magnitude of impact.
- Perform Quantitative Risk Analysis – Numerically analyzing the combined effect of identified projects risks that threaten project objectives.
- Plan Risk Responses – Developing options, selecting strategies and measures to address the overall-, and individual project risks.
- Implement Risk Response – Implementing the agreed-upon risk response plan.
- Monitor Risks – Monitoring the implementation of agreed-upon risk response plans, tracking identified risks, and identify and analyze new risks.

Although the project risk management process can appear as being "straight forward", the risk management work can be comprehensive and difficult to conduct. Hussein (2018) discovered that the project risk management is a human-based process with the following challenges:

- People who are involved in the project form their own subjective perceptions of risk based on habits, work culture, expectations, experience, and skills.
- There is a need for structured methods in order to identify potential risk factors. Such methods are necessary in order to create awareness of the importance regarding risk management as a tool to increase predictability, and to understand project characteristics.
- In some cases, many resources are used to define and discuss risk factors in the projects, but the process by identifying and implementing measures in order to decrease the identified risks are not done.
- Decisions are mostly based on subjective assumptions and are not based on the project´s context, objectives or constrains.

In order to succeed in the project risk management process, it is essential that the people conducting the process have the right knowledge, skills, information about various aspects of the project, and having sufficient time.

### 3.4.7 Conflict Management

"Good project managers realize that conflicts are inevitable, but that good procedures or techniques can help resolve them" (Kerzner H. R., 2013). As mentioned earlier, risk management can contribute to decrease the possibility for conflicts to occur. Although risk management in projects reduce this possibility, it does not entirely eliminate the chance for conflicts. This section will describe how project management tools and techniques can be used to manage conflicts.

There exist several degrees of seriousness when it comes to conflicts. The first are disagreements which are conflicts with a low degree of seriousness. Such disagreements can easily be handled by the involved parties without any further complication. The second level of conflicts are disputes. These disputes are of a higher degree of seriousness and might require the intervention of a third party, such as a mediator. The third and most serious degree of a conflict is when the involvement of lawyers is required because it is no longer possible to solve it by negotiating (Lædre, 2018). However, considering the problem statement of this report, the presented conflict management-approaches will focus on how the project manager can handle conflicts.

When a conflict occur the project manager must study the problem and collect all available information. Furthermore, the project manager needs to develop a situational approach and set the appropriate atmosphere. Kerzner (2013) describes the effective project manager, in conflict problem-solving situations as a person who:

- Knows the organization.
- Listen with understanding rather than evaluation.
- Clarifies the nature of the conflict.
- Understands the feeling of others.
- Suggests the procedures for solving differences.
- Maintain relationships with disputing parties.
- Facilitates the communications process.
- Seeks resolutions.

Kerzner (2013) furthermore presents five different approaches to utilize in order to handle conflicts. The first approach involves *confronting*, meaning that the involved parties meet face-to-face to work through their disagreements. This approach should focus on solving the problems, and not being combative. This approach is used when both parties need to win, and therefore in situations where both parties have the possibility to get what they want.

A second approach is *compromising*, where both parties can search for resolutions leading to some degree of satisfaction. Compromising is often a result of confronting and can be seen as a "win-win" or "lose-lose situation", depending on the specific conflict. The compromising approach should be used in situations where both parties need to be winners, when further relationship between the parties is necessary, and when the involved parties are equally right.

A third approach for handling a conflict is called *smoothing*. This method seeks to reduce the emotions that exist in a conflict. To do this, participants in the conflict must try to emphasize on positive resolutions and use this common ground to smoothen out the conflict elements that the participants still disagree on. This approach should be implemented in order to solve the main issue in a conflict and creating a trade-off way of thinking that can be used in a later stage in the management of the conflict.

Another approach to resolve a conflict is to use the *forcing* approach. Forcing happens when one party impose the solution on the other party. When forcing a conflict resolution, the outcome will be a "win-lose" situation. This approach should therefore only be used when the specific party is certain that its standpoint in the conflict is right, and the situation is a ""do-or-die" situation with little time to spare.

The last approach to handle conflicts is *avoiding*. This method does not necessarily solve the conflict but give the participants the opportunity of buying themselves more time. Avoiding should only be used in situations when the specific party cannot win, when the problem will go away after some time, or if the party win elements in the conflict by delaying. It is important to underline that this approach is seen as a "last reserve", meaning that other approaches should be considered first in order to maximize the possibility for an agreeable outcome of the conflict.

Conflicts are very resource demanding, meaning that project participants will have to focus their time on the conflict, rather on their actual every-day job, which is to lead the project further toward its completion. A fast resolution of conflicts in a way that all project participants can accept is therefore vital in order to deliver the project with respect on the costs-, quality- and timeframe.

## 3.5 Productivity Management Tools and Strategies

The term productivity was in section 3.3.3 explained as the sum of the produced project divided by the resources invested. It was furthermore explained that by adding management into the mix, the companies attained a strategic way of analyzing and understanding how to increase the productivity. This chapter will go even further in the explanation of productivity management, and feature several different strategies and tools, which are created for the purpose of increasing a projects productivity. This chapter will focus on how these methods can be used in order to control the tactical aspect of the project.

### 3.5.1 Supply Chain Management

In recent project theory, companies have started to realize that in order to sustain a competitive advantage in this increasingly globalized and competitive market, the organizations must increase their productivity (Hundnukar, et al., 2013) (Mentzer, et al., 2001). Considering this, the companies have started to look outside of their own organization, with the purpose of investigating the opportunity of collaborating with partners and suppliers to ensure higher efficiency and better project delivery (Hundnukar, et al., 2013). This have inspired the use of supply chain management, which is based on the improvement and standardization of the supply chain.

A supply chain can be defined as “The network of organizations that are involved, through upstream and downstream linkage, in the different process and activity that produce value in the form of products and services in the hands of the ultimate customer” (Vrijhoef & Koskela, 2000). This definition can be integrated into the construction industry, where the process is a composition of several different tasks and activities put together in a professional sequence with the purpose of creating a final product. A simplified illustration of supply chain management is presented in figure 4, where the production flow goes towards the end user, and the information goes back to the producer.

In continuation, supply chain management can be defined as “the systematic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purpose of improving the long-term performance of the individual companies and the supply chain as a whole” (Mentzer, et al., 2001). Supply chain management is in other words a productivity strategy which focuses on better communication between all elements of the supply chain. By stressing the importance of quality, cost and delivery time based on teamwork, co-operation

and effective coordination in the whole supply chain (Akintoye, et al., 2000), one will be able to reduce the amount of misunderstandings, miscommunication, and mistakes. This will ultimately decrease the necessary resources (the input) and increase the productivity. Some research takes this even further and explains that a poor supply chain will lead to dreadful reproductions (Love, et al, 1999). Love (1999) explains how a dysfunctional supply chain will lead to time waste, unnecessary cost, and increased errors and misunderstandings, which can result in rework.

Although supply chain management is a favorably evaluated method used to increase the productivity level, it is not flawless. Some weaknesses with the implementation of supply chain management identified by Akintoye (2000) were barriers associated with lack of involvement from top management, cultural differences, shortage of training and education, and absence of necessary information. Other flaws identified by Hundnukar (2013) were problems such as trust, commitment, stakeholders, co-operation, etc.

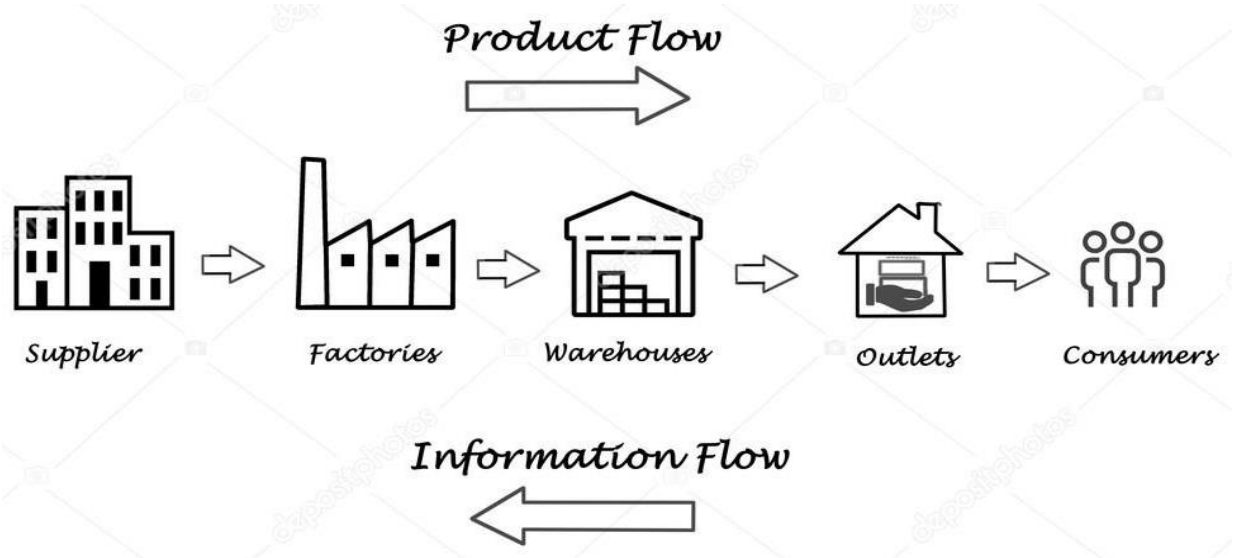



Figure 4 Illustration of Supply Chain Management (Vaeenma, 2015)

### 3.5.2 Lean

The term Lean was first coined by Krafcik (1988) in the article "Triumph of the Lean Production System" where Krafcik (1988) presents how the car industry became more efficient during the 20th century. Krafcik (1988) initiate the article by explaining how Henry Ford´s introduction of the assembly line, revolutionized the productivity of the manufacturing industry, and how Toyota expanded the theory into what Krafcik later called Lean Production System (Krafcik, 1988).

What Toyota did, that transformed the assembly line in to a Lean system was that "Toyota […] taking the minds + hands philosophy of the craftsmen era, merging it with the work standardization and assembly line of the Ford system, and adding the glue of teamwork for good measure" (Krafcik, 1988). This meant that instead of treating the employees as parts of a machine in an assembly line, Toyota gave the appropriate training and respect as a means to increase the productivity level.

The understanding of Lean has developed even further, and today Lean can be defined as to "Develop the highest quality products, at the lowest cost, with the shortest lead time by systematically and continuously eliminate waste, while respecting people and the environment" (Cherrafi, et al., 2016). In a Lean context, waste can be defined as "Anything other than the minimum amount of equipment, materials, parts, space, and time which are absolutely essential to add value to the product" (Cherrafi, et al., 2016). This is supported by (Wig, 2014) who explains that Lean is about using different methods, principles and tools to give the most value to the customer with minimal usage of resources.

It is important to understand that the implementation of Lean is a complicated process where multiple challenges need to be addressed. Companies that fails to realize this, might end up decreasing the productivity level instead of increasing it. It is therefore imperative to identify possible threats, barriers and critical success factors that might hinder the implementation process. For example, employee involvement has commonly been identified as the most important barrier when implementing Lean. When introducing an organizational change, the employees are needed to change along with it, or else the whole process will fall apart. Other critical success factors were identified to be Top Manager Commitment, Skills and Expertise, Education and Training, Communication, etc. (Alhuraish, et al, 2017).

Lean can also be explained as an umbrella strategy that consists of many different underlying tools and strategies. Thus, for the Lean methodology to be implemented successfully and realize its aspiration of increased productivity, some of the methods such as Root Cause Analysis, Total Production Maintance, PDCA 5S, and Last Planner, will be presented. There also exist several others like MUDA, A3, Prefabrication, Kaizen and SMED, but they will not be presented. These tools and strategies could have been described in more detail, but considering the problem statement and the research questions of this report, the project group have decided that the ones explained should be sufficient in order to understand the concept of Lean as a productivity strategy and introduce which tools and strategies that are commonly used in the Norwegian construction industry.

**Root Cause Analysis**

In any event, no matter if it is positive or negative, there always exist an incident or an underlying reason that needed to happen for the event to occur. In a root cause analysis, the main objective is to retrace the steps that lead up to the event and try and understand why things happened the way they did, in order to mitigate the probability for it to happen again. The reasoning behind the root cause analysis is that it is believed that "it is the confluence of many little things done poorly that usually results in some big, bad things happening" (Moore, 2007). This is why the use of a root cause analysis can result in the elimination of a negative event earlier in a project, and ultimately increase the productivity.

Furthermore, some problems might have evolved from long and complex procedures that happened because of a simultaneously occurrence. It is therefore of high importance to analyze and evaluate what is happening, because the elimination of one event might be all that is necessary to eliminate the whole problem (Moore, 2007).

A procedure often used to check the root cause of a problem is the "5 times Why?" technique. This productivity tool is in line with the KISS principle to "Keep It Simple Stupid", as the 5 times why procedure consists of simply asking the question "why" five times. By asking why the problem happened, one will find a general answer to why it happened, but when one repeats the question and press even further, it is possible to get a deeper understanding of the problem. This will ultimately make it is possible to backtrack the problem to its origin and find the root cause of the problem (Moore, 2007). When the source of the problem is found, it would be possible to eliminate it and to increase the projects productivity.

**Total Production Maintenance**

Total Production Maintenance henceforward TPM, is about bringing maintenance into focus as a vital part of the organization´s business strategy. TPM can also be defined as "The Medical Science of Machines" where the goal is to improve the production rate, as well as increasing the employee´s moral (Venkatesh, 2005). Another definition of TPM is that "in a TPM culture, maintenance is about maintaining the plant and equipment function, that is, preventing its breaking" (Moore, 2007). In other words, TPM is about reducing waste by continuously monitoring, correcting, renewing, and repairing the manufacturing machines before they break down, and facilitating the employees moral and job satisfaction.

By using the TPM principle one hope to improve the overall performance by adopting a life cycle approach for every step of the operation, which will inspire the objective of zero- defects, breakdowns, and accidents in all functional areas of the organization. TPM aspire to achieve this by involving the employees in all levels of the organization. This is done in an attempted to increase the motivation of the workers and to use group activities for identifying the causes of failure, and possible plant and equipment modifications (Arditi & Gunaydi, 1997).

Thus, TPM has become an umbrella strategy that consist of several different productivity tools and methods that is about how to prevent equipment from breaking down, rather than fixing them when they break down. The psychological difference is therefore about whether one is expecting things to fail, or to get things under control before they go that far (Moore, 2007). TPM in the construction industry is thus about getting the work under control, continuous improvement, quality control, training, education and HSE, in order to increase the projects productivity. This is also supported by (Wig, 2014) who explains that TPM has become a management system with many tools and methods that are especially useful in industries with lots of machines and equipment's.

**PDCA – Plan, Do, Check, Act**

PCDA was developed by the management consultant William Edwards Deming in the 1950s. Deming wanted to create a procedure of identifying what caused products to fail in order to be able to meet the customers' expectations about the products. The solution Deming came up with was a continues feedback loop designed to discover what needed to be changed, namely the PDCA (Mind Tools, 2017) (Bicheno & Holweg, 2016).

Figure 5 PDCA (Creative Safety Supply, n.d.)

The PDCA technique is four stage approach for continually improving the different processes, products or services and resolving problems. The technique involves a systematic procedure of testing possible solutions, assessing the results and implementing changes in response to the findings. (Mind Tools, 2017) (Johannessen, u.d.) (Bicheno & Holweg, 2016).

The four stages of PDCA is Plan, where you define the problem and create a plan of how to solve the problem. Do, when you are executing the plan. Check, analyzing the result of the plan and execution, Act, if the problem was solved then this is the new standard for solving this problem. If the problem was not solved, then repeat the PDCA cycle until you receive a positive result. (Johannessen, u.d.) (Mind Tools, 2017) (Bicheno & Holweg, 2016).

### 5S

The 5S system is a Lean tool created to improve the workplace efficiency. It is called "5S" because the method is based on five simple, but effective, steps from the five Japanese words: *Seiri* meaning sort, *Seiton* meaning set in order, *Seiso* meaning shine, *Seiketsu* meaning standardize and *Shitsuke* meaning sustain. (The Quest Worlwide Toolbox Series, 1999)

The first three S'es in the 5S system, is about what is happening around us. This means that when implementing the 5S strategy one is supposed to start with sorting the items around the workplace and removing the unnecessary items from the area. Secondly, one is to set the objects in order and organize them, making the items easy to locate. The third S is about shining or cleanliness, meaning that one is to make sure that the workplace is simple and neat. (Wig, 2014) (Mcfadden, u.d.)

The last two S'es are about human behavior. This mean that 5S is not only about fixing the structure around the workplace, but it is also about changing habits. Consequently, the fourth S is about standardizing the actions and incorporating them into the operating procedures, while the fifth S is about discipline, meaning to track the progress and check on the other four S'es in a continues cycle. (Wig, 2014) (Mcfadden, u.d.)

The 5S system has been recommended, by many experts, as the starting point of Lean transformation because of its simple implementation process (Yu, et al., 2013). The benefits given by the 5S system is about how it affects the company's everyday procedures and force attention towards mistakes, messiness, and dysfunctional cooperation. Thus, by putting attention on these everyday procedures, the company hope to increase the communication, teamwork, employee's wellbeing, and create order in the workplace (Wig, 2014).

### Last Planner - Planning

Lean is, as previously defined, about increasing the efficiency by reducing waste. The Last Planner system is used to reduce the amount of time wasted with poor planning and in order to get the work and production schedule under control. "The Last Planner production control system is a philosophy, rules and procedures, and a set of tools that facilitate the implementation of the production unit control and workflow control" (Ballard G., 2000). Furthermore is the Last Planner system a short term commitment among the individuals or groups, where the purpose is to plan ahead in order to increase the participation, commitment, planning and learning outcome (Ballard & Howell, Lean Project Management, 2003).

The term Last Planner started as a research on how to improve the quality of the assignments in the weekly work plan amongst the people who are creating the final and most detailed plan, in other word, the last planners (Ballard G., 2000). The Last Planner system has evolved beyond this and does now include other aspects as well, but at its core the Last Planner system is about how to schedule the work structure of the projects specific goals (Ballard & Howell, Lean Project Management, 2003).

Scheduling can have many different meanings, but in essence, the last planner system is it made of five different stages. The first stage is about creating the overall plan, and it is called the Master Schedule. The Master Schedule should "be at milestone level, specifying the timing of the various phases through which the project will move" (Ballard & Howell, An update on Last Planner, 1994 - upd. 2003). The second stage is called Phase Scheduling, and it is "proposed as a technique for developing a plan for completing work within a phase of a master schedule." (Ballard & Howell, An update on Last Planner, 1994 - upd. 2003). "The plans are produced using a team approach, backward pass and public allocation of schedule contingency to absorb or buffer remaining variability" (Ballard & Howell, An update on Last Planner, 1994 - upd. 2003). The third stage is the Lookahead Planning and is about shaping the workflow and sequence rate of the activities, matching workflow with the capacities, maintaining backlog of ready work, and to develop a more detailed plan of how to execute the work. (Ballard & Howell, Lean Project Management, 2003) The fourth stage is Weekly Work Planning and is about "planning to control workflow and to make assignments ready by proactively acquiring the materials and design information needed, and by expediting and monitoring the completion of prerequisite work" (Ballard G., 2000). The fifth and final stage is called Learning, and is about retracing the execution of the previous stages and evaluating and analyzing the activities in relation to root causes of errors or positive results, and actions taken to prevent repetition (Ballard & Howell, Lean Project Management, 2003).

Constructing the schedules in the Last Planner system requires a strong understanding of the project and the possible problems that might occur during the execution. Ballard (2003) does therefore recommend the use of Team planning and the Pull technique in order to develop each phase of the work.

Team planning is about involving the people with the right and most suitable knowledge about the project in the correct phases. Thus, "Team planning involves representatives of all organizations that do work within the phase" (Ballard & Howell, Lean Project Management, 2003). By involving people with the necessary knowledge of how to execute each individual

project phase, one hope to eliminate wasteful activities and reduce uncertainties. The goal of Team planning is therefore to make use of the individual knowledge of each person in the project in order to create the best schedule possible. One of the techniques used in order to fulfill this goal is to utilize a procedure called interactive blackboard meetings, which is a technique where the necessary project participants come together in order to generate a concrete plan together based on the Team planning principles (Statsbygg, 2018).

Pull planning is about finalizing and creating the most efficient and productive project plans as possible. This is done by introducing the concept of backwards planning, which is about re-organizing the plans created in the Phase Scheduling phase backwards and with the use of Team planning. "A Pull technique is based on working a target completion date backwards, which causes tasks to be defined and sequenced so that their completion releases work" (Ballard & Howell, Lean Project Management, 2003). The high benefits from using the Pull planning technique come from the idea of working backwards from target completion time in order to eliminate unnecessary activities and wasteful time usage that adds no value to the final product (Ballard & Howell, Lean Project Management, 2003).

The Last Planner system can thus be summarized as a concept of what the construction organization Should do, Can do, Will do and Did during the planning of the project. Firstly, the organization Should create a master schedule based on what should be done in order for the project to be completed on time. Secondly, the organization creates lookahead plans and a phase schedules based on what Can be done, identified from the pull planning and the team planning exercise. Thirdly, the weekly or daily plan is created based on what Will be done, and finally the organization should evaluate what they Did and learn from their experience (Ballard G., 2000) (Ballard G., 2019)

### 3.5.3 Six Sigma

In the same way as Lean had its origin in Toyota, the term Six Sigma was coined by Motorola Corporation in the early 1990s (Kerzner H. R., 2017), as a quality control and quality improvement initiative. In statistical terms, Six Sigma literally means <3,4 defects per million products of a given process or product (Moore, 2007), but it is today known as a strategy that "Involves the use of statistical tools within a structured methodology for gaining the knowledge needed to create products and services better, faster, and less expensively than the competition" (Kerzner H. R., 2017).

The aim of Six Sigma is to improve the process performance and achieve high levels of quality by investigating and eliminating the root cause of defects and minimize the processes and product variability (Cherrafi, et al., 2016). However, implementing Six Sigma might not be as effortless as one might hope, and many of the barriers that complicates the implementation of Lean, also obscure the implementation of Six Sigma. For example, are top management commitment, education and training, communication, skills, expertise, and culture, all important success factors for Six Sigma. The most notable difference, however, is the criticality of employee involvement, considering that it is crucial in the application of Lean, while it is not necessary in the implementation of Six Sigma (Alhuraish, et al., 2017). This is because Six Sigma does not require the involvement of the entire organization to be successful, but just a handful of trained individuals.

In order to successfully apply Six Sigma, one can utilize several tools and strategies that can be used to ease the implementation process. For example, is the previously mentioned productivity tool of Root Cause Analysis also important procedures in Six Sigma. There is, however, a few strategies that is especially important to mention when describing Six Sigma, and that is the DMAIC procedure, Total Quality Management and Statistical Analysis.

Six Sigma can therefore be summarized as an organized methodology for reducing the variability of processes by using improvement strategies, structured methods and performance metrics, with the aim of achieving a strategic objective of greater quality consistency and better performance (Cherrafi, et al., 2016) (Moore, 2007).

**Total Quality Management**

Before accurately defining Total Quality Management, it would first be appropriate to properly explain what quality is. According to the ISO 9000, quality is defined as “the totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs” Another definition given by Kodak, is that quality is those products and services that are perceived to meet or exceed the needs and expectations of the customer at a cost that represent out-standing value (Kerzner H. R., 2017). It can therefore be understood that the term quality has a broad meaning, but in general it is about meeting the legal and functional requirements in order to fulfill the costumer’s satisfaction.

Total Quality Management hereafter called TQM can be defined as “less variability in the quality of the products and less waste” (Kerzner H. R., 2017) and is a “way of thinking about goals, organizations, processes, and people to ensure that the right things are done right the first

time" (Pheng & Teo, 2004). TQM is furthermore a strategy that involves every organization in the industry in an attempt to improve the performance, where it permeates every part of a company and makes quality a strategic objective. TQM is therefore achieved through an integrated effort to increase customer satisfaction by continuously improving performance among the personnel at all levels in an organization (Arditi & Gunaydi, 1997).

In order to implement TQM successively, the strategy focuses on the process of improvement, customer, supplier involvement, teamwork, training, and education in a struggle to achieve customer satisfaction, cost effectiveness and defect-free work (Arditi & Gunaydi, 1997). TQM can thereby be understood as a productivity strategy with a long-range outlook into the company's future where thorough managements skills and necessary involvement form the top management is critical for TQM to succeed.

In many ways' TQM can be compared to Leans' TPM which is another strategy that has many of the same characteristics as TQM. There is however, a very clear difference between them. TQM is about how to manage the quality with the customer in focus, while TPM is about increasing the productivity through improving the employee's contribution and maintenance work on the equipment's used to produce the product (Venkatesh, 2005).

### 3.5.4 Lean Six Sigma

Now that Lean and Six Sigma have been presented as two individual strategies, it might be fitting to introduce Lean Six Sigma which is a combined productivity method that are built on the strengths of these two individual strategies.

Lean Six Sigma is defined as a "business strategy and methodology that increases process performance, and develops customer satisfaction, leadership, and bottom-line results by improving quality, speed and costs" (Snee, 2010). And "It achieves this by applying the tools and techniques from both Lean and Six Sigma" (Cherrafi, et al., 2016).

There are several benefits with implementing Lean Six Sigma as a combined strategy, instead of implementing them separately. Some of these advantages include the economic performance, social performance, environmental performance, and sustainability (Alhuraish, et al., 2017). Another benefit is that it is become "widely recognized that Lean Six Sigma is an effective leadership development tool" (Snee, 2010). "This is because Leaders enable an organization to move from one paradigm to another and Lean Six Sigma provides the concepts, methods and tools for changing processes. Lean Six Sigma is thus an effective leadership development tool in that it prepares leaders for their role, leading change" (Snee, 2010).

There are however some barriers that needs to be overcome in order for Lean Six Sigma to be successfully implemented. Including the challenges described in each of the individual strategy of Six Sigma and Lean, other challenges might be connected to organizational issues. For example, the organizational size and financial standing can be a hindrance of the implementation of Lean Six Sigma, because of lack of resources (Alhuraish, et al., 2017). This is why it important to consider and analyze the whole organization and make sure that the employees and the top management are giving their full support to the introduction of Lean Six Sigma as a productivity strategy.

### 3.5.5 Building Information Modeling (BIM)

A Building Information Model (BIM) is an accurate virtual model of a building or construction that can be used for planning, design, construction, and operation of the facility. The BIM helps architects, engineers and contractors to visualize what is to be built, and to identify possible design, construction, or operational issues, before the execution of the construction starts (Azhar S. , 2011). "The AEC industry have been on the outlook for techniques and tools that can decrease project cost, increase productivity and quality, and reduce project delivery time. The Building Information Model offers the potential to achieve these objectives and might just be the needed tool and technique that the AEC industry have been looking for" (Azhar, et al., 2008).

Considering the definition of BIM provided, it is not uncommon that one is to confuse BIM with Computer Aided Design or CAD. The principle difference between a BIM and CAD, is that CAD only include graphical entities such as lines, arcs and circles, creating a 3D drawing of the model, while a BIM includes the CAD model and information regarding the physical and functional characteristics and project life cycle (Azhar, et al., 2008) (CADLearning, 2016). An object in a Building Information Model will therefore not only contain the physical aspects, i.e. dimensions and where the object belongs in the construction, a BIM can also contain data about the supplier, and operation and maintenance procedures. Thus, the word


Figure 6 BIM Elements in a Project Cycle (LetsBuild, 2017)

"information" in BIM is what differs the two expressions CAD and BIM (Azhar, et al., 2008). An illustration of the application areas of BIM are presented in figure 6. Furthermore, BIM can involve and be used for the development of cost estimates and project schedules (Azhar, et al., 2008). The number (n) of dimensions in a BIM model, (n-D BIM), depends on how much information the model includes. A BIM model consisting of the aspects of time and economy will for instance be a 5D model.

Another aspect of BIM is that the sophisticated level sets the prerequisite for how many areas the BIM can be used as tool in. The sophistication level of a BIM can be described using the Level of Development (LOD). "The Level of Development is a references tool intended to improve the quality of communication among users of Building Information Models about the characteristics of elements in the models" (BIM Forum, 2019). The LOD is divided into five different levels as presented in table 8.

Table 8 LOD Levels (BIM Forum, 2019).

| LOD Level | Description |
|---|---|
| **100** | LOD elements in this level are not geometric representations, meaning that the element is only presenting its existence, but not its shape, size, or precise location. |
| **200** | Elements in a LOD 200 can be recognizable as the components they are representing, any information derived from such element must however only be considered as approximate. |
| **300** | In this level any element's quantity, size, shape, location and orientation can be measured with accuracy directly from the model. |
| **350** | Elements in this LOD level are graphically represented within the model as a specific system or object in terms of quantity, size, shape, location and orientation. Measurements can be done with accuracy, directly form the model. Additionally, non-graphic information can be attached to the specific model. |
| **400** | An element in LOD 400 is graphically represented with shape, location, quantity and orientation. Such elements might also have non-graphical information attached to it. An element at this level have sufficient detailed information in order to fabricate, assemble or install the element. |

**The Benefits of Using BIM**

Using BIM provides several benefits. Azhar (2008) claims that BIM provides faster and more effective processes because information is easily shared. The use of BIM also facilitates for better design solutions because building proposals can be analyzed and simulated, enabling improved and innovative solutions. Furthermore, BIM provides more information about the products lifecycle data, meaning that requirements, design, construction, and operational information can be used in the maintenance and operations of the facility.

Center for Integrated Facilities Engineering (CIFE) at Stanford University conducted a research of 32 major projects using BIM. The findings of this research were that 40% of unbudgeted changes were eliminated, and the cost estimation had an accuracy within 3%. Additionally, the cost estimates were conducted much faster (80% reduction in time). The major projects also reported of savings of up to 10%, because errors and clashes were detected before execution. Finally, the average combined project time reduction of all the projects was 7% (Azhar, et al., 2008).

**Barriers**

There is little doubt that BIM provides massive benefits for the AEC-industry. However, there exist barriers to the implementation of BIM. A survey conducted in 2014 points on lack of software compatibility as a main challenge in the use of BIM. Incompatible models create a great impediment for sharing information and working collaborative. Another barrier to the full integrated use of BIM is that there is a lack of an electronic standard for coding BIM software, meaning that different models developed in different software cannot communicate, making it difficult to use integrated models (Stanley & Thurnell, 2014).

### 3.5.6 Virtual Design and Construction (VDC)

"Virtual Design and Construction (VDC) is the use of integrated multi-disciplinary performance models of design-construction projects to support explicit and public business objectives" (Kunz & Fisher, 2012). A central element of VDC is the Lean methodology of reducing waste. VDC can therefore be considered as a tool and technique in order to implement the Lean approach and way of thinking to the design of construction projects (Khanzode, et al., 2006). The construction industry experiences a massive increase in the use of virtual design tools, such as BIM. Since more and more disciplines in the AEC-industry is using virtual tools, the need for coordination and integration between them has also increased. The principle of VDC is to use a virtual building model, integrated, multi-disciplinary, and a performance model. In order to accomplish this, the VDC model utilizes and add together several tools and

strategies, such as Building Information Model (BIM), Product, Organization and Process (POP), and Integrated Concurrent Engineering (ECI) (Kunz & Fisher, 2012).

The Building Information Model (BIM) focuses on the building elements of the VDC model. Although BIM is a great tool for designing the product, the use of BIM is seen as insufficient regarding the management issues involving the building, organization, and process interactions. "Even the use of "BIM best practice" does not model, visualize or analyze the organization and process accurately and effectively. Furthermore, methods to manage and communicate multidisciplinary information and processes are absent" (Kunz & Fisher, 2012). The use of VDC, including POP and ECI will therefore handle these barriers better than the BIM alone.

A VDC model sets out to create models of the aspects of a project that a manager can control. These aspects involve the *product* that is to be built, the design of the *organization* that does the design and construction of the project, and the design-construction *process* that the organization follows (Kunz & Fisher, 2012). The POP model specifies information that is shared among individual product-, organization, and process models. The purpose of a POP model is to share and provide conceptual elements so that project participants can assure that the product, process, and process specifications are appropriate for the specific project.

As mentioned earlier, VDC facilitates for a more integrated and multidisciplinary way of conducting the project work in the design phase. Integrated Concurrent Engineering is therefore an important element that support VDC (Kunz & Fisher, 2012). Integrated Concurrent Engineering (ICE) brings several benefits regarding increased constructability because of a greater possibility to make the "right" decision (Love, Guansekaran, & Li, 1998). The most substantial benefit with ICE seen from the VDC perspective, is that it reduces the impediments different stakeholder perspectives can cause, meaning that the project participants to a larger degree will share their vocabulary, methods, cultures and experience when working together through the use of VDC (Kunz & Fisher, 2012).

**The VDC benefits**

It is widely acknowledged that the use of VDC provides vast benefits, such as enabling more efficient multidisciplinary coordination and adding more value to the projects, in the AEC-industry (Kam, Senaratna, & McKinney, 2013). In order to explore the performance benefits of VDC, Center for Integrated Facility Engineering (CIFE), at the University of Stanford conducted an analysis of 108 applications of VDC in construction projects (Kam, Senaratna, McKinney, Xiao, & Son, 2013). The increased values that the projects reported because of VDC were according to Kam (2013):

- Cost saving.
- Shortening in construction duration.
- More efficient and sustainable design.
- Better collaboration experience
- Better detection of errors, making it possible to fix them before project execution.
- Improved project delivery.
- Increased owner satisfaction as the owners are more integrated in the design phase.

## 3.6 Project Delivery Method

This sub-chapter will present the most common procurement- and contract structures that are used in the Norwegian construction industry, what the properties of the different methods are, and finally how they affect the project. This sub-chapter is included because of the large influence the project delivery method has on the project management.

A project delivery method will in this paper include both procurement methods and contract structures. The project delivery method defines the roles and responsibilities of involved parties in the project, and sets a prerequisite for the design, procurement, and construction of the project. The selection of a project delivery method will therefore have a great impact on how the project is designed, procured, and executed, and who the responsible for the different project delivery element are. The distribution of risk between the client and the contractor is strongly connected to which project delivery method the project is following (Kerzner H. R., 2013). Figure 7 illustrates the most important elements of project delivery methods.

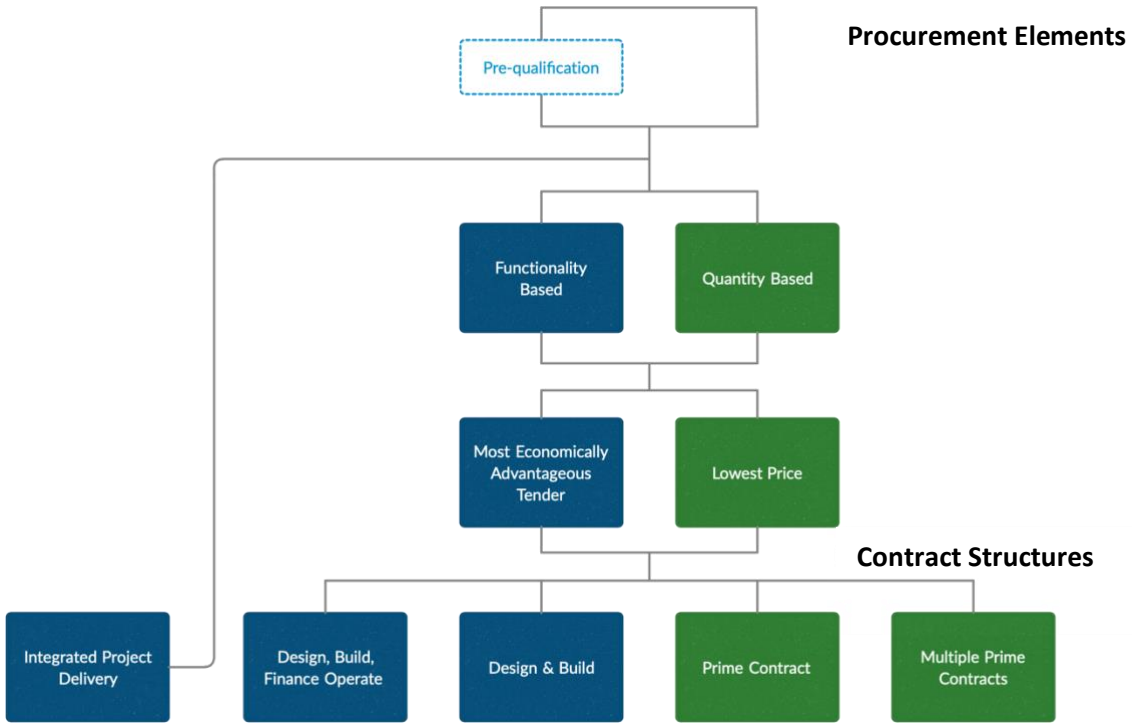



Figure 7 Simplified Illustration of Elements in a Project Delivery Method

### 3.6.1 Procurement Methods

All public procurements in Norway that are above 100 000 NOK must be done through a tender competition and follow the regulation on public procurements (Lovdata, 2016). The traditional procurement method in Norwegian road projects has been a procurement method that use quantity of work and the lowest price when deciding a winner of the tender competition (Lædre, 2006). However, this traditional way of doing the procurement is changing. Today, procurement methods that use functionality-based specification of work and the most economically advantageous tender as a basis, are more common than before (NPRA, 2019). The procurement methods of ECI, CD, and BVP, presented below, cannot be seen as traditional methods, but still highly relevant because of the extensive use of these approaches.

**Early Contractor Involvement (ECI)**

Early Contractor Involvement is a strategy used to integrate the contractor early in the planning phase of a construction project (Song, et al., 2009). The rationale of ECI is that the contractors, by being involved in the planning phase, can use their construction experience to give the designers input, leading to solutions that improves the product´s quality with decreased resources. Contractors usually have substantially more construction expertise than designers and owners because of their knowledge in construction materials, working methods and local practice (Song, et al., 2009). ECI is furthermore seen as beneficial in projects that are: complex, have a significantly degree of uncertainty, when the client has little in-house competence, when a project can benefit from innovative solutions, and when the client is unaware of what is really needed in order to complete the project (Wondimu, 2018).

Wondimu (2018) describes several challenges regarding ECI, the first being that there is a comprehensive cultural change compared to traditional procurement approaches. Another challenge with ECI is that it requires good teamwork. Lack of teamwork will prevent good solutions to develop, and it will also cause misunderstandings in the project concept and its benefits. Finally, ECI requires a large amount of resources early in the project, the ECI approach must therefore be supported by the base organization in order to succeed.

The ECI can be approached in several different ways. ECI can for example be used as a strategy in the project definition and design phase, called an “ECI pre-delivery only”. It can also be used in the project execution phase including detailed engineering, construction, and completion. This is seen as a “Contractor delivery only” ECI approach. Finally, ECI can be implemented in both the two phases as an “ECI Pre-delivery and delivery” (Wondimu, 2018).

**Competitive Dialogue (CD)**

Construction projects have in the past 10 years experienced an increase in complexity and size and this has caused that the need for negotiated based procurement method also has increased (Wondimu, 2018). Competitive Dialogue was therefore developed by the European Parliament in 2004 to fill the void that existed in procurement methods for complex projects (Hoezen, et al., 2010).

Competitive Dialogue is an ECI approach used as a procurement procedure in projects with the intention to enable several pre-qualified contractors to a dialogue in order for all aspects of a contract can be discussed. This early dialogue facilitates for the pre-qualified contractors to present a solution on how to achieve the best project delivery. The CD approach can also be seen as a shift from the traditional procurement method where the input is evaluated, to be focused on the contractor's solution of the project delivery (Hoezen, et al. 2010).

The CD approach is, by Wondimu (2018), divided into four phases where the first phase is the preparation phase. The client in this phase prepares a tender document, develop a plan for dialogue, and does an assessment of the supplier marked.

The second phase is the called pre-qualification phase. In this phase the client announces the project and invite contractors to participate. Contractors then develop and submit a pre-qualification document that the client´s use to evaluate and qualify contractors to a shortlist, which are invited to the next phase.

The third phase is the dialogue phase, where contractors, based on the clients tender document draft, develop sketch proposals. The client then conducts individual dialogue meetings with each contractor and give them feedback on their proposed solution.

The fourth phase in the CD approach is called evaluation and selection phase. Based on the contractor's proposals, the client will develop a final tender document and invite the pre-qualified contractors to a tender competition. The winner of this tender competition is finally awarded the project.

The benefits with CD according to Wondimu (2018), is that the client gain better project control than in a simple design & build or design-bid-build contract. Additionally, a CD facilitates for better trust and communication between the contractor and client, leading to better collaboration of the involved parties in the project.

**Best Value Procurement (BVP)**

Best Value Procurement is an ECI approach used as a quality-based selection method in the procurement process (Wondimu, 2018). Moreover, "Best Value Procurement is a procurement method where prices and other key factors are considered in the evaluation and selection process to minimize impacts and enhance the long-term performance and value of construction" (Scott, et al., 2006).

The BVP approach include three different phases, where phase zero is an optional phase called Pre-qualification. In this phase the client develops pre-qualification criteria that the contractors have to meet, in order to be able to make a project proposal. Such pre-qualification criteria might differ depending on the project and who the client is, but normally includes financial, legal, and company standards elements (Wondimu, 2018).

Phase one, called the selection phase, involves a selection of which contractor that are qualified for the next phase. In the selection phase there are several selection criteria with different weighting. These selection criteria are the level of expertise (35%), risk assessment (5%), value added (5%), interview (20%), and price (35%). In comparison to the CD, a BVP method does not intend to make several contractors give specific and detailed proposals to how to execute the project. The basis for selecting the contractor is therefore done on a simple and non-technical proposal (Wondimu, 2018).

The final phase of the BVP approach is called the clarification phase. This face includes that the chosen contractor gives specific technical solutions on how to execute the project. There is additionally no room for negotiating the project scope, only clarification of how the contractor will execute the project, based on the client´s project specifications given in phase one (Wondimu, 2018).

The benefits with the BVP approach in comparison to traditional procurement methods are, according to Wondimu (2018), that this method provides innovative solutions from the contractor, the project risks are identified earlier, and that contractor and client get a good relation early in the project phase which facilitates for better collaboration in the execution phase. The BVP additionally increases the possibility for a better end product, because the contractor has more influence on the methods chosen to execute the project. Finally, the BVP approach demands less resources for the client in the procurement phase, as they only review simple project proposals from the contractors (Wondimu, 2018).

### 3.6.2 Contract Structures

A Contract structure is in this paper defined as a method that set guidelines for how the responsibility at the different stages in a construction project is organized in the construction project (Gullhaug & Sangolt, 2016). There are mainly two different traditional contract structures when considering the Norwegian construction industry. The first is called an execution contract, while the second contract form is called design & build (Gullhaug & Sangolt, 2016). In execution contracts, often referred as design-bid-build contracts, the client is responsible for all or a significant part of the engineering. The client organization can execute the engineering internal or hire external consultants that will be responsible for the engineering. In a design & build contract, however, is the responsibility for engineering fully given to the contractor responsible for executing the project (Gullhaug & Sangolt, 2016).

The following sub-sections will present the most common contract structures used in the Norwegian construction industry. Both the presented prime contract and multiple prime contracts are variations of an execution contract/DBB contract, while the design, build, finance, operate contract form is a continuation on the design and build delivery method. Finally, the last sub-section will present an untraditional project delivery method called integrated project delivery method, which does not follow the traditional contract form of execution contract or design & build.

**Prime Contract**

A prime contract involves that the project owner appoints one contractor to be responsible for the execution of the project work. However, the client leaves the responsibility for designing the project to its own organization. The client is also responsible for coordinating the designers and contractors. This contract structure is one of the most commonly used, and often referred to as the traditional contract structure. (Lædre, et al., 2006).

**Multiple Prime Contracts**

In a project with multiple prime contractors, the client assigns several contractors to execute the project work. Similar to a prime contract, the project owner is responsible for the coordination between designers and contractors (Lædre, et al., 2006). Leaving the coordination responsibility to the project owner, as in both prime contract and multiple prime contracts, also means that the client keeps the associated risks. Such contract forms are therefore usually used in projects where “business as usually” will be insufficient, meaning that the project requires innovative design and execution methods in order to succeed. It is also important to notice that

both the use of prime contract and multiple prime contracts does not expedite for involvement of contractors in the early stages of a project.

**Design & Build (DB)**

In a Design & Build contract, the client appoints one single contractor to be responsible for the design, execution, and coordination of the project work. When using a Design & Build contract, the contractor gets involved at an earlier phase of a project than in a traditionally contract form. The benefits of earlier involvement of contractors is that the contractors can utilize their expertise and knowledge, regarding choice of materials and methods to execute the project work in the design phase of a project. This also improves the constructability of the project in an earlier phase, than what traditional contract structures will (Lædre, et al., 2006). The fact that the contractor is responsible for the planning, execution and coordination of the project also leads to the contractor being responsible for the quality, schedule, and budget, leaving the risks associated to this to the contractor. The contractor will therefore take this increased risk to account when developing a tender (Lædre, et al., 2006). The same benefits and increased risks will also occur in a DBFO contract structure described below.

**Design, Build, Finance and Operate (DBFO)**

The DBFO contract shares many similarities to the design & build delivery model. In a DBFO there is a singular contractor, responsible for the design, execution, and coordination of the project. In addition, the owner leaves the responsibility regarding financing and operations of the facility to the contractor (Lædre, et al., 2006). A DBFO is in this paper considered to be the equivalent as the Norwegian project delivery model called “Offentlig Privat Samarbeid” (OPS). The DBFO contract shares many similarities to the contract types such as: Public- Private- Partnership (PPP), Private- Finance- Initiative (PFI), and Build- Own- Operate- Transfer (Lædre, et al. 2006). What is similar to them all, is that the client leaves the responsibility of engineering, execution, operation and maintenance, and financing to a private company. In a DBFO will the project owner order a functionality-based project with defined standards and quality. It is then up to the contractors, to solve the project owner´s need and answer the order with a project proposal that includes pricing for the project (Anskaffelser, 2019).

**Integrated Project Delivery (IPD)**

"Integrated Project Delivery is a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction" (The American Institute of Architects, 2007). By definition, an IPD shares several similarities to the competitive dialogue, where the room for negotiation between the project participants is large in the early planning and design phase. However, an IPD-approach also open up for negotiation between the contractor and the client in the execution phase of a construction project, meaning that changes and adaptions as the project physically develops, is easier than in a traditional project structure.

In order for an IPD to work as intended, there are some principles that must be followed. The first principle is trust, meaning that all involved parties must understand that the collaborative way of working will benefit the whole project. Another principle is that early involvement of key participants must be practiced so that the participants, as a team, can come up with the best solution. The final principle is that the IPD approach must recognize that increased effort in the planning phase will result in greater efficiency and time saving during project execution. The IPD is therefore not something that shall reduce the design effort, but instead increase it, and thereby improving the design result and reducing the expensive construction efforts. (The American Institute of Architects, 2007).

# 4. Norwegian Public Road Administration and Nye Veier

In order to create a reference point for comparison of recognized literature and the practice used in the Norwegian construction industry, the authors found it beneficial to include large public construction clients to the study. This chapter will present the two Norwegian road clients Norwegian Public Road Administration and Nye Veier. Additionally, will two internal documents from the NPRA be introduced, before the case study E6 Soknedal is presented.

## 4.1 The Norwegian Public Road Administration (NPRA)

The NPRA is the largest public client that manage roads in Norway. They are responsible for the planning, building, and operations and maintenance for a vast majority of the roads in Norway (Statens vegvesen, 2019).

The NPRA defines the project manager as a person being responsible for achieving the project objectives within the frame conditions of the project. This involves that the project manager creates results through relations to others, continuous measures completed work against planned work, and implement measures in order to secure achievement of project objectives. Additionally, the project manager must develop a project management document that ensure that the project quality plan regarding safety and environment is met. Finally, the project manager is responsible for staffing the right project organization with the necessary interdisciplinary and expertise (Vegdirektoratet, 2018).

### 4.1.1 Handbook R760 - Control in Road Projects

The handbook R760 - control in road projects gives specific requirements for all employees in the NPRA that manage road projects. The manual gives instruction for how all projects shall be identified, planned, executed, and terminated for every phase in a road project. These phases are described as the planning-, construction, and maintenance and operations phase. The handbook divides these three phases into individual projects. The individual projects are then divided into four stages, where stage 1 is the Project Identification, stage 2 is the Project Planning, stage 3 is the Project Execution, and stage 4 is the Project Termination (Vegdirektoratet, 2018).

The handbook describes what responsibility the different roles has. These roles include the project owner, project manager, engineering manager, construction manager and other

professional resources, like control engineers. The summary of the project manager´s tasks described in the handbook R760 is brief and is only intended to give a short description of the project manager´s tasks in the different project stages. The reader is advised to look up appendix 11 for a more comprehensive summary of the project manager tasks in the NPRA´s handbook R760.

### 4.1.2 Project Manager Competence Requirements in the NPRA

Project manager competence requirements is a document that defines the competence requirements for the project manager role in the NPRA, it also forms the basis of a unified understanding of the PM-role within the NPRA organization. Furthermore, the document provides the basis for a more professional and effective project execution in the administration. The document is an appendix to the NPRA´s handbook R760 – Control in road projects (Vegdirektoratet, 2016).

The competence requirements for a project manager is a description of what skills, knowledge and attitudes that are needed in order to succeed in the PM-role. The mapping of PM competence requirements has three functions (Vegdirektoratet, 2016):

- A tool in order to develop custom training for the PM-role at different levels.
- A basis for employees and managers to evaluate own competence against their area of responsibility.
- To give a clarity of expectations and opportunities for career development.

The European Qualification Framework (EQF) is chosen as a basis for mapping and describing the different competency-levels in the model. EQF is an international standard that describes the competency with eight competence levels. Level 4-6 is chosen by the NPRA as relevant for describing todays PM-needs in the administration, see table 9 (Vegdirektoratet, 2016).

Table 9 European Qualification Framework (Vegdirektoratet, 2016).

| EQF Level | Knowledge | Skills | General Competency |
|---|---|---|---|
| **4 Skillful** | Broad knowledge within the field of study | Uses practical and theoretical methods in order to solve specific issues within the profession. | Work independent in known and predictable situations. Can manage routine work executed by others, and to some degree responsible for evaluation and improvement of this work |
| **5 Experienced** | Specialized knowledge within the field of study. Conscious of own professional limitations. | Uses practical and theoretical methods in addition to creativity to solve abstract issues within the profession. | Manage situations that are unpredictable and changing. Can evaluate and develop own and other´s achievements. |
| **6 Expert** | Advanced knowledge within the field of study. Deep understanding of theories and principles. | Handles advances and innovative methods for problem solving in complex and unpredictable situations within the profession. | Manage complex technical activities or projects. Takes responsibility for the professional development of individuals or groups. |

The document identifies four areas of competencies for project managers: *Project Planning, Project Control, Project Management,* and *understanding of roles.* These four areas are also divided into elements of competence, as shown in figure 8 below.

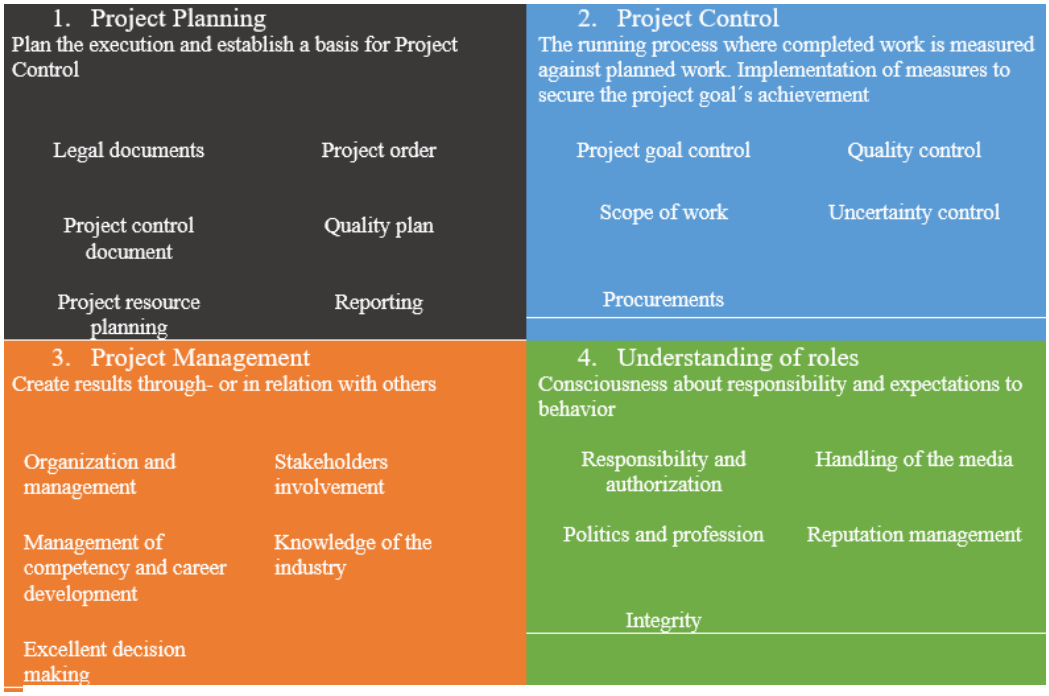



Figure 8 Four Areas of Competency (Vegdirektoratet, 2016)

### 4.1.3 Practical Control of Uncertainty – PUS

The practical control of uncertainty, hereafter called PUS, is an internal uncertainty management tool in the NPRA. The intention of PUS is to create awareness, identify, handle, and manage potential project uncertainties affecting a project. PUS is used with the aim of having a systematically overview and documentation of the project´s uncertainties at all times (Vegdirektoratet, 2018). PUS uses a risk matrix where the possibility for an event occurring and the consequence if the event occurs to map the significant of the specific risk. Thereafter is a focus list, based on the risk's significance, developed that shows the most important risks and measures to manage them. Project risk can harm the project, but it can also indicate project opportunities (Prosjekt Norge, 2008).

| | Consequence | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Risk | | | | Opportunity | | | |
| **Probability** | Disastrous | Critical | Serious | Small | Small | Medium | Large | Very large |
| Very large >50% | | | | | | | | |
| Large 25-50% | | | | | | | | |
| Medium 5-25% | | | | | | | | |
| Small 1-5% | | | | | | | | |
| Almost unthinkable <1% | | | | | | | | |

Figure 9 Illustration of PUS Risk Matrix. **(Prosjekt Norge, 2008)**

### 4.1.4 Project Charter

The project charter founds a basis for all further project work and must be completed before any other project work starts. It is the project owner´s responsibility to develop a project charter, describing and defining the distribution of responsibility, project goals, and frame conditions. These frame conditions include a framework for management, consisting of monetary managemental maneuverability for the project manager. A project charter is normally developed for each phase of a project, i.e. the early planning-, design-, and execution phase (Vegdirektoratet, 2018).

### 4.1.5 Project Management Document - PMD

The project management document, often referred to as "Sentralt styringsdokument" in the Norwegian language and project management terminology, is the project manager´s response to the project owner´s project charter. The PMD shall clarify the project´s goal and the connected goal priority, conditional framework, project delivery method, and control basis. A description of the PMD's content can be found in figure 10. The PMD follows the project from early phase to termination, is continuously updated, describes how the project shall be managed in the different phases, and gives guidance on how to manage the project (Vegdirektoratet, 2018).



Figure 10 Illustration of the Content in NPRA´s PMD

### 4.1.6 Quality Assurance – QA

All state financed projects exceeding a combined cost estimate of 1 billion NOK must be subjected to an external quality assurance before final funding is approved by the Norwegian Parliament (Regjeringen, 2019). The NPRA´s projects with a cost estimate must also go through the external quality assurance (Vegdirektoratet, 2018). The quality assurance is divided into QA1 and QA2, where the purpose of QA1 being "To ensure that the choice of concept has been subjected to a political process of fair and rational choice. The ultimate aim is that the chosen concept is the one with the highest economic returns and the best use of public funds." (Haavaldsen, et al., 2012). Furthermore, is the purpose of QA2 to "ensure the quality of the

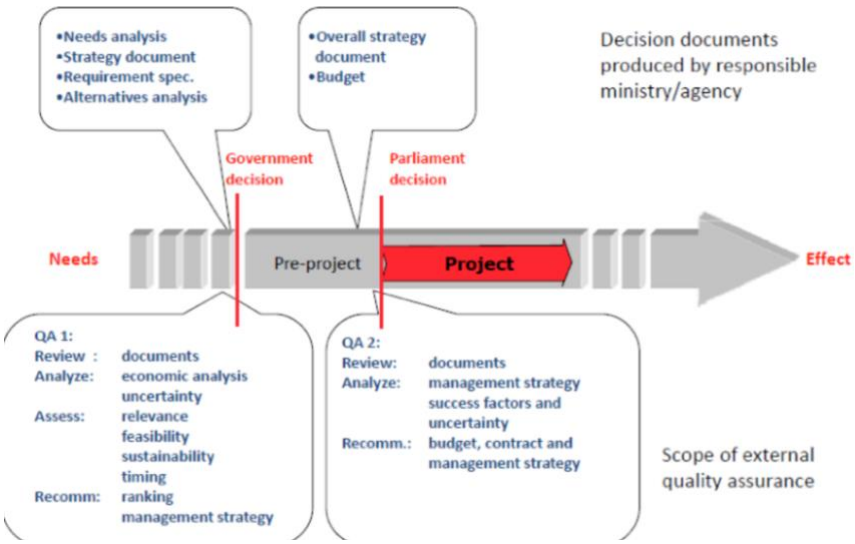



Figure 11 Illustration of the Quality Assurance Regime (Haavaldsen, et al., 2012)

decision basis including cost estimates and uncertainties associated with the chosen project alternative before it is submitted to Parliament for funding. The control aspect is the main feature in this exercise. Also, the evaluation shall focus on challenges related to project management in the implementation phase." (Haavaldsen, et al., 2012). The QA2 applies for NPRA projects on a zoning plan level (Vegdirektoratet, 2018). The quality assurance regime that the project has to go through is presented in figure 11.

## 4.2 Nye Veier (New Roads)

Nye Veier is a newly established corporation listed on the Norwegian stock exchange market. The corporation was established in 2015 and is owned 100% by the Norwegian government (Nye Veier, 2018). Nye Veier was formed by the Norwegian government because of the desire of a more lean, effective, and specialized public road client organization. The idea is that Nye Veier will be able to execute a more comprehensive planning and construction faster, and more cost effective than what has been the case earlier in Norwegian road construction (Nye Veier, 2019). The corporation will plan, build, and operate major highways for 150 billion NOK the next 20 years. This massive funding by the Norwegian government gives the opportunity for building more roads "in one go", which provides lower project costs and faster execution of road projects (Nye Veier, 2019). The mandate that Nye Veier is given by the government includes large monetary sums which the organization can distribute to the portfolio as they see it the most beneficial and profitable, seen from a socio-economic perspective (Nye Veier, n.d.). "The road projects in the portfolio with a high socio-economic profitability is prioritized to be executed before road projects with a low socio-economic profitability. This provides a strong and rationalized reasoning behind the order of which road project that it to be built first". (Nye Veier, n.d.).

Nye Veier is, on the same line as the NPRA, a large public client with the responsibility of managing large road projects. The authors therefore find it useful to include Nye Veier in the study because their practice regarding managing road projects can be used to compare how the NPRA conduct the managing of roads. Additionally, including Nye Veier to the study will give the opportunity to explore the similarities and differences between Nye Veier´s managing practice and well recognized theory on the topic.

Since Nye Veier is a fairly new established organization, the accessible information on how project management is executed is limited. The main source for gathering this information will therefore be through interviews of project managers within the corporation.

## 4.3 The Project - E6 Soknedal

The project used for the purpose as the case study in this thesis is called E6 – Soknedal. The following table 10 presents the project´s properties.

Table 10 Properties of E6 Soknedal (Statens vegvesen, 2019).

| Element | Description/Value |
|---|---|
| Client | The Norwegian Public Road Administration |
| Project Delivery Method | Multiple prime contracts |
| Size | 1600 MNOK (Inc. VAT) |
| Phase | Construction |
| Timeframe | 2017-2020 |
| Two-lane tunnel | 3,6 km |
| Two-/three-lane road | 2,9 km |

The road project comprises of the construction of a new two/three-lane road on a 6,5 km stretch. Moreover, 3,6 km of this distance will consist of a two-lane tunnel, while the remaining 2,9 km will be a two- and three-lane road. The road project also consists of five concrete construction, with one roundabout plan crossing, two E6 bridges, and two local road bridges.

E6 Soknedal was chosen as the project to be used in this thesis' case study because of its size and complexity. The budgeted 1,6 billion NOK is, in a Norwegian road construction scale, considered as a fairly large road project. The project consists of many involved parties and multiple different

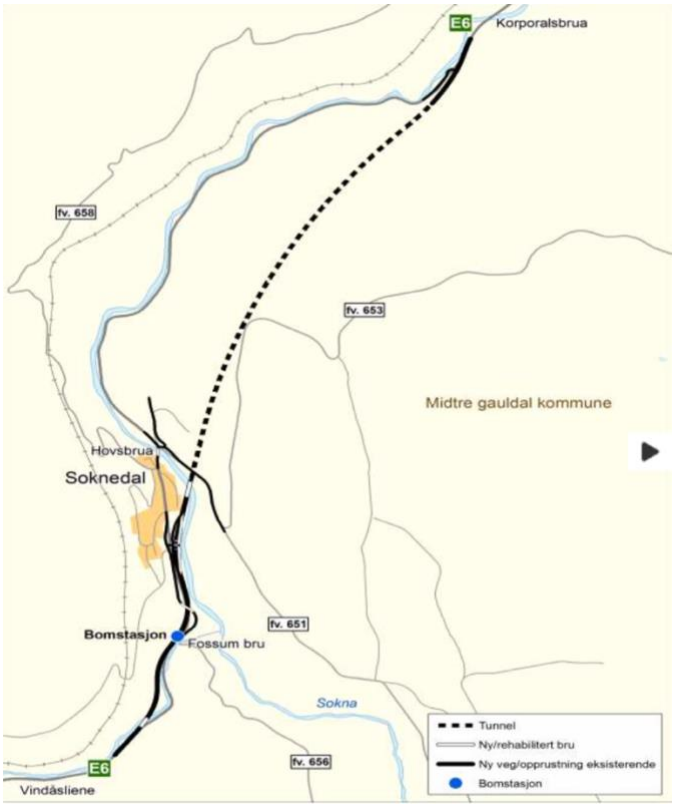



Figure 12 Map of E6 Soknedal Map of E6 Soknedal (Statens vegvesen, 2019)

disciplines including road, bridges, tunnels, and electrical work. This complexity, in addition to that the project is divided into multiple prime contracts, causes a great need for communication, cooperation, coordination, and administration. This requirement for management applies to both between the contractors, but also between the client and the contractors. Because of this high level of complexity and need for management, the project is considered to be well suited as this thesis' case study when exploring how to achieve improved project management.

The project is set to be finished by December 2020 and is currently well within the time schedule. This means that most of the work is already done, and that the project is entering its final stages towards completion. Since much of the work already is finalized, the project is experiencing a decrease in the activity level and downsizing in staff, both in the client´s- and the contractor´s project organization. This will affect the case study in the sense that there will be less workers on site, giving the authors less people to observe and question. It can also affect the employee's morale as the project is coming to an end, influencing the result of the case study.

# 5. Results of the Interviews

This chapter will present the findings from the conducted interviews of employees in the NPRA, Nye Veier and the project manager representing the contractor on the E6 Soknedal project. There was in total conducted 13 interviews, whereas five of the candidates represented Nye Veier, seven the NPRA, and one the contractor on the E6 Soknedal project. Furthermore, did four of the candidates from Nye Veier work as project managers, while the fifth candidate was head of the project support department. From the seven candidates representing the NPRA, two of them acted as project owners, one as the director for the development department, while the other four candidates were staff from the E6 Soknedal project. One of the four candidates from the E6 Soknedal project acted as the assisting project manager, while two were construction managers, and the final one was a control engineer.

This chapter is divided into four different sub-chapters which is divided into smaller topics. The first sub-chapter involves questions related to execution of project management. The second sub-chapter will contain questions regarding project management tools. The third sub-chapter comprises of subjects involving productivity management. The fourth sub-chapter will include the topic of project delivery method. Lastly, the fifth sub-chapter will include the pre-study interviews conducted with Lean consultants.

## 5.1 Project Management

The following sub-chapter includes questions concerning the field of project management and its associated challenges. In addition, this sub-chapter includes opinions provided by the candidates about what they believed would be the best solutions to deal with these existing challenges.

**Opinions About the Most Important Project Management Tasks**

In the specialization project the authors learned that there existed a discrepancy between what the different actors considered the most important aspects about project management. As a result, the authors thought it would be imperative to ask the candidates about their opinions in relation to the project management tasks. The interviewees almost unanimously answered, with 10 of the 13 interview candidates, that the most important project management task was to deliver on the outputs such as HSE, quality, cost, and time of the project. The second and third most important project management task were mentioned five times each, and they were about

the importance of collaboration between the organizations and about focusing on completing the goals of the project, respectively. Furthermore, was risk management, resource management, surveillance, facilitating, including the stakeholders mentioned by the different interview candidates.

**Typical Challenges of Project Management**

When asked what the interview candidates thought were the greatest challenges regarding project management, there were few differences between the organizations. The interview candidates mentioned these elements as the greatest challenges of project management: resources with the right competence, to be in control of disputes linked to the expenses and costs, proper information flow between the employees both internally and externally, collaboration, risk management, dealing with people with a low ability to make decisions, and making sure everybody understands the project goals.

In addition to this, stood three answers out from the rest. One of the interview candidates mentioned that the collaboration between the organizational teams improved tremendously after changing work from NPRA to Nye Veier. “A challenge faced by a project manager is to use the right resources at the right time, by having composite teams of people with the right competence, this challenge can be mitigated. In Nye Veier, the project manager has its own contract advisor, project controller and a communication advisor, which gives the project manager the ability to focus on the project managers tasks. In the NPRA however, I felt very alone on projects, because I had to be the contract advisor, the communication advisor, and the project controller by myself, with little to no support.”

Another interview candidate emphasized the importance of a project manager to feel safe and confident about the responsibilities a project manager has. The candidate continued by explaining that if a project manager feels unsecure it could lead to decision-avoiding which in turn will lead to cost increase and time delays. A third interview candidate explained that the largest challenge a project manager faces is the fact that a public road project uses the society’s mutual resources and money. It is therefore essential that the project manager handles the project outputs with care and respect.

**Improvements to Deal with These Challenges**

The interview candidates were then asked what they thought the different organizations could do in order to improve project management. The answers differed from one another, and there was no correlation between the organizations. There were however a few factors that was

mentioned by several of the different actors. One of them was the organizations ability to become more unified. Both Nye Veier and the NPRA explained that this was a great area of improvement for project management as they experience discrepancies of the execution of projects between the different departments. Many of the interviewees also explained that a reorganization had resonantly been started in both Nye Veier and the NPRA in order to deal with this. “I believe we could be similar and more uniform. We are a large organization with projects all around the country, and for us to be a clear client it is important that the different companies and users recognize who we are and what we do. This I think we can be better on, and one of the ways to achieve this is to create contracts and other documents which requires less room for interpretation, leading to a more uniform organization.” Explained by an interview candidate from the NPRA.

Another factor mentioned was about the relationship between the different people in the project. This was explained as a challenge because a poor relationship within the project team can pose a challenge to a project, and one should therefore consider this an area of consideration. “It is a timely process before an organization starts working optimally, it could therefore be an advantage if one could to a larger degree reuse the organizations when starting new projects.”

A third area of improvement mentioned was about the importance of sharing experiences from the projects internally in the organizations. Other areas of improvement were better collaboration, using the enough resources with the right competence, better communication, better risk management, better at understanding the project goals, and an improved attention on the project outputs.

**Project Staffing and Resources**

It was only six of the interview candidates, with three from the NPRA and three from Nye Veier, who answered on the question about project organizational structure. The reason for this was either that the other candidates did not know the answer, or because the interviewers deemed the question as inapplicable considering the candidates role in the organizations.

Both the NPRA and Nye Veier were in strong agreement that having a broad project team with comprehensive knowledge was vital, but the two organizations had a different approach on how to achieve this. Nye Veier emphasized that they are a “slim organization” which means that they have only the key personal in the project management team from their own organization. The candidates then explained that the rest of the necessary personal would be temporarily hired from external consultants, based on needs in the projects. The NPRA explained on the other

hand that they mostly had all the necessary project management roles employed in the organization, and that it was highly uncommon that they had to temporary employ resources.

In addition to this Nye Veier explained that "Our foundation is based on a slim client organization with few employees. We are therefore putting a larger responsibility on the contractors and consultant than what they are doing in the NPRA. We believe that this will lead to fewer conflicts and better project solutions and less wasted resources." One of the candidates from Nye Veier also explained that using a matrix structure would enable the organization to fully utilize the employees to their full extent by having them work on more projects than one, when it is necessary.

The candidates representing the two client organizations were also asked if they had sufficient resources on the projects, all of the 12 candidates from the client organizations unanimously answered that they had sufficient amount of resources on the larger projects. The candidates elaborated this by explaining that it is not in the projects best interest to have too many resources, but rather optimize the amount of resources available. It is therefore imperative that the resources have the appropriate competence and that they are utilized correctly. Some of the candidates mentioned that a few techniques to optimize the use of resources was to, do a proper risk analysis of the project, create a better project plan, and a better delegation of the work tasks.

The candidates from both Nye Veier and the NPRA explained that one way to optimize the use of resources was to utilize a matrix organization where one is to allocate the resources several tasks within the organization, and not only a single project. In addition to this explained both Nye Veier and the NPRA that this would give the organizations higher flexibility leading to an optimization of resources.

All four of the candidates from the E6 Soknedal project explained that they experienced that the project had enough resources. That being said, one of the candidates did explain that "it would be nice if we had at least two to three resources extra, but all in all we are a sufficient number of employees." The project manager from the contractor second this by explaining that the client had both sufficient and competent personnel.

**The Link Between the Project Charter and the Project Management Document**

In the specialization project an interview candidate explained that a common problem that could arise in a project was a misunderstanding about what the project was supposed to entail. By this the candidate meant that the ones conducting the project did not understand the intention behind the project, described by the project owner. This can lead to differences in the planned and the

produced product. The project group therefore decided to revisit this and asked the interview candidates what they thought about the project charter.

The interview candidates with a project role below the project manager in the organizational hierarchy had little to no knowledge about this document, which was explained by a candidate as reasonable considering that this is a document created by the project owner and the project manager. Thus, that excludes four of the interview candidates from this question.

The interview candidates from the NPRA explained that project charter was an important document as it explains the intended outcome of the project, and that it works as a great support document when creating the PMD. The candidates from the NPRA also explained that while the document is essential and serves an important purpose, the project charter can probably be improved. One of the candidates also explained that "some project owners and project managers might in some instances rush through this document and treat it only as a steppingstone necessary to produce in order to start the project." Thus, not utilizing the project charter to its full potential and thereby confirming what the interview candidate said in the specialization project.

The overall answer given by the candidates from Nye Veier was that they did not use the same term as the NPRA, but since some of the interview candidates had previous experience from the NPRA, they knew what was meant by the term project charter. These candidates continued by explaining that Nye Veier instead use a system called the eight gateways. This system serves the same purpose as the NPRA´s project charter but is according to the candidate a better solution. One of these candidates also clarified that by using this system, Nye Veier had become better at risk management than what the candidate had experienced in the NPRA.

**Experience of the Planning Process**

The candidates had a very similar understanding of how they experienced the planning process in their own organization, but the answers varied quite a lot between the NPRA and Nye Veier.

In the NPRA the overall understanding of the planning process was that it was time consuming and inefficient. Six of the interview candidates mentioned that there are many checkpoints in the NPRA where multiple different actors have to be involved. "Many of the plans that the NPRA works on becomes very old, because the political process of involving the municipality, the government and other political entities causes the project to wait for the plans to be approved. If the different entities are not satisfied, or the project do not pass through the QA2, corrections and changes have to be made. This is because the NPRA require governmental

funding based on the societal assets, obligating the project to be thoroughly evaluated." This long and bureaucratic process often leads to changes in the plans and causes delays. However, many of the candidates also emphasized that this creates a strong democratic process that makes it possible to find the best solution, even if it is inefficient. Some of the candidates also stressed that this process makes it difficult to create good project plans leading to long waiting time, meager resource planning, and poor time management.

One of the candidates from the NPRA mentioned that the changes in plans could sometimes lead to not only long waiting times during the project, but also an incredible push for the works to "win back" the lost time during the project execution. This can sometimes be stressful, and the candidate hoped that better planning could solve this problem. This was supported by other interview candidates who thought a possible solution could be to start some of the planning processes earlier and try and to make some of the processes run simultaneously with one another.

Nevertheless, the experience provided by the interview candidates from the project E6 Soknedal showed that they were generally very satisfied with the planning process. Two out of the four candidates did however mention that the NPRA sometimes had a long and inefficient process, and they explained that the project had been subjected to several changes and time delays during the planning process. The execution of the project has however gone relatively painless according to the candidates.

According to Nye Veier was the planning process quite good. The candidates explained that Nye Veier's mandate facilitates for a higher efficiency than the NPRA, clarifying that this was because Nye Veier is able to undergo other processes to shorten the evaluation gates as much as the Norwegian law allowed. Nye Veier is for example not subjected to the QA2. The candidates furthermore explained that because of the difference in how they gain the governmental funding, Nye Veier could also run several processes at the same time increasing the time efficiency. This has also given Nye Veier the ability to have more predictable plans, increasing the resource and time management.

Considering the answers provided by both the NPRA and Nye Veier, one of the interview candidates were asked if it could be beneficial for the NPRA to become similar to Nye Veier as a follow up question. To this the candidate answered "It could be very tempting to use the same model as Nye Veier as it is a very effective strategy. I am on the other hand quite unsure

if this is an appropriate method for using the public resources as it might reduce the benefits on the smaller communities, and only focus on the benefits on the larger cities."

**Challenges with Collaboration During the Planning Process**

According to the interview candidates there are always some minor challenges happening between the different stakeholders in a project, but it is however very rare that there are any larger problems occurring between them during the planning process. If a challenge arises, the candidates explained that proper communication between the different stakeholders would help to solve the issue. Nevertheless, some issues that can happened is in relation to misunderstandings and human related mismatches.

The Interview candidates from the NPRA and the contractor on the E6 Soknedal project second this and explained that there had been no real challenge between the different stakeholders in the planning or execution process. "We have done a lot of good work in the planning process in this project. We have had external collaboration meetings with many of the different stakeholders which have helped us create a good planning process".

**Challenges with Local Authorities During the Planning Process**

The candidates were asked if there existed challenges with local authorities in the planning process, i.e. the process of developing municipality plans to finish building plans. To this, all of the candidates answered that most of the challenges with the local authorities happened during the development of the municipality plans and zoning plans. The candidates furthermore explained that there existed no major challenges with local authorities after the approval of these plans.

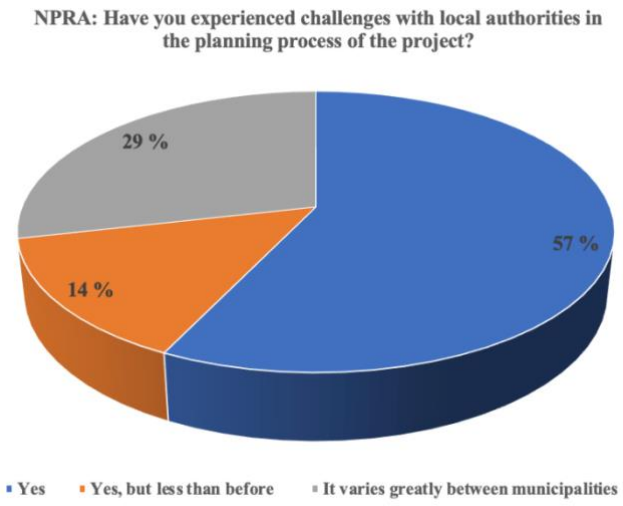



Figure 13 Challenges with Local Authorities - NPRA

The majority of the candidates from the NPRA stated that they had experienced challenges with the municipality when developing zoning plans. The candidates explained that the municipalities want as much benefit out of the project as possible. "There are many municipalities that tries to include extra work and benefit that strictly speaking has nothing to do with the road project in the first place". The

candidates also explained that the municipalities often want more local intersection adjustments, and that this can cause conflicts in the developing of zoning plans. This was supported by the assisting project manager from the Soknedal E6 project, who perceived the municipality as being too demanding in the development of the zoning plan. Another candidate believed that these challenges are dependent on the specific municipality. "I see that smaller municipalities have fewer rigid systems and that they therefore are perceived to have more eager to get decisions through, because the process goes faster." Moreover, 14% of the candidates meant that the issues regarding the municipalities still existed, but less than before. According to the candidates, this was because Nye Veier had contributed with their mandate to change the culture in the municipalities and that it therefore now exist more willingness to accept less local benefit in the municipalities, which the NPRA also took advantage of. Furthermore, the candidates stated that there was a greater willingness to use governmental plans, meaning that the local authorities no longer were the plan authority. This mitigated, according to the candidates, a lot of the challenges regarding local benefit demands from the municipalities. One candidate supported this by stating that "I believe that we are on a much more reasonable level regarding local benefits for the municipalities than before."

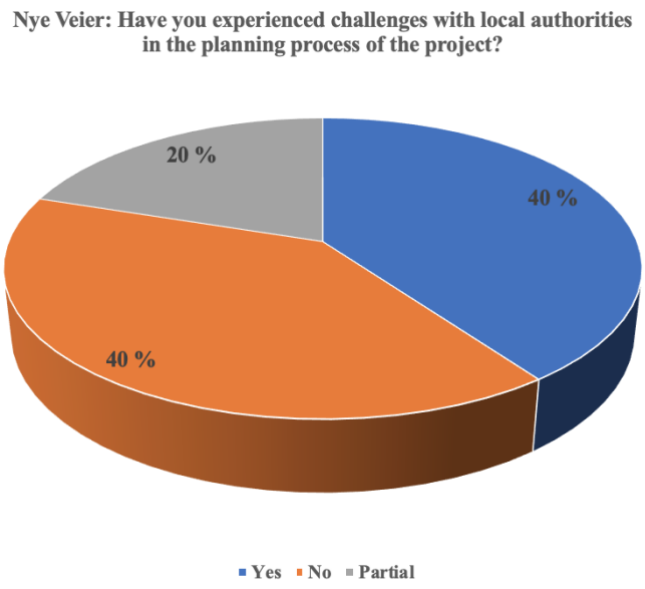



Figure 14 Challenges with Local Authorities – Nye Veier

The candidates from Nye Veier had mixed opinions about the magnitude of the challenges with local authorities in the planning phase. 40% of the candidates believed that the municipalities wanting too much local benefit raised challenges in the planning phase of the project. "The challenge is that the municipalities want more benefit than what Nye Veier believe is right. This is especially an issue when considering the amount of intersections. Everyone wants an intersection down to their little village; however, this is not possible to realize with the mandate that Nye Veier have gotten from the government". Other candidates do not perceive this as a big challenge, but that it is more about explaining and creating understanding to the local authorities about Nye Veier´s plans, and in that way reducing the municipalities' "wishing lists" for local benefit. Some of the candidates

also explained that the municipalities they have been involved with have acted solution oriented. One candidate furthermore explained that Nye Veier experience that the municipalities wants to integrate other projects into the Nye Veier´s projects, but that Nye Veier uses positive incentives in order to solve issues regarding this.

## 5.2 Project Management Tools and Strategy

Based on the project management theory, the project group decided to ask the interview candidates what they thought about the crucial project management aspects of project management strategy, the handbook R760, communication, trust, stakeholders, monitor and control, and risk management. The following sections will therefore cover the candidates' thoughts and opinions on these different project management tools and strategies.

### 5.2.1 Project Management Strategy

The candidates were asked if the organization had a specific strategy of how to perform project management. To this, three of the candidates from the NPRA answered that R760 worked as the organization's overall strategy. and that the PMD worked as a project specific strategy.

One of the candidates from Nye Veier explained that they did not have specific strategy on how they were to perform project management for the organization as a whole, but that they were in the process of creating one. However, the same candidate together with the remaining three individuals from Nye Veier, explained that an PMD was used for specific project management strategies.

**Project Management Strategy Compared to Actual Execution**

Only six of the candidates answered on questions related to the comparison between actual and planned management execution, where three of them were from the NPRA, two from Nye Veier, and one from the contractor. The candidates from the NPRA were generally satisfied with the execution of the project management as it mostly was executed in accordance with the project management strategy.

On the E6 Soknedal project, the contractor was satisfied with the project management of the NPRA and meant that the actual execution was in-line with what was agreed upon. "We had two collaboration meetings in the start of the project, where the entire project organization gathered to go through the project plan. In addition to this was there an overall plan of how the communication and collaboration was supposed to be executed on the project. I felt that this project management strategy was completed as planned, and that the strategy worked well."

One of the candidates from Nye Veier explained that "I am experiencing a close connection between theoretical and actual execution of project management in Nye Veier because we are using the employees with different work competence around on different projects within Nye Veier. This leads to similar execution on the different projects." The same candidate also explained that the NPRA is more open for individual decision making based on the specific project then Nye Veier, and the candidate believed that this would create more differences between the planned and executed project management in the NPRA.

Another candidate second that the actual and planned execution was very similar but highlighted that since Nye Veier was such a new organization, the overall strategies might have changed, creating discrepancies between planned and executed project management.

### 5.2.2 Handbook R760 – Control in Road Projects

The project group found that the handbook R760 – Control in Road Projects was an important part of how the NPRA executes project management. Knowing that this is an internal document in the NPRA, this section, was only included in the interviews with employees of the NPRA, meaning that 7 out of the 13 in the interview selection answered.

**Degree of Handbook R760 Use**

Understanding that the R760 is an important control document on how to execute project management in the NPRA, the project group wanted to identify the usage of the handbook. Four of the candidates answered that they use the handbook actively. One answered sometimes, while the last two answerer that they almost never used R760.

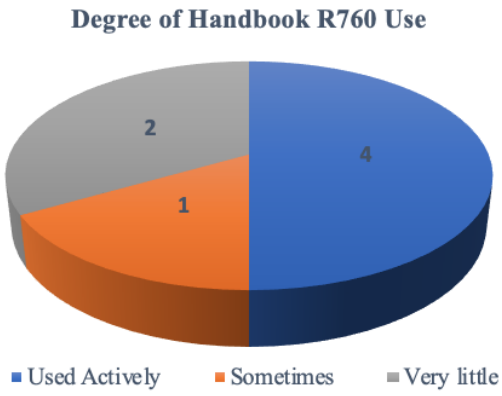



Figure 15 Degree of Handbook R760 Use

**Opinions Concerning the Content of R760**

Four of the seven interview candidates had good knowledge about the content of the handbook. These four all responded that the handbook is a great guideline that describes the roles of a project manager and a project owner well. "The handbook is a great tool for creating a uniform way of executing project management." It is also prominent that these four candidates perceive the handbook as a good tool for determining responsibility in a project, which can be very beneficial for newly employed staff in the NPRA. However, these responsibilities and tasks mentioned are presented as bullet points and does not describe how to execute the activities. One candidate claimed that the handbook requires that the users have competence and

knowledge about how to manage road projects. “The handbook is not intended to be a textbook used for education of project management”.

The fact that the handbook is based on bullet points makes it, according to one candidate, demanding for many employees to execute the tasks as they should. However, the four candidates meant that the handbook had to be put in context with the organizations digital quality systems, where the frameworks for different tasks are given.

Three of the interview candidates perceived the handbook as very comprehensive, and that it was overwhelming. Two of the candidates suggested that the handbook should be revised, comprised, and formed in a simpler way.

**Challenges Connected to the Use of R760 And the Size of the Project**

From what was discovered in previous research about the handbook R760, the project group thought it valuable to examine if there existed possible mismatches between the handbook and the size of a project. All the candidates confirmed the suspicions that there exist challenges regarding the use of R760 and the size of the project. The main essence of the answers was that the handbook R760 is to comprehensive for smaller projects.

Two of the six candidates explained that the handbook R760 is “too much” for smaller projects. “I perceive that there is way too much bureaucracy when using R760 in smaller projects” The two candidates suggested that the handbook should be divided into two separate handbooks, one for smaller projects (<100 million NOK) and one for larger projects (>100 million NOK).

The other four perceived that the handbook is “too much” if you are not experienced enough, and able to acknowledge that many of the activities does not require much effort to complete, or that they even can be skipped in some cases. The candidates continued to explain that many of the same activities are needed and that the roles described remain the same, regardless of the project´s size. However, one must be able to scale down the activities. One candidate claimed that in smaller projects one activity can be answered by simply writing one line, while in larger projects one will have

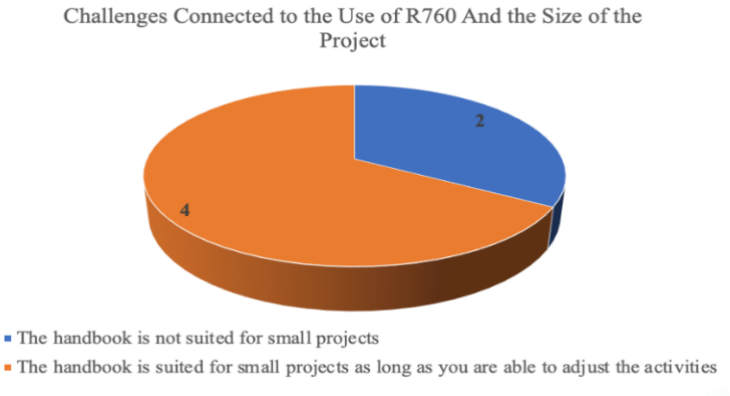



Figure 16 Challenges Connected to the Use of R760 And the Size of the Project

more comprehensive documents answering out the activities. The candidates additionally pointed on lack of staffing for smaller projects to be the main issue in order to fulfill all the guidelines given by R760.

**Correspondence Between Theory Presented in R760 and Actual Performed Project Management**

The project group wanted to explore if there existed gaps between the project management theory presented in R760 and the executed project management in the NPRA. To this all the candidates answered that there exist gaps between R760 and the practical execution of project management. However, this depends on how detailed one investigate each individual case. Furthermore, the candidates believed that there does not exist large gaps, but only minor differences between the handbook and project management practice. The candidates also explained that the majority of the employees comply with the theory presented in R760, even if they do not realize it themselves. One reason for this was explained to be because of different use of project management terminology.

### 5.2.3 Communication

This section maps the 13 candidates' perspectives on; the importance of communication, which communication channels that are used, the degree of communication satisfaction, and the power distance´s influence on the communication.

**The Importance of Communication**

The project group started the section of communication by asking an overall question about what communication meant to them. As seen in the word cloud in figure 17, communication is by the majority of the candidates seen as critical in order to succeed with project management.


Figure 17 Meaning of Communication – Word Cloud

The overall element that is repeated is that communication is essential in a project, both internally within the project organization, but also externally towards the contractors, consultants, local authorities, affected landowners and project end users. "Communication is

essential in a project, both internally and externally. Communication is a really important tool in order to get our plans approved by other stakeholders with high influence. Communication is something we really spend a great deal of resources on"

Some of the candidates also mentioned that it is not enough to simply have a lot of communication, the information that is communicated has to be the right type of information, and that it has to be given in a clear way that does not give any room for misunderstanding. Two of the candidates answered this when asked what communication meant to them: "Communication is really important; however, it's not about getting as much information as possible, it's about getting the right information that you need." "Transferring enough information is vital, however too much information is not good. There is a fine line between these two things".

Other candidates claimed that creating informal communication channels between the client and contractor is crucial. "It can´t be said enough that we need informal communication channels between the client and the contractor. Having only formal channels will hinder a good collaboration and the work towards common project goals."

**Communication Channels**

The project group asked the candidates which communication channels they used for both internal and external communication.

Internal: The participants all mentioned traditional communication channels such as face-to-face communication, E-mails, MS Teams and project meetings to be the most used channels for internal communication. However, Nye Veier also mentioned weekly lookahead planning using digital blackboard as a good way for communicating within the project organization.

External: For external communication between the client and the contractor mentioned the candidates from both Nye Veier and the NPRA formal communication channels such as construction management meeting, discipline meetings, economical meetings, E-mail and digital systems such as web-hotels. Nye Veier also mentioned that they used the project´s BIM-model as a communication channel. Furthermore, explained the two organizations that informal communication between the client and the contractor happened through text messages, phone calls, E-mails, a cup of coffee, and inspections on the construction site. In addition, did Nye Veier also mention that using oral communication what the preferred channel to use when informing and discussing the project with the landowners.

### Degree of External Communication Satisfaction

The project group asked how satisfied the candidates were with the external communication. There was a slight variation in the answers about the communication between the client and the contractor. The majority said that the communication works very well, however some also disclosed that this varies a lot depending on the different persons, organizations, and projects. The rest claimed that the communication was satisfying but that it also was challenging in some cases. Furthermore, communication involving questions regarding economy was seen as the most challenging topic to discuss. Figure 18 displays the degree of communication satisfaction between the client and the contractor. There was no obvious distinction between Nye Veier and the NPRA on this matter.

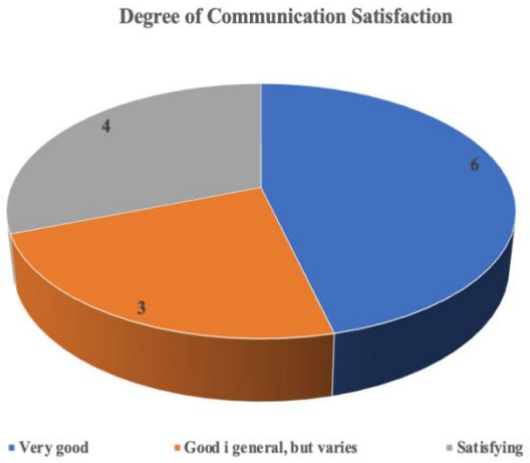



Figure 18 Degree of Communication Satisfaction

### Degree of Internal Communication Satisfaction

The project group asked the interview candidates if they received the necessary information at the right time. Nye Veier and the NPRA did show some differences as shown in figure 19.

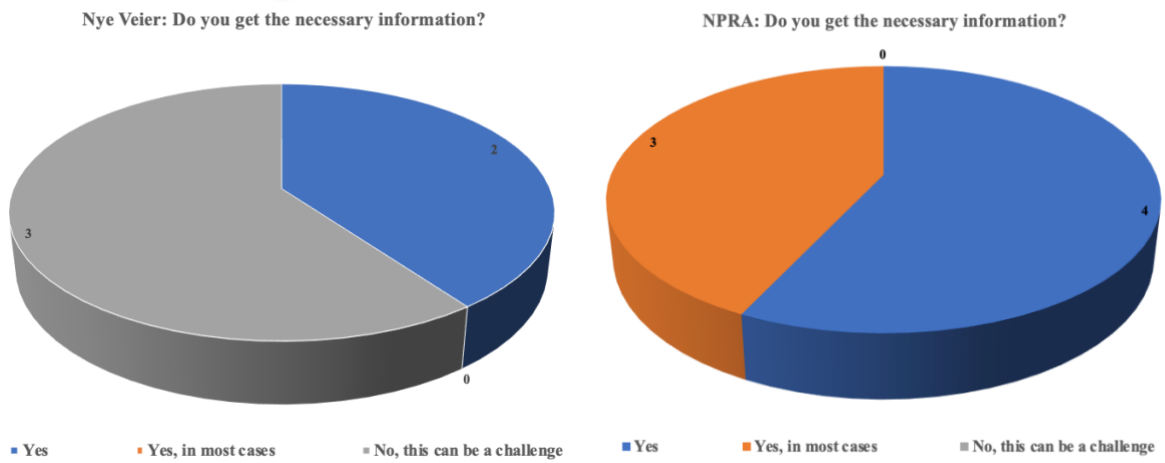



Figure 19 Degree of Internal Communication Satisfaction

The candidates from the NPRA all responded that they were satisfied with the internal information-flow. “I feel that I always have the information that I need. Much of the information

comes continuously and is not dependent on the reporting intervals." "The information-flow works excellent within the internal project organization".

The degree of internal communication satisfaction was, however, more divided within Nye Veier. Two of the candidates perceived the information flow to be good, while three candidates claimed that Nye Veier have issues regarding the internal information-flow. "It is not uncommon that I do not get the necessary information that I need. I think that much of the reason for this is the geographical spread between our offices in Nye Veier. I feel quite often that we do not have the same information than what the main office does. There is a huge potential for improvement when it comes to internal communication in Nye Veier." Another candidate from Nye Veier supported this by stating that "there exist a challenge when it comes to decision being made by the top management in Nye Veier. The information does not come as fast and as clear as it should. This is something we are trying to fix with the ongoing re-organization of the company." A third candidate stated that one part of the reason for this challenge is the fact that Nye Veier still is a fairly new organization. The issues being pointed out is lack of information to the project managers on how they shall act when interfering with the contractor, counties, and surroundings

**Communication and Power Distance**

The project group wanted to investigate if different positions and "hierarchy" influenced the internal communication in any way. On this matter all of the candidates claimed that the organizations had a horizontal organization. Nevertheless, a few of the candidates explained that there sometimes exist issues when communicating vertically in the hierarchy.

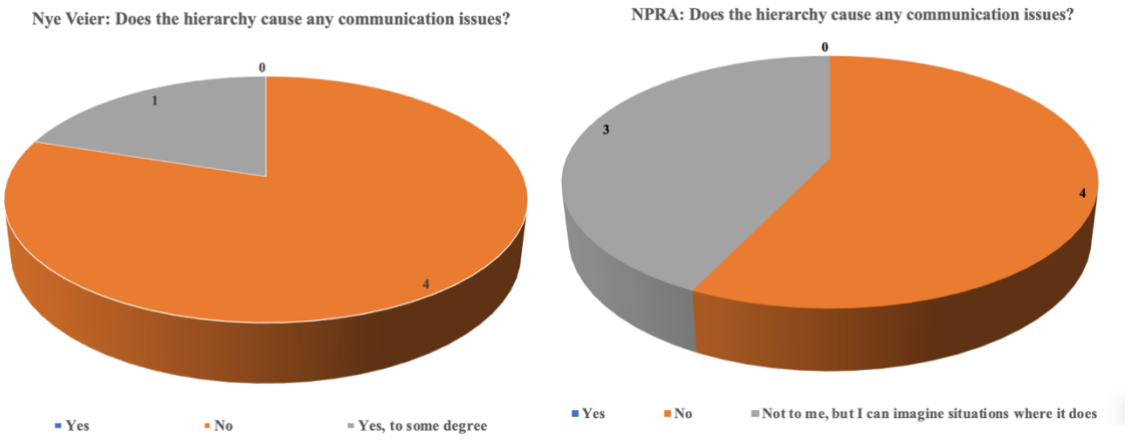



Figure 20 Communication and Power Distance

As shown in figure 20, one candidate from Nye Veier experience some difficulties in the communication due to the hierarchy. The candidate stated that "we are trying to think that we

have a horizontal organization, however I don't know if that is the case. A part of the problem is that I get very little information from my leader, which makes it hard to inform my employees. We have tried to solve this by having regular meetings with the leaders, however we are not the best at this. I experience that it is hard to get a hold of my leader via phone calls, but that I get answers if I send E-mails". In comparison stated another candidate that "It is much easier to communicate in Nye Veier than in the NPRA where I used to work."

The general perception of the candidates from the NPRA is that the hierarchy does not cause any issues regarding communication, at least not for them. Two of the candidates answered that they can imagine that some NPRA employees acts a bit arrogant and that this can cause issues for newly employed staff, however they do not recognize this as a large problem in the organization. Another candidate believed that one of the reasons for not noticing any difficulties regarding hierarchy and communication is because the whole project organization is sitting at the same project office. "If the project manager had been sitting at another office and not showed presence at the project, then I think it would be much harder to communicate with the individual."

**Implemented Measures to Ensure Good Communication**

The project group asked what the candidates did in order to achieve good communication towards the contractor. Both the candidates from the NPRA and Nye Veier emphasized that creating and maintaining good communication is a continuous task that demands a lot of work.

The NPRA: The five candidates interviewed from the E6 Soknedal project mentioned colocation of project offices as one of the best implemented measure in order to have good communication with the contractor. By having the offices side by side, it made it easy for both parties to stop by each other if issues occurred. The project manager from the contractor said that collocation was not something the candidate had previously experienced with the NPRA, but was sure that this collocation was much of the reason for why the project had such a good communication between the client and contractor. The seven candidates interviewed from the NPRA also mentioned Start-up meeting with connected collaboration documents to be good tools in order to ensure good communication. The collaboration document is project specific and determine how the communication between the contractor and the client shall take place. One guideline in this document is to always try to solve issues orally, and always give a heads up of future demands orally, before formalizing it in writing. This would, according to the candidates, decrease the chance of misunderstandings between the two parties. In addition to

this, the candidate also mentioned regular construction management meetings, disciplines meetings, and collaboration meetings as good tools to maintain good communication. In the collaboration meetings, the client and contractor will mutually evaluate each other, so that issues on communication can be discovered and solved.

Nye Veier: The candidates from Nye Veier also mentioned regular construction-, disciplines- and collaboration meetings as good tools to develop and maintain good communication with the contractor. Nye Veier also meant that creating informal communication channels towards the client was beneficial, some even characterized it as critical for the project. In addition to this, did the candidates from Nye Veier also develop risk assessment plans to secure that the right information was given at the right time, and that Nye Veier held interaction meetings with the contractor before and during the development of the contract.

**Communication Improvement Potentials**

When asked if there exist ways to improve the communication on the E6 Soknedal project, both the assisting project manager from the NPRA and the contractor´s project manager responds that there will always be a potential for improvements. The contractor´s project manager emphasized that having an oral conversation before formalizing it in writing is something that can be improved. The NPRA´s assisting project manager stated that "there is only one thing that can be repeated when considering communication, and that is clear messages. I feel that the contractor can improve and make more clear messages when they convey questions to us, so that there does not occur confusions." Another candidate from the NPRA mentioned BIM as a great tool that can be used in order to improve the communication towards the contractor.

Internally, all the candidates from the NPRA said that there will always exist room for improvement, however they could not give any specific examples of elements they wanted to improve.

All the candidates from Nye Veier also believed there is room for improving the internal communication. One candidate believed that re-organizing the company and gathering the different disciplines inside Nye Veier would increase the organization´s capability and create clearer discipline environments in Nye Veier. This would, according to the candidate, lead to more lessons learned transferring and better decisions in the future. Another candidate stated that Nye Veier currently is working on how to optimize the reporting from ongoing projects to the company management. It was also stated that there should be a better prioritization on which issues and cases that are the most important.

### 5.2.4 Trust

**Degree of Trust Within the Project Organization:**

The project group wanted to map the degree of trust within the project organizations. As shown in figure 21, the candidates all answer that they trust the project organization and that they feel that this is mutual.

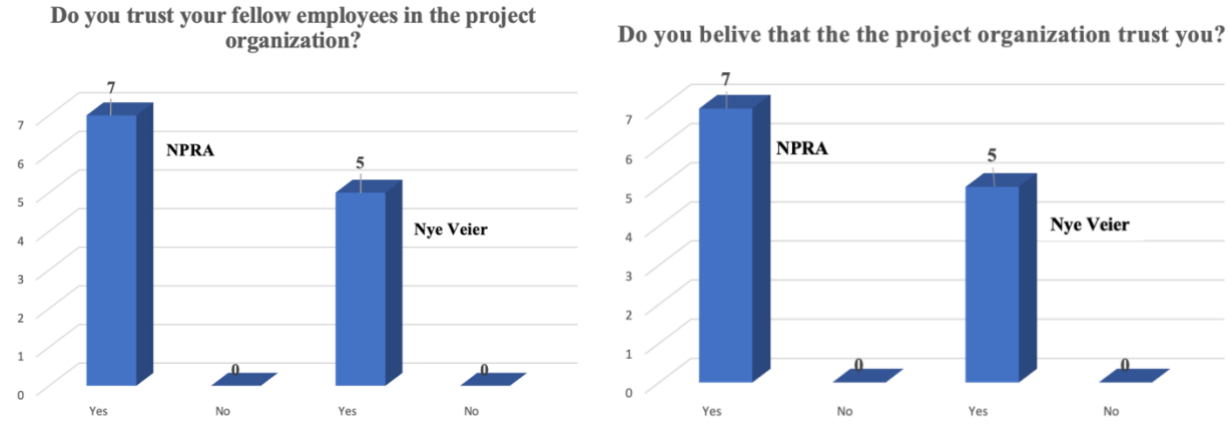



Figure 21 Degree of Mutual Trust Within the Project Organization

The candidates from the NPRA stated that they feel they have a large degree of freedom, responsibility and that they are given broad authorities to make decisions. This is, according to the candidates, something that makes them feel that they have the support and trust from the other employees in the project organization.

The candidates from Nye Veier answered that they have appraisals where they get feedback from fellow employees, and the result from these appraisals is that they are trusted. One candidate from Nye Veier claimed that it´s important to take responsibility in order to build trust, and that it is easy to get responsibility if you want to in the project organization. Another candidate stated that Nye Veier as a "slim client" demands much responsibility from the individuals and that the organization therefore is completely dependent on trust.

**Measures to Achieve Trust Within the Project Organizations**

The project group then asked the candidates how they worked in order to gain trust within the project organization.

The candidates from the NPRA responded that trust is first of all something that must be earned. In order to so, showing real work effort and the will to deliver on the work you have promised to do was explained by the candidates as vital. Moreover, were elements such as being honest, trustworthy, open, and clear factors that must be in place to build trust. "It´s about making sure

everybody is part of a team and being a team player who is willing to join your fellow employees in the line of fire and give them back up whenever it is needed." Another candidate who act as the project owner believed that giving people responsibility and authorities is a good way of building trust. "My philosophy is that I wish my project managers to have the largest possible maneuverability in the project. At the same time, I show them that I got their back if they need support."

The candidates from Nye Veier also gave answers corresponding to the answers given by the NPRA. "Trust is not something you buy. I have contributed to building up this project organization and always tried to find engaged employees. This has been a great starting point for building trust". This is supported by another candidate from Nye Veier, "We strive to find competent employees so that it is easy to show trust." One candidate answered that "trust is dependent on achievements over time. Trust is not something that can be built overnight, all though it can be torn to pieces overnight". One candidate claimed that the project organization works a lot with teambuilding in order to create a culture where they have confidence in each other. There is a common perception within Nye Veier that by being open, including employees in decision makings, transferring information, giving responsibility, and acting professional are necessary in order to build trust. "You gain trust by showing trust."

**Degree of Trust to the Organization**

The project group asked the candidates if they trusted their respective organization. The candidates from the NPRA responded that they to a different degree trust the organization. One candidate said that "I perceive the NPRA as a very professional road client and fully trust my organization". On the other hand, did two candidates explain that while they trusted the organization, there exists room for improvements. These two candidates continued to explain that this is connected to the re-organization of the NPRA, were they experienced that the top management was passive with a lack of information and actions, making some of the employees criticize the organization. Another candidate did on the other hand explain that the employees of the NPRA had to understand that the organization is administrated by the Norwegian government and that the top management therefore have limited influence when political decisions are being made. One candidate also explained that the re-organization caused a change in some of the routines which could impair the level of trust. "We have just transferred into a new form of organization where many leaders have been given new tasks and responsibilities. This has caused new routines that are not settled yet. This re-organization has

caused many issues that take time to solve. I have however overall trust to the NPRA as an employer and as an actor in the society"

Nye Veier is to some degree more synchronized in their answers with all the five candidates answering that they absolutely trust the organization. "I definitely trust the organization. There is so much passion in Nye Veier. There is so much that is new, and the mandate we have been given from the government gives a very fine motivation. The organization is very positive, something that gives trust both ways".

**Degree of Trust Between the Contractor and the Client**

The candidates were asked if they have trust in external project participants, more specific the contractor. Notice that one of the participants answering on the behalf of the E6 Soknedal Project is the project manager of the contractor on that project. This candidate was consequently asked if the candidate trusted the client on the project.

As shown in figure 22, one can clearly see that there exists a large degree of trust on the E6 Soknedal Project. This trust is also mutual since the project manager from the contractor answered that the candidate trusted the client in this project. The degree of trust between the contractors and Nye Veier is also high considering that four of the five candidates answered that they trusted the contractor. The last candidate from Nye Veier, did however, support the answers given by the NPRA candidates whom all perceived the trust to variate, depending on the project and the phases of the project. This is also supported by the project manager of the contractor in the E6 Soknedal project who stated that "I have a large degree of trust to the client on this project. However, this was not the case on my previous project with the NPRA as clients." The two candidates answering "medium" explained their answer by claiming that the contractor always take advantage of loopholes in the contract which can gain the contractor more profit. "We don´t think anyone is trying to cheat us, however the contractor will always try to use elements that are open for interpretation to the benefit of the contractor."

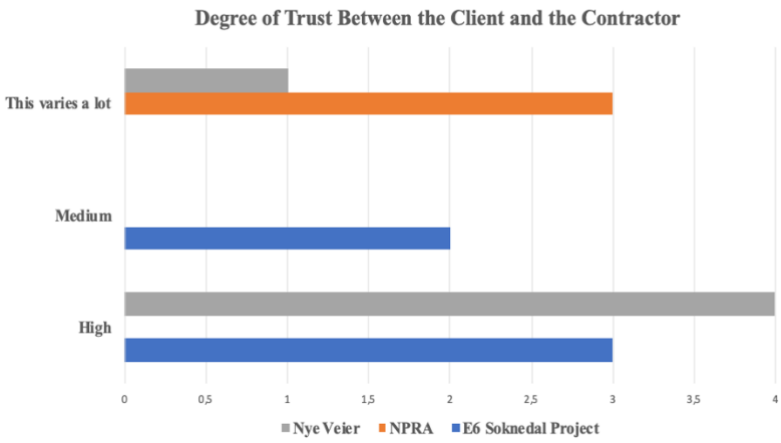



Figure 22 Degree of Trust Between the Client and the Contractor

**How to Achieve Trust Between the Contractor and the Client**

The project group asked the candidate how they worked in order to gain trust from the contractor or the client in the projects. The project manager representing the contractor´s perspective answered that this is mostly something one shows through deliverables. “We have to show that we are able to deliverer according to the contract. Additionally, we must show that we have good HSE routines and that we are capable at dealing with challenges.”

The candidates from the NPRA explained that creating a proper communication channels as vital in order to achieve trust toward the contractor. One candidate also stated that “We have to play together on the same team as the contractor and try to find good solutions together. Additionally, we have to understand the fundamental principle of the industry, which is that the contractor needs to earn money. If we can show that we understand this to the contractor, then we earn their trust.” An answer that was repeated by the candidates was to use interaction processes before the execution phase. This interaction process was according to the NPRA a process where the intention is to get to know each other and to build trust between the client and the contractor early on in the collaboration. One candidate however, explained that these collaboration meetings does not always work as intended, and does not create the strong bond of trust between the organizations as desired. The candidate believed that the issue might lay in the contract. “If the contract is open for interpretation and there is a too large gap between the client´s and the contractor´s interoperation, then mutual trust will not be created.”

The candidates from Nye Veier agreed that communication and establishing the right dialogue for being important measures in order to gain trust to the contractor. One candidate also claimed that the reason for the high level of trust between the project and the contractor is because the candidate has worked with the contractor for many years on different occasions. In addition, another candidate answered that the professionalism and the great expertise of the organization is the reason why they have such a good relation to the contractor. Another candidate answered that in order to build trust they evaluate each other two times a year where they give each other a score on their performance. Furthermore, the same candidate also explained that building trust is about having informal conversations, by for example having informal inspections on the construction site. Another element that was mentioned as a way of building trust with the contractor was regular coordination meetings. On these meetings Nye Veier and the contractor would discuss culture and how to interact between one another in order to make sure that everyone was satisfied with the collaboration.

### 5.2.5 Stakeholder Management

In order to get an understanding about how Nye Veier and the NPRA operated in consideration to the stakeholders on their projects, the project group found it imperative to ask the candidates about how they handled the stakeholders. The different interview candidates unanimously agreed that it was really important to include and evaluate the stakeholders in the project. “The stakeholders have to be taken seriously and we need to listen to what they have to say.” The candidates, furthermore, explained that in order to understand and properly consider the different stakeholder’s effect on the project, they had to be analyzed. Some of the candidates continued to explain that in this analysis they would rank the stakeholder’s importance by calculating the effect they could have on the project, and develop strategies based on this. The candidates from both Nye Veier and the NPRA also explained that this was done in the planning stage of the project in a risk assessment system in the PMD. The candidates further explained that this analysis is to be updated continuously as the project progresses.

The candidates were explicit on explaining that informing the stakeholders was of high importance. Both the candidates from the NPRA and Nye Veier explained that they had systems in place where they informed the various stakeholders. Some of the information channels mentioned was meetings, social media, SMS, open office, and other informative events. Moreover, the candidates from the NPRA and Nye Veier explained that they had systems in please where they informed the various stakeholders. A candidate form the NPRA said that “We have open office days and information days where the society are informed about the project, we have collaboration meetings with the authorities, we contact and informs affected neighbors, and if there are any problems with the different stakeholders, then we try and accommodate them in the best way possible.” A candidate from Nye Veier supported this, “The stakeholders are included in our project planning phase where the authorities, neighbors and other relevant parties are included and informed about the project”

The interview candidates from E6 Soknedal second this and explained that “We have a risk assessment system called PUS where all the stakeholders are evaluated. We have collaboration meetings with neighbors, the authorities, and the affected industries, where we inform them and update them on the project situations.”

### 5.2.6 Monitor and control of Project Work

The following section includes questions about how the two client organizations monitor the project and implement measures to control the project work.

**PMD – Project Management Document**

The candidates were asked if they had used the PMD, and the collective answer was that the PMD is really important in the project as it contains the strategies for, HSE, scheduled time framework, quality, economy, project goals and other necessary parts needed in order to successfully complete the project.

When the candidates were asked if they used the PMD regularly the mutual response was that the document was continually updated, and that there were several aspects of the document that were used regularly. Nevertheless, several of the candidates from both organizations mentioned that the document was not read or used in their daily activities, and that it could be beneficial for the projects to take more time reading the PMD.

A candidate from Nye Veier said this about the use of PMD "PMD is a very important document that provides a detailed description about how the project are to be controlled. We are updating it regularly, but most of it happens in the planning process. The document furthermore follows the decisions gates in Nye Veier were the frameworks are specified. We do however not use the document every day, but since it is the project team who is creating it, the content is at the core of the project team's execution."

A candidate from the NPRA explained the use of the PMD like this "The PMD is updated regularly if necessary, but there are parts of it like the risk assessments that are updated more frequently. My experiences of the use of PMD is that the project team is very familiar with the content of the document, as it is them who develops it. I therefore believe that the PMD serves its purpose."

The candidates from the E6 Soknedal project agreed to these answers as they explained that the PMD was very important and that it was at the core of the project. They also confirmed the suspicion given by the other interview candidates regarding that the PMD was not used in the daily activities on the project.

**Method Used to Control Time, Quality, and Cost**

The candidates had a similar perception of how to conduct controls of time, quality, and cost on the projects. However, there were some small discrepancies on how often and which system that were used. The overall answer given by the candidates was that the project schedule was used as a measure of time, whereas a control system was used to measure the quality of the work, and a cost forecast together with the actual cost.

On the matter of cost and time, both Nye Veier and the NPRA answered roughly the same, which was that these controls were conducted at set intervals and that the findings were to be presented in meetings. The quality was on the other hand what differed between the two organizations. A candidate from Nye Veier explained that the NPRA have more resources on surveillance, were they constantly check the contractor and control that it is within the agreed upon scope. The candidate continued with clarifying that in Nye Veier, the responsibility of quality control was mostly put on the contractor. The candidate explained that this was possible because Nye Veier's projects are entitled to a warranty period of 20 years, forcing the contractor to be more thorough with their own work. Apart from this, the quality control executed was similar to one another from the answers provided by the candidates.

**Actual Project Execution Compared to Planned Project Execution**

Not all of the candidates from either the NPRA or Nye Veier knew how to answer the question regarding how the organizations monitored actual project execution compared to planned project execution, but those who did, explained that the best way to measure this was to look at the time schedule and the billing cycles. A candidate from the NPRA stated, "We compare this by looking at the work completed by the contractor against the time schedule presented by them in monthly meetings." In addition, stated a candidate from Nye Veier that, "We assess this by comparing the actual billing against the planned billing and compare this against the main time schedule."

If the actual execution was behind schedule, the candidates from both Nye Veier and the NPRA explained that if a problem occurred, they would discuss it with the contractor and try and find solutions together with them. Additionally, if it was necessary, a risk assessment is conducted in order to generate a priority list about which problem should be addressed first. That being said was the most important notion that the project managers worked proactively by having meetings with the contractor in order to find anomalies before they grew into larger problems.

If these previous methods proved unsuccessful, two candidates from the NPRA explained that they would make use of daily fines or fees to pressure the contractor in order to uphold the contract. In comparison explained two of the candidates from Nye Veier that they did not believe in daily fines, but rather positive incentives given to the contractors when they complete their tasks on schedule. They did however neither confirm nor disconfirm if they used daily fines themselves.

**The Decision-Making Authority**

In the specialization project one of the candidates explained that the project managers in the NPRA client organization experienced criticism about their lack of authority during the decision-making process. By this the interview subject meant that it was not uncommon that delays and problems could occur because the project management team sometimes did not have the necessary authority to make decisions. When the candidates in this interview round where asked to consider their extent of autonomy during decision making, they answered that it was at a good level. The interview candidates from the NPRA continued to explain that they experienced that they had the necessary authority to make decisions in the project. “My authority is very good. I have a great degree of freedom to make decisions. We are, with Nye Veier’s mandate, dependent on having employees with the ability and capability to make decisions when needed. I am also experiencing that the top managers are able to make the necessary decisions on their level, thus are the necessary decisions made within reasonable time.” Another candidate also explained that “if a manager is incapable of taking charge and dealing with the responsibility of making decisions, that person is not the right person for the job. The worst that can happen is not that the wrong decisions are made, but that no decision is being made at all.”

The candidates from the NPRA also explained that they experienced that their project managers had enough authority to make decisions. A candidate said, “The authority is good. From my experience I believe we have very skilled and good project managers who are capable to make the necessary decisions in the projects. The project management team can make the necessary decisions when it comes to finding the best possible solutions as long as the goals of the project are achieved. That being said, the different project managers do not have that much room for their own decisions when it comes to the funding. Which means that as long as the decision does not make things more expensive, they have the authority to handle any problem.” Another candidate did however explain that “Project managers have the necessary authority to make decisions in the larger picture, but there are examples of how a decision-making process can take very long if the necessary authority lies at very high level in the hierarchy. Nevertheless, my philosophy is to give the managers at the lowest level as much authority as possible.”

The candidates from the case study E6 Soknedal supported the other candidates from the NPRA and explained that they mostly experienced that they had the necessary authority to make decisions. Furthermore, did one of the candidates explain that in order to make the proper decisions one needs to be up to date with the invoices and project changes, and thus be able to

handle everything quick without letting them grow into a large and difficult problems. One of the candidates from the project also explained that “they occasionally experience criticism because decisions that needs to be taken quick sometimes have to be lifted to the next manager in the hierarchy, delaying the projects schedule.”

The candidate from the contractor on the E6 Soknedal project explained, “The decisions might in some instances be a bit slow, but from my experience are most of the challenges solvable within reasonable time. There are issues that sometimes need to be sent to consultants that requires longer waiting time. I have also experienced that some problems have to go far up in the management chain instead of just leaving it with the onsite manager. I therefore believe that the onsite managers could have a bit more decision-making authority.

### 5.2.7 Risk Management

The following section includes questions about how the client organizations manage uncertainty and risk, in addition to the candidates´ degree of satisfaction on this.

**The Management of Uncertainty and Risk**

The project group asked the candidates from Nye Veier and the NPRA how they manage uncertainty and risk. The candidates from the NPRA explained that they use the project uncertainty management tool called PUS, however the extent on how rapidly they performed PUS varied between the candidates. One candidate mentioned that PUS follows the project from early planning all the way to project termination. The candidate also explained that they, on the E6 Soknedal project, uses PUS to some extent on every construction management meeting in order to discover elements that can have both a negative and positive consequence. “The use of PUS is a great tool for making the project less expensive and easier to carry out, because it contributes to determine measures to implement and optimize solutions”. Although every candidate from the NPRA claimed that PUS is a great tool, some also mentioned that there are some challenges involved with using it. The candidates stated that risk management in general is a comprehensive exercise which requires experience in order to succeed, this is also the case when using PUS. It is therefore important to include enough personnel when performing PUS, because having enough expertise to foresee all possible uncertainties is a challenge. One candidate furthermore claimed that the management of risks is one of the areas where the NPRA has the greatest potential for improvement. The candidate continued by explaining that while they have the tool PUS, they need to use it to a larger extent and improve the way that they use it in order to fulfill the potential of PUS. This will, according to the candidate, improve the risk management in the NPRA substantially. The same candidate also

mentioned that the pricing of risk is the hardest part, and that the NPRA needs stronger guidelines so that the PUS will be more used. “The only way to get better at pricing risk is to perform PUS more, and thereby build experience.”

The candidates from Nye Veier all claimed that risk management is one of the most important tasks in a project, and that they therefore use a lot of resources on risk management. All the five candidates mentioned that they early on in the project start to use an uncertainty register, this register is thereafter updated every month. “We have a detailed uncertainty register with a risk matrix for all projects. This uncertainty register is thoroughly revised every month in order to discover new risks and to control that the original risks are properly priced. We also have people at the main office who deals with project- and company risk on a full-time basis.” One of candidates also stated that risk management important in the procurement method BVP. “A BVP shall include a list of the clients risks and be transferred throughout the whole construction of the project. It is the contractor’s responsibility to revise and report on the clients risks every week.”

**Degree of Satisfaction on the Risk Systematization**

The candidates were asked if they thought that the risk systematization performed as intended, or if there exist opportunities for improvement.

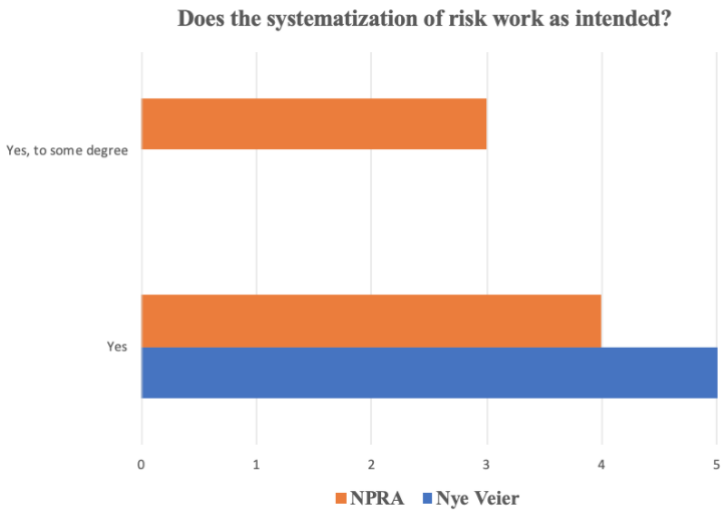



Figure 23 Degree of Satisfaction on the Risk Systematization

The candidates from Nye Veier were very satisfied with their systematization of risk in their projects. One candidate from Nye Veier who previously had worked in the NPRA stated that “I feel that we have significantly better processes for handling risks in Nye Veier, than what my experience was in the NPRA. My experience from the NPRA was that managing uncertainty and risk was seen as something you had to in the last minute, and not something that was done because of the benefits it brought to the project.” Another candidate answered that the handling of risk works very well. The candidate substantiated this by saying that Nye Veier has received external feedback from contractors and consultants, that the organization and the projects are well developed when it comes to risk management.

When considering the NPRA, one can from figure 23 see that all the candidates believed that the risk management systematization worked as intended, or at least to a certain degree. Three of the candidates believed that there exists a potential for improving the system. It is important to notice that the candidates do not believe that it is the tool of PUS itself that is challenging, but how the NPRA is practicing it. The three candidates believed that the NPRA needs to improve and implement a system that makes use of the tool PUS to a greater extent. "PUS is a great tool. However, the use of PUS varies a lot throughout the organization. There is a large gap on to which degree the tool is used, some are good at it, while others are not as good at it."

As a last question in this section the candidates from Nye Veier and the NPRA were asked if they felt that the projects had a proactive way of dealing with risks. The answers given to this question reflected on the answers given when they were asked if the systematization worked as intended. All the candidates believed that they had a proactive way of dealing with risk, but that three of the candidates from the NPRA meant that there was a great potential for improvement.

### 5.2.8 Conflict Management

Conflicts can arise in many situations especially when there are different organizations working together. The authors therefore found it necessary to ask the candidates about their experiences regarding conflicts in their respective organization. This section will highlight how the organizations handles conflicts, as well as the different candidates' experiences on the matter.

**Conflict Management and Conflict Management Procedures**

All of the interview candidates were very clear on the matter that conflicts were to be handled seriously and should be solved quickly. Furthermore did 13 out of 13 candidates explain that conflicts should be solved at a lowest possible level in the project. If, however, the disagreement grew in degree of seriousness, the candidates all explained that it would be lifted to the next level as soon as it was deemed necessary. The following procedures however, differed between the organizations.

The candidates from Nye Veier explained that the next step in the conflict resolution process was to use something called PRIME or "Project Integrated Mediation", which the candidates believed worked well. This is a conflict resolution board consisting of three people, where two of them are lawyers and one of them are a technical specialist. The candidates continued to explain that this resolution board worked proactive by having meetings with the projects two to four times a year. In these meetings are problems that have occurred, as well as possible future problems that can occur, discussed.

One of the candidates at Nye Veier did also emphasize that while PRIME worked great, Nye Veier still needed to create a better procedure to handle conflicts before they reached PRIME. Nye Veier was, according to the candidate, in the process of developing such a procedure.

The candidates from the NPRA explained that they used something called a conflict staircase for handling the disagreements at the appropriate level. This method was explained by one of the candidates as something that had been developed by the NPRA together with the industry. If a disagreement increased in difficulty it is supposed to be lifted to another level and solved there. If it is less serious than originally thought it might be sent back to the previous level, but if it is even more difficult to solve it will be lifted to the next level.

The candidates from the NPRA explained the conflict resolution staircase "starting at the lowest level with the people who are directly responsible, then the next step would be the top managers of the projects. If this does not work, the next step would either be to use an expert, or a conflict resolution board." The expert was explained by the candidates as an efficient and proactive tool for solving problems. Furthermore, would this expert be an independent third party who is a part of the project from start to finish, where this person´s only job is to come up with neutral solutions to problems that might arise between the different organizations in the project. On the other hand, is a conflict resolution board a group of experts and lawyers who handle conflicts based on their experience and expertise.

The candidates from the NPRA also explained that they worked proactive by having multiple collaboration meetings where they discuss problems informally and openly before things become formal. Some of the candidates explained that the expert would attend these meeting together with the clients and the contractors.

The candidates form the E6 Soknedal explained that they had not experienced any large problem with conflicts in this project. They made use of the overall strategy in the NPRA, and had collaboration meeting with the contractors, third parties and an expert. If there was a problem, they tried to solve it informally at the lowest possible level, before making it formal and lifting it to another level. The interview candidate from the contractor also second this.

**The Responsible Parties for Handling Conflicts**

As a follow up question to the conflict management procedure, was the different candidates asked who the responsible parties for handling conflicts in a project was. The candidates from the NPRA answered that it was firstly the client´s construction manager who is responsible, if it develops further it is the project manager, and if it develops even further it is the expert or the

conflict resolution board together with the top managers of the project. In other words, as one of the candidates explained it "we are very clear on the matter that the responsibility to solve the conflicts goes through the hierarchy of managers, which means that we have no employee that deals only with conflict resolution on the projects."

The candidates from Nye Veier did also state that the project manager is the person who is responsible for solving the conflict at the lowest possible level, before lifting it up to the project director. After this they make use of PRIME to solve the problem. The candidates from Nye Veier also explained that they do not have an employee on the projects who only deals with conflicts.

**Conflict Escalation**

Another follow-up question asked in the context of conflict management was what the different candidates did in order to hinder possible conflict escalation. To this the candidates, independent on their organization, answered that solving them fast, informal, and at the lowest possible level was the best way to stop possible conflict escalations.

One candidate explained that finding the cause and avoiding misunderstandings would also be a great way to solve problems before they develop into serious conflicts. "Find the root cause of the problem and eliminate it. Try to avoid misunderstanding." Another candidate explained that "it is first and foremost the coffee cup conversations that are used for informal conflict resolution" If this does not work, they utilize the expert, conflict resolution board or PRIME. If nothing works, then a candidate from the NPRA said that they would prepare for going to court.

**Types of Conflicts**

The interview candidates explained very clearly that the largest cause of conflicts were financial problems. Some of these sources of conflicts were disputes regarding who is responsible for the cost of changes in the project, disagreement about the cost of the different technical solutions, and arguments surrounding the cost of the quality of the products in the project. Other sources of conflicts that were mentioned was quality, contractual, personal conflicts, the responsibility, and interpretation of the contracts. The number of times the different interview candidates mentioned the different types of conflict is presented in figure 24.


Figure 24 Types of Conflicts

## 5.3 Productivity Management tools and Strategy

Considering the growing focus on increasing the productivity, the project group found it imperative to ask the candidates about what their organizations does in relation to this. The following sections will therefore cover the candidate's thoughts and experiences in relation to several different productivity management tools and strategies. This sub-chapter will start with presenting the answers in relation to Supply Chain Management, followed by Lean, BIM and finally VDC.

### 5.3.1 Supply Chain Management

From the responses given in regard to the questions related to supply chain management it became clear that the candidates had little knowledge about the method. Out of the 13 candidates, only one person knew what supply chain management was. This candidate from Nye Veier said, "We do not use supply chain management in Nye Veier to my knowledge other than the internal logistic and the decision processes between the project and the top managers. There we have a control group who is evaluating the information and money flow in order to optimize good solutions with reduced costs." The other candidates either explained that supply chain is something the contractor does, or that they did not know what it was. Thus, the result showed that neither of the candidates used supply chain management.

### 5.3.2 Lean

One of the productivity management strategies the project group considered essential to ask the candidates about, was Lean. The response showed that there was a clear difference in the use of Lean between the different organizations. The candidates from the NPRA explained that they had no Lean strategy, but that they instead used some of the Lean methods unsystematically. "I barely even know what Lean is, but it is about increasing the effectiveness of the production so parts of it are relevant. Lean is also not a term we use in the NPRA, but we are an organization who values learning and improvements, so I believe that if you read in R760 you will find lots of the same methods as described in the Lean methodology." Another candidate from the NPRA explained "We have no definite Lean strategy, but we work on improving the efficiency of our projects and I believe we utilize many of the Lean methods, but without the systematic approach."

The candidates from Nye Veier did on the other hand explain that they knew what Lean was, and that the organization used Lean as a strategy. The candidates furthermore explained that they made use of many of the Lean principles and that they strived to utilize it even more in the

future. “We use Lean in order to eliminate waste, and to create a streamline process in order to handle the different situations.” Nevertheless, did also the same candidate from Nye Veier explain that they can become even better at utilizing Lean. “I believe Nye Veier still has a long way to go in regard to fully implement Lean.”

The candidates from both organizations does therefore explain that they facilitate for the use of productivity strategies and that they wish to improve their efficiency, but they disagree on the importance of utilizing Lean to accomplish this.

**Lean Responsible**

Another question asked, in order to explore the organizations implementation of Lean, was if the organizations had specific personnel responsible for the implementation of Lean. The candidates from the NPRA answered that they did not have a Lean responsible. The candidates from Nye Veier did on the other hand explain that they had people directly responsible for Lean at the main office of the organization. Nevertheless, the candidates from Nye Veier also explained that on the individual project there was not an employee who is dedicated to only implementing Lean, but that it was the project manager’s responsibility to follow up Lean.

**Lean Challenges**

The next follow-up question was in regard to challenges experienced with implementing Lean. The candidates from the NPRA did not answer this question. However, one of the candidates from Nye Veier explained that “the greatest challenge is about how we can adopt the Lean principles. We have tried to use it in relation to how we work on organizational change and between interorganizational teams.” Another candidate explained that the largest challenge, was that there were so many other things to remember apart from Lean, which sometimes could lead to less focus on the Lean elements.

**Last Planner**

The candidates from the E6 Soknedal project did not have any knowledge of what last planner was. The manager candidates from the NPRA did not know a lot about the last planner system either, but they did explain that they use the last planner principles in the form of weekly lookahead-plan meetings and interactive blackboards meetings. The candidates from Nye Veier explained that they used the Last Planner system with lookahead planning, team planning, and pull planning with the use of digital blackboards.

### PDCA

10 out of the 12 candidates from the client organizations did not know what the PDCA circle was. After the interviewers explained what PDCA was, the candidates mostly answered that it would make sense if they did utilize the concepts, but that it was not a strategy they were familiar with. The remaining two candidates, one from the NPRA and one from Nye Veier said respectively, "The NPRA uses PDCA" and "Yes we utilize this on several different levels, both in quality control internally and externally."

### Team Planning

The candidates from Nye Veier explained that they utilize team planning in the sense that they involve all the necessary people early in the planning process. One of the candidates explained "We have made use of a digital input-portal where the different parties that are effected by the project can share their thoughts. This has worked extremely well, and we are now working on developing new methods to involve the different stakeholders' even further." Another candidate explained that "they wish to involve the contractor early in the planning process in order for the contractor to help identify challenges, and to make use of their expertise to find the best solutions." The candidate also mentioned that early involvement of the stakeholders is the greatest Lean principle used in the candidate's perspective. On the other hand, answered only one of the seven candidates from the NPRA that they used team planning.

### Root Cause Analysis

Most of the candidates from both the NPRA and Nye Veier had not heard of the term root cause analysis. However, after explaining what it was, some of the candidates answered that their organization used similar methods to root cause analysis, especially in relation to HSE. From the figure 25 one can observe that only 1 out of 7 of the candidates from the NPRA knew what root cause analysis was. While 2 out of 5 of the candidates from Nye Veier had knowledge about it.

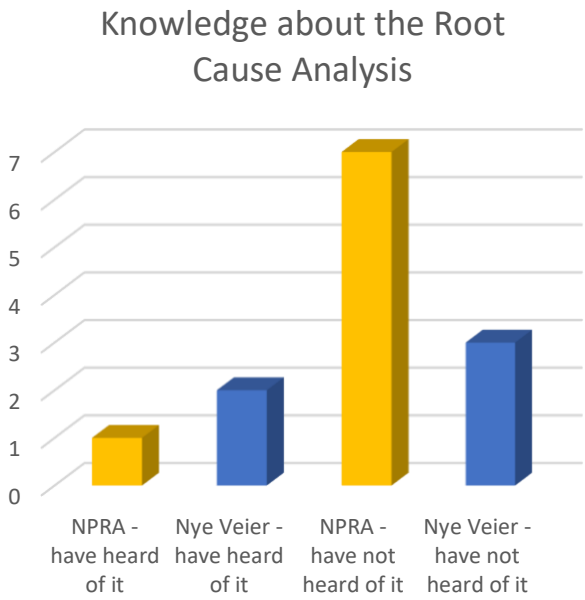



Figure 25 Knowledge About the Root Cause Analysis

**Lean Six Sigma**

The interview candidates answered in unison that both the NPRA and Nye Veier did not use Lean Six Sigma. Some of the candidates did not know what it was, while others chose not to elaborate any further on the reason why it was not used. There was however one candidate from Nye Veier who explained that they used some of the principles from TQM in their quality plans and clarified that the ideas behind the productivity strategy might be in use through other names and procedures.

### 5.3.3 BIM

The candidates from both the NPRA and Nye Veier explained that they use BIM in their projects, and that the two organizations have a goal of becoming completely digital in near future.

A candidate from Nye Veier explained that "the organization has made it one of its objectives to increase the degree of digitalization on our projects. We are therefore including strict requirements about the use of BIM in the tendering process. By doing this we have been able to push the market into a more digitalized tomorrow, which we have received good feedback about from both contractors and consultants."

A candidate from the NPRA also said that "BIM is something we have been using for a while and have reached a strong maturity level on. Furthermore, it is a requirement for all new projects to use BIM."

The sample project of E6 Soknedal does not necessarily live up to the standards presented by the other candidates in the NPRA. A candidate from the E6 project explained "We are a project that started in 2015 and does not have the same requirement as new projects today. Our project is therefore more of a mix where we are utilizing both model-based solutions and paper-based solutions parallelly. That being said, all the newer constructions created later in this project are fully model based." Another candidate seconds this by explaining that "We have used 3D models, but they have not been filled with all the necessary information and therefore we have not implemented BIM completely on this project."

**Level of Development**

In order to get a better understanding of how BIM is used on the projects the candidates were asked how detailed the digital model is. To this the candidates of both Nye Veier and the NPRA answered that the ambition is that a BIM is supposed be created in the planning phase and be a part of the project all the way until the its termination. Furthermore, after the project is handed

over to the users, the candidates explained that the BIM is supposed to also be used by the facility managers in a maintenance and operations of the end product.

A candidate from Nye Veier explained that "We have a BIM coordinator on our projects, who is supposed to maintain the model and follow the project from the start, all the way until the operation and maintenance phase of the project. The BIM in our projects have a high level of development, meaning that you can find the necessary information about the construction elements in the model." The same candidate also gave a short explanation of a challenge with the BIMs. "The problem with using BIM is that it is not fully standardized yet, so at the beginning of the project we were not really sure what we needed at the end of the project. We are now working on creating a standard, which will make it possible for Nye Veier to know what to expect from the contractors."

One of the candidates from the NPRA supported this, "The idea is that BIM is supposed to be used through the whole lifetime of the project, meaning that it is supposed to be used even in the maintenance phase of the project. We have high ambitions about the use of BIM, and we are for example about to introduce financial planning and time scheduling into the models. But this is still in its early phase yet."

The candidates from the NPRA on the E6 Soknedal project second this and explained that the project was old, so they had both paper drawings and a digital model on this project. But they also explained that the model was detailed enough for them to collect drawings of for example concrete reinforcement. This was second by the candidate from the construction company. Another candidate also explained that they use BIM – kiosks and that they ordered construction plans based on the model. Nevertheless, one of the candidates indicated that having both a model and a paper-based construction plans sometimes led to uncertainty about which plans was the right ones, and in some cases even led to the wrong plans being used. The candidate from the construction company did also mention that it sometimes could be a challenge that the workers needed to learn to work with digital models. "BIM has worked well on the project; the challenge, however, is that some of the workers needed to go out of their comfort zone in order to work more digitally. Nevertheless, I believe this has gone surprisingly well."

**Access to the BIM**

Considering how important communication is in order to fully utilize project management theory, the authors were interested in investigating if the professional clients all had access to the BIM, in order to fully utilize BIM as a collaboration tool. The candidates answered that they had access to the visualization model of the project. There were however some differences in what more the candidates had access to.

One of the candidates from E6 Soknedal explained that "we don't have access to the entire BIM model, but we have access to the visualization model. Not everybody has access to the complete model, however, not everyone has the competence to use it anyway."

In contrast explained a candidate from Nye Veier that "the contractor and the consultant have access to their BIM, and it is written in the contract that Nye Veier should be able to look into the BIM at all times during the lifetime of the project."

### 5.3.4 VDC

BIM is something that have been around for quite a while now, and after hearing about the candidates understanding and knowledge about BIM, the authors deemed it necessary to hear about their knowledge about VDC as well.

The candidates did not have much knowledge themselves on the subject, but they did however explain that VDC was something that both the NPRA and Nye Veier thought of as important for the future. The candidate from Nye Veier explained that they are educating and certifying the project management teams on VDC, but that it has not been implemented just yet. Furthermore, did one of the candidates explain that Nye Veier have made VDC a requirement for future projects.

The candidates from the NPRA explained that they are educating personnel on VDC and that it has been used on a few projects as an experiment. One of the candidates explained that there is some mixed feedback, but it has mostly been good. "9 out of 10 people participating in VDC have been giving a positive feedback while the 10th person indicated that it was time consuming with lots of waiting time, if there were too many people in the room."

A candidate from Nye Veier explained that some challenges with VDC is that it requires the employees to meet in one room, which can be difficult if they are in different geographic locations. In addition, does it require a lot of technical equipment which can make VDC quite costly to implement.

The candidates from the E6 Soknedal project explained that VDC was not used in the project, but that it is something that they believe can become more used in the future. One of the candidates further explained that BIM is essential in early contractor involvement, and that the candidate therefore believed that VDC probably will become a more substantial part of the NPRA.

**Knowledge on VDC**

After asking the candidates what they thought of VDC, the authors deemed it necessary to try an understand the different candidates' level of competence in VDC. From figure 26 the response is summarized with a total of seven answers from the 12 possible candidates. Out of the five candidates from Nye Veier, three of them had little to no knowledge about VDC. In the same way did four out of seven candidates from the NPRA answer that they had little to no knowledge about VDC. None of the interview candidates had more knowledge then this.

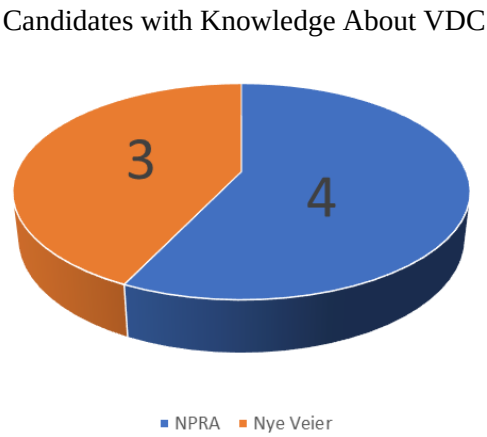



Figure 26 Candidates with Knowledge About VDC

## 5.4 Project Delivery Method

The following sections involves the organizations´ project delivery method. This sub-chapter is divided into two parts, namely the procurement method and the contract structure.

### 5.4.1 Procurement Method

The following part will include the client organizations' utilized procurement methods and the candidates´ opinions about parameters affecting the choice of procurement method. This part will also involve the candidates´ thoughts regarding how the chosen procurement method has influenced the project.

**Utilized Procurement Methods**

The first question of the procurement method section was about which procurement methods the road clients had used and are currently using. The NPRA has traditionally only used open tender competitions with the lowest price being the only award criterion. However, the NPRA have, according to the candidates, shifted the award criteria to involve more than only the lowest price. "Until now, the only award criterion in the NPRA has been price. We are now trying to shift to the use of more criteria like the contractor's previous experience and competence. Climate considerations and solutions are also a part of the award criteria." The candidates from the NPRA also stated that the organization are using more pre-qualifications of contractors in their contracts. "The contracts are getting larger and more complex than what we have seen in the past. The contractor therefore has to use more resources in developing a tender. We use pre-qualifications in order to mitigate that the contractors are using unnecessary time on developing a tender if they are not qualified for the job". The candidates also mentioned that the NPRA, to some extent, use competitive dialogue where the client can discuss solutions with the different contractors, before determining a winner of the tender competition.

When considering Nye Veier, the candidates mentioned that the organization only use Best Value Procurement (BVP). "Nye Veier has made a decision to only use BVP as the procurement method." On candidate described the BVP as following: "In the BVP method that Nye Veier use, the contractor delivers a six pages proposal for how they will solve the predefined project goals and how they will handle the client´s risk during the project. Additionally, key-personnel from the contractor is interviewed, and this interview together with the proposed solutions, risk management, and price will determine which contractor that proceeds to the next phase. The next phase involves clarifications, where the contractor must confirm that the contractor can fulfill the performance requirements specified in the offer. Moreover, there is no room for

discussions with the contractor in this phase. The clarification phase lasts between four to six weeks and Nye Veier can choose to continue with the contractor or terminate the work and try the clarification process with another contractor if we don´t come to an agreement."

**Parameters Affecting the Choice of Procurement Method**

The project group then asked the candidates what they believed was the parameters affecting the choice of procurement method.

The candidates from the NPRA believed that risk and uncertainty was one of the parameters affecting the choice of procurement method. "In simple projects with little risk can traditional open tender competitions be used, however in complex projects with a high degree of uncertainty is a competitive dialoged much more suiting." One candidate also mentioned that the market plays a role when choosing procurement method. "One must have a dialogue with the market and choose the procurement method based on this".

The candidates from Nye Veier had not reflected much about this question and said that Nye Veier has not given itself any possibilities to choose other procurement methods than the BVP. However, the candidates believed that the project´s size and complexity are parameters affecting this choice. Furthermore, the candidates believed that the project risk, and how the BVP method facilitates for the contractor to handle the client's risk throughout the project, to be one reason why Nye Veier has chosen the BVP as a procurement standard. One candidate also claimed that client requirements on project price, quality and solutions are elements that can be considered to be parameters affecting why Nye Veier has chosen BVP as only method for procuring contracts. "The founding principle of the BVP is to get the best contractor and expert to the job, not necessarily the cheapest contractor".

**The Chosen Procurement Method´s Influence on the Projects**

The project group wanted to explore how the chosen procurement method affects the project. The candidates were therefore asked in what way the chosen procurement method affected the projects.

The project manager representing the contractor at E6 Soknedal meant that the traditional way of procuring projects in the NPRA prevented the contractor to come up with good solutions. "I believe that a competitive dialogue would be more suiting for the E6 Soknedal project because then we as a contractor would be able to contribute with our experience, making the project cheaper, of better quality, safer and faster to build." The project manager continued by explaining that they had many ideas in the start of the building phase that could make the project

"better." However, the chosen procurement method did not give the contractor the opportunity to contribute with their solutions.

The candidates representing the NPRA meant that the procurement method was very important and that it influenced the projects greatly. "The larger the contract is, the more dialogue with the contractors one must have. For example, is pricing of known uncertainty easy, but if the contractor does not know the uncertainty, then the contractor must increase the cost in the tender in order to accommodate the uncertainties. This is why it is so important with dialogue in projects with a high degree of uncertainty." Another candidate form the NPRA claimed that is was too early to determine what the different procurement methods meant for the project, but the candidate finished by stating that "We had a project where we used competitive dialogue, and we would never had come up with the chosen solution on our own. It is too early to know for certain that this has made the project cheaper and faster to execute, but we think it does." Another candidate believed that the chosen procurement method can influence the number of contractors joining the competition, the size of the contractors joining the competition, and that it affects the projects result. The candidates also believed that a procurement method that forces the contractor to work on solutions in the proposal is advantageous because then the contractor becomes familiar with the project from the start. This will, according to the candidates, make the contractor to price the project better and thereby positively influence the execution phase a great deal.

The candidates form Nye Veier all believed that the use of BVP influences the project positively. "With a BVP we get the possibility to get to know the contractors, and therefore choose the contractor who is best suited for the job." Another candidate stated that "BVP gives us the possibility to choose a contract not only based on price. We also together with the contractor agree on a target price for the project. This is crucial in order to get the contractors to focus on previous experience and to come up with good solutions, without limiting themselves to the price". Another candidate supported this and answered that the use of BVP has a great influence on the project's quality and solutions. Additionally, does the BVP facilitate for the contractor to handle the client's risk. This means that the contractor has to focus on the client's risk in order to be awarded the project. Nye Veier has furthermore, according to the candidates, benefited greatly from this.

### 5.4.2 Contract Structures

The following part takes on the organizations´ utilized contract structures. This part will furthermore include parameters affecting the project delivery method, the level of the

candidates´ expertise in the chosen contract structure, and finally what challenges the candidates believed have occurred because of the chosen contract structure.

**Utilized Contract Structures**

The project group asked the candidate what contract structures the respective organizations used. The candidates from the NPRA all answered that traditionally the contract structure has been execution contracts of either prime or multiple prime contracts. This has however shifted towards the use of more Design & Build contracts. “Only five years ago, execution contracts were the main rule for almost every project. Today the main rule is to use Design & Build contracts on our large projects.” Another candidate supported this by claiming that “it has been publicly announced that the NPRA shall use more Design & Build contracts and therefore a more differentiated portfolio.” The candidate also mentioned that they have used other structures such as design and build with operations and maintenance involved, and that they in a few projects have used DBFO contracts.

The candidates form Nye Veier answered that the organization is only using Design & Build contracts with collaboration in their projects, apart from one pilot project on IPD. The candidates further explained the strategy behind only using design build contracts. “The Design & Build contract with collaboration facilitates for involving the contractor early. We involve the contractor to come up with solutions as early as in the zoning plans. After this, the next phase is to develop a building contract with the contractor in the form of a Design & Build structure with a target- or fixed price.” The candidates highlighted the importance of including the contractor early in the project. “By including the contractor in the development of zoning plans we avoid large changes and re-doings of the zoning plans when the construction begins this is very cost-saving and gives the opportunity for the contractor to come up with good solutions.”

**Parameters Affecting the Project Delivery method**

The project group asked the candidates what they believed could affect the choice of project delivery method. As shown if figure 27, one can see that the parameters of market, client’s competency, project uncertainty and risk, size, complexity, and type of work stand out as six significant parameters affecting the project delivery method.

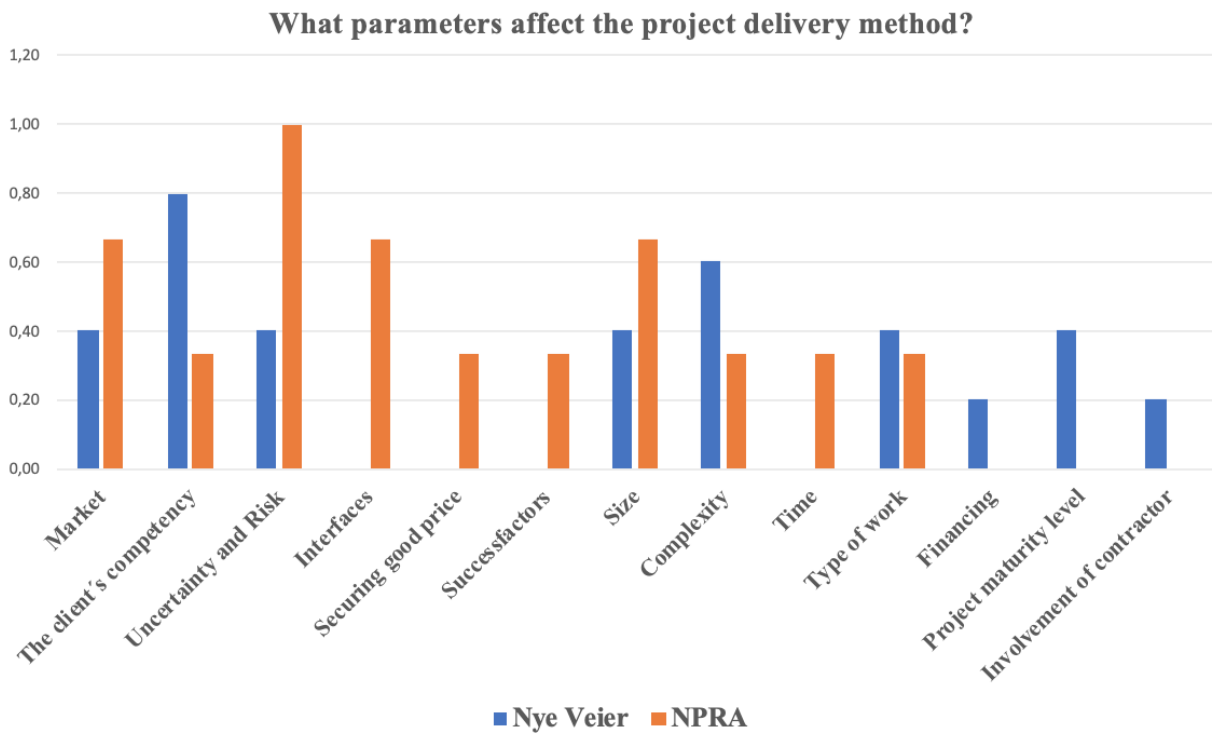



Figure 27 Parameters Affecting the Project Delivery Method

The candidates explained that the market situation influences the project delivery method as both the NPRA and Nye Veier wants a fair competition with many contractors' participating in the tendering process. "If the market consists of local and medium to small contractors, then we see that an execution contract will provide more contractors to participate in the competition for the project". The two road clients also mentioned that the market plays a big part when choosing the size of the projects.

Another element stands out is the client's competency. 80% of the candidates from Nye Veier acknowledged that the client´s competence has a large influence when choosing contract strategy. "Nye Veier is a slim organization without the same broad competence that we see in the NPRA. This is one reason for why Nye Veier has chosen Design & Build as our contract structure, because it suits the organization better."

Uncertainty and risk are acknowledged by the candidates as a parameter affecting the project delivery method. However, considering that Nye Veier is only using Design & Build, one of the candidates claimed that "Nye Veier´s philosophy is that a Design & Build contract structure is the best method no matter the project. But from my time in the NPRA, I perceived that the philosophy there was to see where the uncertainty lay and find out who carried the uncertainty the best".

The project´s size and complexity are also perceived to influence the project delivery method. 40% of the interviewed candidates from Nye Veier mentioned size as a parameter, while this number is almost 70% from the candidates representing the NPRA. When considering project complexity, 60% from Nye Veier and just over 30% from the NPRA mentioned this to be a parameter influencing the project delivery.

In addition, 40% from the Nye Veier and 30% from the NPRA mentioned that the type of work influences the project delivery method. “Different types of work might influence the project delivery method. Building a tunnel provides other project properties than for example building a bridge. This has to be taken into consideration when developing the project delivery method”.

**Expertise in Used Contract Structures**

From previous research conducted by the authors, it was found that the general level of expertise when using a D&B contract structure in the NPRA should be increased in order to fully utilize the contract structure´s potential (Skaara & Liland, 2019). The project group therefore wanted to map the level of expertise in the contract structures used by the two client organizations, in order to discover areas of improvements to the organization’s expertise in the used contract structures.

The candidates from the NPRA perceived that the organization and many of the employees had good experience level with the use of execution contracts. “The use of execution contracts has traditionally been a part of the core in the NPRA. We are very familiar with using this contract structure.” However, the experience is lacking when considering Design & Build contracts. “95% of all our contracts in the NPRA was execution contracts five years ago. This number has been drastically reduced with Design & Build taking over much of the contracts. I think that this shift in such a short time has caused many of our employees to be uncertain on the contract structure of Design & Build.” One candidate described the NPRA as being in the startup-phase of using Design & Build and that the expertise therefore was low. Another candidate also acknowledged that the NPRA does not have the best expertise in using Design & Build but underlined that the organization has enough competence to use the contract structure of Design & Build.

The candidates representing Nye Veier responded that the use of Design & Build is a part of the organization’s strategy. However, the candidates continued to explain that a Design & Build structure in road projects is fairly new, meaning that few have expertise in using the contract structure for road projects as of today. “Using Design & Build for road contracts is very new

for road projects. This is something that Nye Veier has experienced. We have through the last four years become better at hiring new employees with the appropriate experience and skills with the Design & Build contracts from the building industry. We have and are currently experiencing a steep learning curve with the use of Design & Build, but I still believe that we are on a good competence-level today". This is supported by another candidate who stated that "Nye Veier has now built a great experience and understanding of the Design & Build contract structure." In addition, the candidates from Nye Veier responded that they were not completely familiar with the use of Design & Build for road projects before they started working for Nye Veier.

**Challenges as a Result of Chosen Contract Structure**

The candidates were thereafter asked if they had noticed any challenges that could have been avoided by choosing a different contract structure. The candidates from the NPRA answered from an execution contract perspective, while the candidates from Nye Veier answered from a Design & Build perspective.

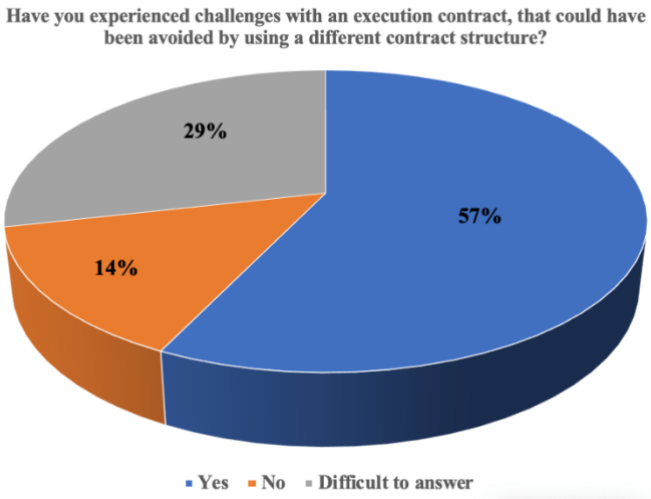



Figure 28 NPRA – Avoid challenges by Selecting Another Contract Structure

Some of the candidates from the NPRA had difficulties when trying to answer if there exist challenges that could be avoided by selecting another contract structure. One candidate claimed that challenges that arise, often are connected to interpretation. "It is not certain that a Design & Build contract structure will handle challenges regarding interpretation of the contract better than an execution contract structure, but it is too early to conclude with anything". Another candidate on the other hand, answered that it is clear that the choice of using execution contracts brings challenges. "We as a client will be responsible for the risks connected with quantities and design of the project in an execution contract. This can provide challenges. But on the other hand, will a Design & Build contract also bring challenges if changes in the project are needed." Three of the candidates from the E6 Soknedal project believed that many discussions involving the design of the project could be prevented if the project had used a Design & Build contract. "We as the client are responsible for the engineering of the project in an execution contract, and

this involves some risk. I believe we would have saved our self from some conflicts and additional project work by using a Design & Build contract." Additionally, one candidate perceived that the coordination between the contractors and the consultants as a challenge for the NPRA. "The collaboration between the consultants and the contractor is something I believe that the contractor could have done in a better way. Today we are the connecting link between the contractors and consultants, this can sometimes challenge." Also, the project manager from the contractor on the E6 Soknedal project agreed that being more involved in the planning of the project would be beneficial. "We as a contractor could have been involved in an earlier stage and influence the choice of solutions. We tried to come up with alternative solutions to the NPRA that would have made the project cheaper and faster to build, however there was no time to re-design and get the solutions approved."

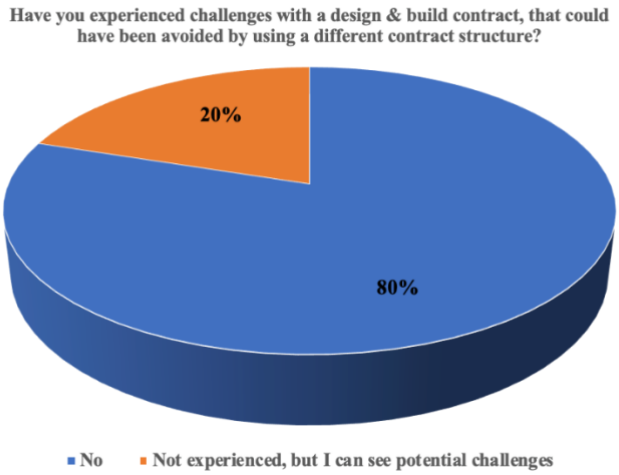



Figure 29 Nye Veier – Avoid Challenges by Selecting Another Contract Structure

Nye Veier had not experienced any challenges with the Design & Build contract structure that could have been avoided by choosing another contract structure. However, one candidate saw a potential issue with the Design & Build contract if the project experiences large changes that demands changes in the contract. Another candidate on the other hand, claimed that the chance of a contractor to get approved changes is much smaller in a Design & Build, than in an execution contract structure. This is because the D&B contract is functionality based, rather than quantity based as it is in an execution contract structure. Furthermore, the candidates agreed that involving the contractor early in the planning phase, and moving the risk to the contractors, saves the projects for many possible challenges. "Challenges connected to soil conditions are typical conflicts that arise in traditional contract structures. We try, in a D&B contract, to pass such responsibilities, that traditionally have belonged to the client, over to the contractor, in order to minimize the chances of conflicts to occur". Another candidate explained, "we are many employees in Nye Veier who previously have worked in the NPRA, where we used execution contracts. We see that the use of D&B only has given us positive experiences."

## 5.5 Interviews with Two Lean Consultants

In order to get a better grasp about which Lean tools are used in the construction industry in Norway, the project group interviewed two professional Lean consultants. The interviews were short and was specifically targeting understanding the implementation of Lean in the construction industry,

The answers provided by the candidates was that Lean is starting to become a well-known strategy for most of the bigger contractors and clients in the construction industry. They did however explain that there is still more work to be done in order for Lean to be completely integrated.

As a follow-up question to this were the candidates asked what tools and strategies that are the most suitable in the construction industry. To this the candidates answered that 5S, Last Planner, MUDA, PDCA, A3, Prefabrication, Kaizen, and Root Cause Analysis. The candidates continued by explaining that in their Lean education programs these techniques receive different amount of attention depending on the experience level the candidates are on.

The project group also asked about Six Sigma, as this had previously been mentioned as an important part of Lean Six Sigma. To this the Lean consultants answered that they had removed this from the curriculum, because to their experience, the strategy did not provide as much benefits as Lean, and they therefore wanted to shift the focus on other Lean tools instead.

# 6. Discussion and Evaluation of Findings

The discussion chapter is the part of the paper where the scientific findings and theory are discussed and evaluated, in relation to the topic of the paper. This chapter will therefore feature a discussion about **How to Achieve Improved Project Management – A Study of Norwegian Road Clients**, based on the theory and results presented in the previous chapters.

The information gained from the literature review in the theory chapter, and the interviews from the result chapter, will be discussed and compared against one another. By comparing them, it will be possible to understand how theory and practice work together in relation to one another, which is a great way to understand how to initiate improvements.

As introduced in the beginning of this paper will the topic sentence for convenience be divided into five research questions. The structure of this chapter will therefore follow this split, by dividing the overall discussion into five sub-chapters, where each of these research questions will be discussed in relation to the theory and the result chapter. Furthermore, are some of the research questions comprehensive and includes several elements. Thus, the first three research questions will include a key summary at the end, where the most important discussed findings and a conclusion to the specific research question is presented.

## 6.1 How does Recognized Project Management Theory and the Organization´s Project Management Strategy Correspond to the Actual Executed Project Management?

When pursuing how to achieve improved project management, one must understand the existing theory, the organizational project management strategy, and the practiced project management, before seeking a resolution to the inquiry. This is exactly the purpose of the research question being discussed in this sub-chapter. Although the intention of a research question is to divide the paper´s problem statement into more tangible tasks, the project group acknowledge the comprehensiveness of the research question presented above. This is why the sub-chapter is divided into three sections, whereas the first section discusses project management on a general level, the second project management tools and strategy, while the last section is a summary of the most important discussions and conclusions of the sub-chapter.

### 6.1.1 Project Management

The following section will include a discussion of theory connected to the interview candidate´s overall perception of project management, the candidates experience regarding the respective organization's execution of project management, and existing challenges connected to the executed project management. Additionally, challenges connected to the project planning process, project personnel resources, and the project charter are discussed. Finally, this section will result in a presentation of suggested solutions in order to deal with the discovered challenges.

**Project Management Tasks, Connected Challenges and Measures to Implement**

Project management was in sub-chapter 3.3 defined as "The application of knowledge, skills, tools, and techniques to project activities to meet the project requirements" (Project Management Institute, 2017). Additionally, defined Kerzner (2017) the critical success criteria for project management as conditions that much be achieved in order to reach the project objectives. These objectives were by Kerzner (2017) presented as involving that the project is finished on time, within budget, and that the outcome realizes the desired performance, i.e. reaching the project´s efficiency goals. Furthermore, was a project management task defined in this paper as the necessary work executed by the project management in order to reach the project objectives. Moreover, was it revealed in the result chapter that 10 out of 13 interview candidates believed that the most important project management task was to deliver on the efficiency goals such as HSE, quality, cost, and time of the project. Thereby, matching Kerzner

(2017)´s perception on the most important project objectives. In addition to this, mentioned the candidates collaboration, risk management, resource management, surveillance, facilitation, and including stakeholders as other important project management tasks, and in that way supporting Kerzner (2017)´s project management processes, presented in table 4. The candidate's perception of important project management tasks is also supported by both Murphy (1974) and Chan (2004) who described good coordination with stakeholders, adequate project planning, adequate communication, use of control mechanism, effective coordination, effective decision making, and monitoring as important project success factors.

In the result chapter, mentioned the interview candidates several challenges connected with the project management tasks. These challenges included having enough resources with the right competence, to be in control of disputes linked to project costs, having proper internal and external information flow, good collaboration, satisfying risk management, inadequate decision-making, and proper understanding of the project goals.

The interview candidates provided the project group with their beliefs regarding how to deal with these challenges. One solution that was mentioned, in order to mitigate the chance for not having the right and enough resources, was to use composite teams of people with the right competence. According to one of the candidates could such composite teams consist of a contract advisor, project controller, and a communication advisor, in addition to the project manager. This would give the project manager the ability to focus more on the most important project management task, i.e. achieving the project´s efficiency goals. The Nye Veier candidate, who was a former NPRA employee, further elaborated that this was substantially improved, compared to how the NPRA organized the project organization. "I felt very alone on projects in the NPRA, because I had to be the contract advisor, the communication advisor, and the project controller by myself, with little to no support." Although this is a potential measure to implement in order to get the right and enough recourses on the project, the project group suggests that it has to be considered regarding the client organizations different properties. The NPRA is executing everything from minor to enormous projects. It is therefore not apparent that it is beneficial for the NPRA to have such composite teams in regard to the smaller projects. Nevertheless, this could be beneficial for the larger projects executed by the NPRA. Nye Veier, on the other hand, have a more balanced portfolio with similar projects. One can therefore argue that having uniform composite project teams' suits Nye Veier better than what it does to the varying NPRA portfolio.

Another suggested way to deal with the challenges connected to project management, was that the client organizations should be more uniform in the way they executed project management, considering that both Nye Veier and the NPRA experienced discrepancies of the execution of projects between the different departments. Some of the candidates also believed that creating a clearer client with a more uniform execution of project management would be beneficial for the organizations both internally and externally. A suggested solution to this was to re-organize the organization into larger and more uniform divisions. Additionally, stated one candidate that developing construction contracts and internal documents with less room for interpretation, as a potential approach to create a more uniform organization. This solution, as the project group see it, can on the other hand bring negative effects. Developing a uniform organization for both Nye Veier and the NPRA is seen as beneficial. However, the project group does hesitate when contemplating to evolve contracts and internal guidelines that are less open for interpretation. This is because the project group believe that every project is unique, and therefore demand different adaptions to how they are managed. The project group also believe that such a solution, to some degree, will hinder the creativity on the project, from both the contractor and the client.

The interviews also revealed other potential improvements areas to be more lessons-learned sharing across projects, better collaboration, better communication, improved risk management, and an improved attention on the project output. However, the candidates had little perceptions on which specific measures that could be implemented in order to deal with these areas of improvement. The project group does, nevertheless, recognize that creating firm organizational guidelines that enable the awareness of the mentioned areas of improvement, is a possible approach to deal with the challenges.

**The Project Planning Process and Associated Challenges**

The project planning process is by Kerzner (2017), in table 4, presented as one of the five process groups defining project management. Being a crucial process for the project management, the project group found it necessary to map the interview candidates experience with this process. This, to discuss how possible challenges in the planning process could be mitigated or solved.

It was in the result chapter discovered that the NPRA and Nye Veier had a different experience regarding the project planning process. The overall understanding of the planning process in the NPRA was that it was a timely and ineffective process. This was mostly, according to the

candidates, a result of the many checkpoints with various stakeholders the project had to go through, in addition to the governmental QA2. Some candidates from the NPRA perceived that the inefficient and timely planning process caused the project to develop unsatisfying project plans, changes in the project plan, project delays, meager resource planning, as well as poor time management. Furthermore, was it discovered that the candidates felt that the inefficient and long waiting time in the planning process led to an attempt to compensate for the lost time, causing a rush in the design and execution phase of the project. However, some candidates supported the current planning process because it ensured the right allocation and proper utilization of governmental funds.

Opposite to the NPRA, the result showed that the candidates from Nye Veier had a positive experience with the planning process. The candidates believed that their mandate facilitated for a more efficient planning process compared to the NPRA. The result also showed that Nye Veier is exempt from the QA2 decision gate and that the organization could run several activities in the planning process simultaneously, leading to a better efficiency, more predictable plans, better resource- and time management.

When comparing the two organizations, it was discovered that the planning process in Nye Veier´s projects seems more efficient, and that the candidates from Nye Veier are more satisfied with the process than what the NPRA candidates express. However, there might not exist a quick fix for solving the inefficient planning process in the NPRA. One suggested solution is to give the NPRA a more similar model to the one that Nye Veier has. Nonetheless, it is important to understand the organizations roles when discussing how to make the planning process more efficient. Nye Veier was established in order to construct main highways connecting large cities in Norway faster and cheaper. On the other hand, the role of the NPRA is not only to build the largest roads, but also smaller and more local roads. The two organizations therefore have different prerequisites, where one of them is how they are committed to fit the projects to local communities. This was supported by one of the candidates from the NPRA who said it would be tempting to use the same model as Nye Veier, but that it probably was not the best way for the organization to use public resources. This is because the model of Nye Veier reduces the influence and the benefits of the smaller communities. One can therefore argue that the timely planning process with the many checkpoints in the NPRA´s projects is a “necessary evil” considering that its purpose is to ensures good investment of public resources, but that it comes to a cost, by making the planning process inefficient and causing delays. Based on this one can further argue that the framework conditions of the

planning process in the NPRA cannot be changed, but that it is rather a question on how to make the framework more efficient.

The candidates from both Nye Veier and the NPRA stated that there were mostly minor challenges with the collaboration between project stakeholders in the planning phase. Nevertheless, the candidates believed that the most challenging stakeholder during the planning process was the local authorities when developing municipality- and zoning plans. The result show that the NPRA perceived the local authorities to be somewhat more challenging in planning process, than what Nye Veier did. In continuation to this it was explained that the challenge with local authorities was that the municipalities want as much local benefit as possible, and that they also have the power to influence the projects since the they are the planning authority. Considering that the candidates from the NPRA feel that there exist more challenges with the municipalities in the planning phase, can be because of the fact that the NPRA and Nye Veier have a different mandate.

The mandate of Nye Veier provides a leverage towards the municipalities in the way that Nye Veier can prioritize projects in their portfolio and choose not to continue with projects if they are not pleased or does not get approved municipality- or zoning plans. Additionally, the result showed that some of the candidates from the NPRA believed that challenges with local authorities was less than before, arguing that this was because Nye Veier´s mandate had contributed to a culturally change within the municipalities, causing the municipalities to accept fewer local benefits. On a different note one can argue that the use of more governmental plans, instead of municipality or zoning plans is an approach that can mitigate the challenges concerning the municipalities demanding too much local benefits out of the project. However, this will, as previously discussed, compromise on fewer local adaptions on the projects, thereby increasing the possibility for not allocating governmental funding properly to benefit of the greater public.

Although the candidates from Nye Veier had split opinions about the challenges with local authorities in the planning phase, it seemed that the challenges had less magnitude on the projects than in the NPRA. The candidates from Nye Veier believed that the approach to solve challenges with the local authorities was to explain and create understanding about Nye Veier´s plan and to use positive incentives in order to reduce the municipalities “whishing list” for local benefits. Using positive incentives can be argued as a great way for NPRA to create a better collaboration with the local authorities, as it potentially facilitates for more “goodwill” and a give-and-take mindset between the client and the local authority.

**Project Staffing and Resources**

Defining the needed resources for a project is by Kerzner (2017) described as an important task and is included in one of the five process groups defining project management. This was also in the theory chapter supported by both Murphy (1974) and Chan (2004) who stated that adequate planning on needed resources with the right project structure are crucial project management success factors. Based on this, explored the project group how the two client organizations of Nye Veier and the NPRA staff their projects and if the candidates believed that the projects had enough resources when considering needed personnel with the right competence.

From the result chapter it became apparent that both the two clients strongly agreed that having a broad project team with good competence was vital for the project success. However, the result also showed that the two organizations have a different approach when staffing the project organization. While the NPRA claimed that they had all the needed personnel in-house, Nye Veier stated that their principle of being a "slim client" meant that only the key personnel in the project management team was employed in the organization. Any other needed competence had to be temporarily hired from consultants to the projects. Although the candidates from Nye Veier believed that hiring consultants to projects when needed, gave the organization better flexibility and therefore easier resource management, one can argue that hiring project specific resources affect the project management negatively. This is because temporary employment can cause a greater uncertainty for both the employee and the rest of the project management team. Furthermore, will this lead to a continues effort of building new relations between project participants, ultimately compromising on the establishment of proper communication and trust. This is crucial when considering that proper communication in the theory chapter was described by both Rajkumar (2010) and Kerzner (2013) as vital in order to achieve project success. It was also shown that a high level of trust would lead to repeated business, less documentation, and a greater acknowledgement of responsibility when problems occur (Kerzner H. R., 2017) (Kadefors, 2004). In addition to threatening the communication and trust, can the employer not be certain of the temporary employee´s competence and that this individual can perform the work as intended. In contrast, might having all of the resources in-house be challenging to manage and resource demanding. However, one can argue that this will lead to better communication and trust between the project management team and facilitate for less complex project management. The project group therefore believe that organizations using temporary

hired resources must be aware of the negative effects and develop frameworks that mitigate the probability for them occurring.

Moreover, both Nye Veier and the NPRA stated that they use matrix structures in their project organizations in order to fully utilize their employees. Although using a matrix structure can facilitate for flexibility and effective use of resources, one challenge, as the project groups sees it, can be that the individual employee experience a work overload, this because it is more difficult to distribute appropriate amount of work when being a part of several projects. This can ultimately be argued to affect the quality of executed project management.

As revealed in the result chapter, the 12 candidates from the two client organizations believed that they had sufficient resources on their projects. The techniques mentioned to optimize the use of resources was to do proper risk analysis of the project, create good project plans, and to perform correct delegation of the work task. This is also supported by Kerzner (2017) in the process group about project planning, presented in table 4. It can therefore be argued that such techniques facilitate for optimized personnel resource usage.

**The Link Between the Project Charter and the Project Management Document**

The project charter is, as explained section 4.1.4, a document developed by the project owner. It is then the project manager´s responsibility to answer the project charter in the form of an PMD that, as described in section 4.1.5, provides an overall strategy and framework for the project on how to execute project management. The connecting link between the project charter and the PMD is, by the project group, seen as critical considering that Kerzner (2017) presents that defining quality and quantity of work is crucial in the planning process. In addition to this, can a clear project charter be argued as important in order for the project management team to understand the intended project outcome and how this can be transferred into a project output, i.e. the project delivery (Hussein, 2018). This is supported by PMI (2017) who stresses that successful project delivery depend on if the project output realizes the project´s purpose and goal.

From the results it became apparent that Nye Veier did not use the project charter as a term, and that it was only used in the NPRA. However, it became clear that both Nye Veier and the NPRA used the term PMD. The result showed that the candidates representing the NPRA believed that there exists a potential for improving, and better specify, the project charter, securing a better link between the project charter and the PMD.

One important question that arises is how the PMD and its following output can realize the project charter´s intended outcome, if the PMD is poorly defined. It can therefore be argued that improved project charters, defining the projects intended outcome more accurate, will mitigate the chance for answering out the project order incorrect in the PMD, thereby facilitating for improved project management.

The project group believe that the following three suggestions can be implemented in order to secure a good link between the project charter and the PMD. The first suggestion is that the project order should go through a quality assurance gate, checking that it is adequately defined in order to develop a matching PMD, before it is handed over to the project manager. The second suggestion is that the project owner and the project manager together describe the project charter, and in that way, secure that the project manager understand the project owner´s intension. Finally, the last suggestion is that the project owner participates in the project manager´s process of answering the project charter when developing a PMD. In this way, one will secure that the project owner can check that the project manager has developed a PMD matching the project charter, thereby facilitating for creating a project output that is in line with the intended project outcome.

### 6.1.2 Project Management Tools and Strategies

This section comprises of a discussion and evaluation of the different project management tools and strategies that have been presented as the most vital management aspects in both the theory chapter, and the result chapter. In order to realize this, the section is divided into several parts with the headlines, Project Management Strategy Compared to Actual Executed Project Management, R760 – Control in Road Projects, Communication, Trust, Stakeholder Management, Monitor and Control of Project Work, Risk Management, and Conflict Management.

**Project Management Strategy Compared to Actual Executed Project Management**

The result showed that the candidates from the NPRA claimed that the handbook R760, presented in chapter 4, works as an overall project management strategy within the whole organization, and that the PMD serves as a project specific strategy. The result furthermore showed that Nye Veier does not have a similar overall project management strategy, but that Nye Veier also use the PMD as a project specific strategy for the project management. Having a project management strategy can be argued as crucial in order to develop a framework that ensures that important project management elements such as project success criteria and factors, communication, stakeholder analysis, monitoring and control, risk management, and conflict

management are being maintained. This is supported by Murphy (1974) and Chan (2004), who express several success factors in relation to project management. Thus, can it be argued that it would beneficial for Nye Veier to incorporate an organizational strategy for project management. On another note, it can be argued that that the PMD facilitates for realizing the project success factors, and that a well-defined PMD is crucial to develop for every project. It is therefore indisputably important that the actual performed project management correspond to, and follows, the framework of the PMD.

The result chapter furthermore showed that the candidates from both the NPRA and Nye Veier did believe that the executed project management corresponded well to the organizations project management strategy. It was however, also revealed that since Nye Veier was a new organization, the overall strategies might have changed, creating discrepancies between planned and executed project management.

Perhaps the most interesting finding in this section was that a former employee of the NPRA, whom now worked at Nye Veier, believed that Nye Veier had a more uniform and similar execution of project management on the different projects, than what the individual believed the NPRA had. The candidate elaborated this by claiming that the project managers in the NPRA have more room for individual decision-making, thereby creating more differences between the planned and executed project management in the NPRA. Although the candidate believed that the project managers of the NPRA have more room for making own decisions, they still have to adhere to the overall project management strategy of R760, thereby weakening the Nye Veier candidate´s statement. Additionally, mentioned none of the candidates from the NPRA anything that could support this statement. Then again, one argument that can support the candidate is that Nye Veier have more similar projects in their portfolio than what the NPRA does. This can endorse the statement that it is easier to perform a more uniform project management in Nye Veier since the projects themselves are more similar, thereby demanding less individual adaption for the project´s specific project management strategy.

**R760 – Control in Road Projects**

It is, as previously discussed, important to develop project management strategies in order to facilitate for achieving project management success. In section 4.1.1 was the handbook R760 described as a document that provides requirements for how road projects in the NPRA shall be managed, i.e. identified, planned, executed, and terminated for every phase in a road project. Having a project management strategy is important, however it was discussed that this alone is

not enough. The strategy has to be followed in the actual executed project management in order for it to perform as intended.

The result showed that the candidates generally perceived the handbook´s content to be good, and a helpful tool in order to create a uniform way of executing project management. Furthermore, believed the candidates that there only existed minor gaps between the handbook and the practiced project management. Moreover, was it discovered that some employees executed the activities described in R760 without realizing it, because of misunderstandings related to different practice of project management terminology. On the other hand, did it become apparent that the way the handbook is structured, by only mentioning project management elements and activities in bullet points, caused challenges regarding how elements and activities should be conducted, especially for less experienced employees. In addition to this it was also discovered that the handbook was perceived as comprehensive and even overwhelming, and that it should be revised, comprised, and formed in a simpler way to deal with the challenges. On the other hand, it was discovered that R760 is not intended to be a textbook used for educating project managers, that it is supposed to be used together with the digital quality system, and that it is a prerequisite that the users know how to execute project management in the NPRA.

Another result was that the handbook is too demanding for smaller projects, and there was a perception that insufficient personnel became a hinderance for fulfilling the guidelines of R760. This also supports the result when the candidates claimed that smaller projects often had too little personnel resource, showed in sub-chapter 5.1. Some candidates therefore believed that R760 should be divided into two separate handbooks, one for small projects below 100 million NOK, and one above 100 million NOK. However, it was also discovered that the handbook is misunderstood as too comprehensive when the employee is not experienced enough to understand that activities and elements must be adapted to the specific project. This was substantiated by one candidate claiming that the level of detail on the activities was depended on the project´s size, but that they still had to be performed.

Therefore, based on the result, it can be argued that there exist room for improving the handbook´s content and the way that it is used. One suggested measure to improve the R760 is to divide it into two separate handbooks based on the project´s monetary size. By doing so, the project group believe that issues connected to the handbook’s comprehensiveness for small projects can be mitigated. This could also arguably lead to less misunderstandings for inexperienced employees when performing the required activities. In addition to this, does the

project group find it odd that the handbook sets prerequisites for the user to know how to execute project management in the NPRA. It is therefore suggested that the handbook should be revised into a more explanatory matter, where the execution of the activities is thoroughly explained. This being said, does the project group acknowledge that making the handbook more explanatory might also make it more comprehensive. Nevertheless, is this, as well as dividing the handbook, perceived as being the best approach in order to develop a project management strategy that provides a uniform execution of project management. This is substantiated with the theory and result showing that having a clear project strategy, with less room for own interpretation will provide more similar execution of project management activities and elements, i.e. a more uniform project management execution within the organization. Based on this can it therefore be concluded that revising R760 into a more explanatory matter, can facilitate for creating a more uniform organization as discussed in sub-chapter 6.1.

The result showed that Nye Veier did not use a project management strategy, such as the R760 or similar. The project group, however, believe that possible advantageous from exploiting a framework for how to execute project management, such as R760, could benefit Nye Veier considering that the project management could be more uniform, facilitating for less misunderstandings about how project management should be executed. However, making use of a management strategy could lead to the content being misinterpreted regarding how much work the activities in the strategy demands, as was the case for the NPRA. A misinterpretation of the strategy can make a hinderance for development and creativity. It is therefore considered crucial that such a project management strategy framework must be well defined, with well described project management tasks, hence permitting the minimum room for misinterpretation of the strategy framework.

**Communication**

In the theory chapter a project management tool was defined as “a document, framework, procedure, system or method that enables a company to achieve or clarify an objective” (Brady, et al., 1997). With respect to this, it can be argued that one of the most important project management tools is communication. The reason for this is that effective project communications ensure that the right information is delivered to the right person at the right time, in a cost-effective manner. Proper communication between the project participants is therefore vital to the success of a project (Kerzner H. R., 2013). Additionally, it was underlined by Rajkumar (2010) that one can never take for granted that the receiver will interpret the message the same way as the sender intended it.

In the result chapter, stated the different interview candidates that “Communication is essential in a project, both internally and externally. Communication is a really important tool in order to get our plans approved by other stakeholders with high influence. Communication is something we really spend a great deal of resources on.” Furthermore, was it elaborated by some of the candidates that it is not enough to simply have a lot of communication, the information that is communicated has to be the right type of information, i.e. that the information has to be given in a clear way that does not give any room for misunderstanding. In addition to this was it also explained that “it is necessary to have informal communication channels between the client and the contractor. Having only formal channels will hinder a good collaboration and the work towards common project goals.”

From the results can it be determined that the candidates, and their organization, agrees with what is presented in the theory chapter and understands the importance of having good communication. It was furthermore elaborated that the communication had to be both clear and precise in order to reduce the chance of creating misunderstandings. Thus, can it be argued that it is not enough to execute communication, but that it has to be the right type. This is also supported by both Kerzner (2013) and Rajkumar (2010) who explained that one can never take for granted that the receiver will interpret the message the same way as the sender intended it. Communication can therefore be interpreted as a double edge sword where one side is the benefits of conducting proper communication, and the other side being the hazard of people misunderstanding the message. One of the techniques that can be used to make sure the communication is used correctly was presented in the result chapter as to have informal communication between the different stakeholders. This was also supported by Kerzner (2013)’s nine techniques to improve the communication flow.

In addition to this, provided the candidates different communication tools and techniques used in order to convey information both internally in the project organization, and externally between the different stakeholders in the project. The overall answer was that they used different tools in relation to the various occasion, but that both organizations preferred to have open informal communication together with formal communication. It can therefore be argued that a manager who foster good relationships with both informal and formal communication with all the project participants, will have a great possibility of achieving proper communication regardless of the tools used.

Furthermore, it was presented in the result chapter that the candidates generally were satisfied with the external communication, but that it could vary between the different stakeholders on

the various projects. There was, however, some differences in the answers provided regarding the internal communication within the organizations. While the candidates from the NPRA explained that they were satisfied, the candidates from Nye Veier disclosed that there existed challenges with the information flow.

This could indicate that there exist challenges with preforming communication, and one can therefore argue that using the right techniques might not necessarily be enough. This is explained by Abudi (2013) who claims that proper communication requires planning, because this will improve the effectiveness, frequency, and quality of the communication. Thus, it would be possible to solve Nye Veier´s communication challenges by incorporating better planning. Two candidates from Nye Veier did however explain that the organization was fairly new and some of the plans had not been fully developed yet. Nevertheless, the candidates also explained that Nye Veier is already working on creating such a plan, which indicates that they have acknowledged their shortcomings, and are working on improving them.

On another question related to the internal communication, the candidates explained that they had a horizontal organization structure. By this the candidates elaborated that there was low power distance between the employees within the organization. Nevertheless, a few of the candidates explained that there sometimes exist issues when communicating vertical in the hierarchy.

The result in relation to the organizations hierarchy and power distance can indicate that the communication generally is flowing quite freely between manager end employee. This can arguably be very beneficial for an organization as it decreases the difficulty for employees to speak up when they have something on their mind, and reduce the potential problems associated with poor communications. This was supported by a candidate from the NPRA who explained that in order to reduce the distance between the links in the hierarchy, they practice the use of colocation. By having the important project personnel placed at the same location, the NPRA hoped to optimize the communication and information flow. On the other hand, did one of the candidates from Nye Veier explain that the information flow is not always as perfect as they would like it to be. One argument supporting this could be that the organization is very large, with multiple different geographic locations, and many different divisions. This could make it difficult for the information to flow perfectly at times. As a final remark did a candidate from Nye Veier mention that while the information flow is not perfect, the person experienced it much easier to communicate in Nye Veier compared to the NPRA, which signifies that both organizations have work to do in order to maximize the benefits of proper communication.

The result chapter presented measures used by Nye Veier and the NPRA in order to perform proper communication. The most important element presented was that creating and maintaining good communication is a continuous task that require a lot of work. Another element mentioned by both the organizations was colocation, a third was the importance of start-up meetings, a fourth was about meetings, and a fifth about informal communication. Apart from these mentioned also the NPRA a collaboration document, and Nye Veier mention risk assessment as great tools.

Thus, it can be drawn clear lines between the improvement techniques presented by Kerzner (2013) and the organizations' utilized procedures. This information can therefore be used to support that one can improve the communication by utilizing different tools and techniques. That being said, could it also be argued that it is necessary to implement these tools and techniques systematically, as discussed earlier.

In the last part of the communication section presented the candidates different improvement potentials. Most of the candidates agreed that there will always exist areas of improvement. Some of the areas of improvement mentioned by the candidates were the importance of having oral communication before formalizing it, to become better at giving clear messages in order to reduce misunderstandings, to utilize BIM better as a communication tool, to be better at communicating the lesson learned to the rest of the organization, and to be a better prioritization on which issues and cases that are the most important.

All in all, can it be concluded that the NPRA and Nye Veier concurs with project theory, and that they are utilizing communication as a management tool, in order to achieve improved project management.

**Trust**

Trust is another vital aspect in relation to the collaboration between the project participants. Furthermore, will all parties benefit when trust occur in a project, because trust will facilitate long-term contracts, repeated business, less documentation and need for project team meetings (Kerzner H. R., 2017). This is supported by Kadefors (2004) who argues that "if trust is present, people can spontaneously engage in constructive interactions without pondering what hidden motives the exchange partners might have"

In the trust section of the result chapter explained the candidates several techniques, tools, and measures for gaining trust. Furthermore, elaborated one of the candidates from the NPRA, that trust is something that needs to be earned, and that showing effort and delivering on what you

promise is vital. This was second by a candidate from Nye Veier who explained this as especially important to them, considering that they are a "slim client" who demands much responsibility from the individuals. In addition to this, explained some of the candidates that giving people responsibility and authorities is a good way of building trust, because trust is not something that can be built over night, but requires time to develop. Moreover, were elements such as being honest, a team player who supports their colleagues, reliable, including, open, and clear, factors that must be in place to build trust. This was supported by a candidate from Nye Veier who stressed that "You gain trust by showing trust."

From the responses given by the candidates one can deduce that the organizations value trust vastly, and that the organizations aspire to utilize the benefits of a high trust level. One could therefore argue that the NPRA and Nye Veier are aspiring to achieve the benefits that a team with high level of trust possesses, as presented by Lencioni (2002) in table 6. Furthermore, explained several of the candidates that trust is something that needs to be earned over time by being honest, open, supportive, etc. which is in accordance with the definition of trust presented by Maurer 2010 "most researchers agree that at its core, trust is an expectation concerning the initiation or behavior of others". On the other hand, can it be argued that having too much trust can be negative. The reason for this is that some people might start to feel obligated to make irrational decisions benefiting the relationship, rather than the project, or that one starts to neglect important tasks trusting that somebody else will execute it. This can lead to dreadful consequences where important tasks are given to the wrong people, executed poorly, or simply not completed at all. Nevertheless, can the correct usage of trust lead to many benefits as presented by Kerzner (2017) and the candidates from the NPRA and Nye Veier.

Furthermore, it was in the result chapter presented that the candidates felt that there was a large degree of trust between the employees and managers. The candidates from the NPRA explained this as a result of the large degree of freedom, and authority given to the employees in the organization. This was second by the candidates from Nye Veier. In addition to this explained both of the organizations that they had appraisals or meetings, where the individual employees were given feedback on their performance, including trust. It can therefore be argued that the NPRA and Nye Veier consider the degree of trust as important within the organizations. Which could further amplify the indication that the organizations are valuing trust highly.

In the next part of the result chapter was the degree of trust to the organization explained as fairly high by both the NPRA and Nye Veier. It was however, explained that the trust towards the NPRA as an organization had fallen in the last years as a result of the reorganization. It was

furthermore explained that because the top management had acted passively and given little information about this reorganization, many of the employees in the NPRA became uncertain about their positions and as a result lost some of their trust. Moreover, explained another candidate that the reorganization caused a change in some of the routines which could impair the level of trust. This was however explained by another candidate as unfair towards the top management, as the NPRA are politically controlled by the Norwegian government. Nevertheless, expressed some of the candidates that they fully trusted the NPRA as a professional client.

In consideration to the information presented by the candidates and the project management theory, one could argue that this lack of provision of information from the top management is what creates distrust. It can therefore be argued that the top management failed to fulfill their task in being open and transparent. On the other hand, can it also be argued that in consideration to the organization being politically ruled, one cannot put the blame on the top management of the organization. Nevertheless, it can be disclosed that according to project management theory, not being able to provide the necessary information to the employees in the organization, can decrease the level of trust.

In relation to the trust between the clients and the contractor, the answers variated among the candidates. Nye Veier experienced the level of trust fairly high, while the candidates from the NPRA explained that this variated between the different projects. Furthermore, supported the candidate from the contractor organization the NPRA's statement. In addition to this, explained one of the candidates from the NPRA that they have experienced that the contractors exploit loopholes in the contract, in order to increase their profit. The candidate continued this by elaborating that the NPRA do not believe that they are cheating them, but that this is one factor when considering trust between the contractor and a client.

In consideration to this, it can be argued that Nye Veier and the NPRA have a completely different take on trust between the contractor and the client. From the result it seems that the NPRA have a lower trust level and that they are keeping the contractor under more surveillance than Nye Veier. This could be because of the different project delivery methods utilized by the two organizations. For example, is Nye Veier focusing on leaving as much work as possible to the contractor, including the operation and maintenance of the product, while the NPRA traditionally have been doing this themselves. On the other hand, might it be a case of experience. The NPRA have been around for a long time, while Nye Veier is a fairly new organization. Nevertheless, based on the project theory, it would seem advantageous for the

NPRA to try and increase their level of trust towards the contractor in order to improve the project management.

In addition to this, presented the different candidates numerous techniques used in order to build trust between the contractor and the client. The project manager from the contractor explained that they showed that they were trustworthy by following through on the deliverables, which corresponds to what the candidates from the client organizations explained as an important aspect in creating trust. From this result, one can argue that the contractor and the client have similar understanding of what is necessary in order to build a trustworthy relationship.

Furthermore, explained the candidates from the NPRA that the creation of proper communication channels, teamwork, collaboration and start up meetings where the project participants get to know each other, and mutual understanding of each other's purpose with the project, as important in order to generate trust. The candidates from Nye Veier also agreed with the NPRA about the importance of having collaboration meeting where they would discuss culture and how to interact with one another in order to make sure that everyone was satisfied with the collaboration. In addition to this, explained Nye Veier that informal communication and establishing the right dialogue as important measures in order to gain trust from contractor.

From these results, one can argue that there is a strong connection between having good communication and having trust between one another. This can be seen in connection to Abudi (2013)'s impacts on projects due to poor communications, as many of these elements would also lead to distrust and a poor relationship. Something similar was also explained by one of the candidates in relation to failed collaboration meetings, where the strong bonds of trust and communication did not occur because of disagreement's regarding different interpretations over the terms in the contract. On the other hand, explained another candidate that personal relationships play an important part of trust and communication. The candidate elaborated this by explaining that the candidate had worked with a contractor over many years and had thus created a strong personal connection. This was also supported to some degree by another candidate who explained that great professionalism and expertise would serve as a reason for good relations to the contractor. Thus, can it be argued that having proper communication and a good relationship between the contractor and the client, will help establish a high level of trust.

In summary, both the NPRA and Nye Veier understood the importance of trust, and thereby, aspired to utilize the project management tool as described in the project management theory.

In addition, the organizations understood that trust might be hard to gain, but ones it is built, it is a strong force that can help achieving improved project management. However, it also became apparent that trust requires maintenance in order to be sustained.

**Stakeholder Management**

In the theory chapter stakeholder management was explained as another imperative project management tool. A project stakeholder was defined in the theory chapter as "an individual group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project" (Project Management Institute, 2017). Furthermore, was it explained that one source of uncertainty in projects are connected to the stakeholders´ willingness, capacity, and ability to perform as required in order to achieve the project objectives. Being able to analyze and understand the stakeholders´ influence and interest in a project is therefore vital for a project manager (Hussein, 2018).

The interview candidates unanimously agreed that it was important to include and evaluate the stakeholders in the project. "The stakeholders have to be taken seriously and we need to listen to what they have to say." The candidates furthermore explained that in order to understand and properly consider the different stakeholder's impact on the project, they had to be analyzed and ranked to generate project strategies. It was also explained that both the NPRA and Nye Veier executed a stakeholder analysis in the planning stage of the project, and that the analysis was updated continuously during the project. In addition to this explained the candidates that informing the stakeholders was of high importance, and that they had different methods and systems in place to insure this.

In respect to the answers provided, one could argue that both the NPRA and Nye Veier concur with Hussein (2018), in relation to the necessity of analyzing and understanding the stakeholders in a project. This was endorsed by the candidates, who explained that the stakeholder's impact on the project needed to be considered in order to produce possible strategies to control the project, while preserving the interest of the stakeholders. The candidates, furthermore, explained that they conducted a stakeholder analysis in the start of the project. This could be argued as a clever approach, as it makes it possible to identify the different groups and their potential affect early in the project. In addition to this, was it also mentioned that the analysis needed to be updated regularly. This could be argued as necessary because the stakeholders' perspective can change during the project, failing to realize this can lead to problems such as, delays, additional costs, conflicts, etc. Moreover, can the incorrect

use of a stakeholder analysis, where the wrong information is given to the wrong stakeholder, lead to irritation, mistrust and confusion between the different stakeholders and the project. That being said, explained the different candidates that both of the organizations prioritized giving information to the stakeholders, and that they used different methods to accomplish this.

It can therefore be presumed that both the NPRA and Nye Veier understands the benefits of conducting a proper stakeholder analysis, and that the organizations are using stakeholder analysis actively in their project management strategy. As a result, can it therefore be concluded that the proper use of stakeholder analysis can be a valuable management tool used in order to achieve improved project management on projects.

**Monitor and Control of Project Work**

An important project management strategy presented is the monitor and control of project work. The key benefit of this strategy is that it allows stakeholders to understand the current progress of a project, why actions are made regarding performance issues, and to foresee future project status with cost and schedule forecast.

In the result chapter it was discovered that the candidates from both Nye Veier and the NPRA used PMD, and that it was an important project document that contained the project strategy, that the organization used to monitor and control the project work. It was furthermore revealed that the PMD was consistently updated, and that several aspects of the document were used regularly. It was however, also disclosed that some of the project management candidates did not use the document in their daily activities, which they themselves explained as something they could become better at. In addition to this, it was explained that the PMD received most attention during its creation, and that some of the elements received more consideration than others.

The answers presented indicates that both Nye Veier and the NPRA uses the PMD to monitor and control the project work, in relation to the Project Management Institutes (2017) definition of the project strategy. Furthermore, it was disclosed that the PMD contained several strategies for, HSE, scheduled time framework, quality, economy, project goals, and other necessary parts needed in order to successfully complete the project. Which is also indicated as important elements in the project theory in relation to current progress of a project, performance issues, and cost and schedule forecast. (Project Management Institute, 2017). It was however, disclosed that some of the project management candidates did not use the document in their daily activities, which was confirmed as the case in the E6 Soknedal project. It can on the other hand

be argued that there is no need to use the PMD in the everyday activities, considering that "it is the project team who is creating it, and that the content is at the core of the project team's execution." Nevertheless, can it be concluded that the right use of the monitor and control of project work can be considered important in relation to both the results presented by the interview candidates, and the project theory.

On the matter of time, cost, and quality, was it explained in the result chapter that the candidates generally experienced the procedures relatively similar. The overall answer was that the project schedule was used as a measure of time, whereas a control system was used to measure the quality of the work, and a cost forecast together with the actual cost. There were however some discrepancies between Nye Veier and the NPRA on the matter of quality, as it was explained that the NPRA used more resources on surveillance than Nye Veier. A candidate clarified that Nye Veier focused on giving more responsibility to the contractor and therefore used less resources themselves on the surveillance of the project.

From the results it can be argued that organizations are monitoring and controlling the project aspects of time, cost, and quality. This is not a very surprising result as this is one of the most basic ideas in relation to fulfilling the tactical aspects of the project deliverables, as presented in the theory chapter by Hussein (2018). What one the other hand was an interesting finding, is that the NPRA and Nye Veier execute the quality control differently. Nye Veier focus more on giving trust to the contractor and letting them be responsible for a longer warranty period, while the NPRA are focusing on controlling the contractor by having multiple inspections. As argued in the trust section, can it be advantageous for the NPRA to incorporate less control over the contractor, while maintaining the necessary control in order to reap the benefits presented by the Project Management Institute (2017).

The results regarding how the organization monitored actual project execution compared to planned project execution, some of the candidates explained that the best method to measure this was to look at the time schedule and the billing cycles. It was furthermore elaborated that if the actual execution was behind schedule the problem would be discussed with the contractor in order to try and find solutions. Additionally, was it explained that the project managers worked proactively with meetings in order to find anomalies before they grew into larger problems. If this were unsuccessful, the NPRA would use daily fines in order to pressure the contractor to uphold the contract. In comparison explained the candidates from Nye Veier that they preferred giving positive incentives to the contractors when they complete their tasks on schedule.

In relation to how the organizations monitored the difference between executed and planned project execution, it can be argued that the NPRA and Nye Veier are utilizing several of the elements described as necessary in the monitor and control of project work process presented by the Project Management Institute (2017). In addition to this, can it also be argued that by involving the contractors and proactively working to find anomalies, the organizations are also following some of the strategies presented in the section regarding trust and communication. That being said, emphasized the two organizations on different solutions regarding how to pressure the contractor to uphold their end of the contract. Using daily fines could be argued as damaging because if the contractor is not able to uphold their end of the contact, the relationship might become poor and conflicts might occur. On the other hand, can positive incentives be perceived as an encouragement, increasing the moral of the project participants. However, only having positive incentives can make the contractor relax as there are not negative consequences. Nevertheless, can it be argued that having positive incentives carries greater benefits to the project, but that it should not be used exclusively without negative incentives.

It was evident from the result that the candidates from both the NPRA and Nye Veier believed that the project manager had the necessary authority to make decisions in the project. The candidates from the case study E6 Soknedal confirmed this and explained that they mostly experienced that they had the necessary authority to make decisions. On the other hand, explained the candidate from the contractor on the E6 Soknedal project that the decisions are in some instances a bit slow in relation to when problems have to go far up in the management chain, instead of letting the construction manager handle it. That being said, explained the candidate that most of the challenges were solved within reasonable time

It can be argued that not having the necessary authority to make decisions can make it difficult for a project to move forward at times of uncertainty. From the answers provided by the candidates from the NPRA and Nye Veier does this not seem like an issue, as the candidates explained that they have enough authority, enough freedom, the right skills, and ability to make decisions. One of the candidates however, explained that while the project managers generally have enough authority to make decisions, there are restrictions in relation to finances. “Which means that as long as the decision does not make things more expensive, they have the authority to handle any problem.” Another candidate supported this and explained that “the project managers have the necessary authority to make decisions in the larger picture, but there are examples of how a decision-making process can take very long if the necessary authority lies at higher level in the hierarchy”. This was also supported by the candidate from the contractor

on the E6 Soknedal project, who explained that it would be beneficial for the construction manager to have more authority to make decisions.

Based on the theory and the result, it can be concluded that the NPRA and Nye Veier utilizes the project management strategy monitor and control of project work. Furthermore, it can be concluded that there exists a potential for Nye Veier, and especially the NPRA, in relation to improving the use of the management strategy, ultimately leading to improved project management.

**Risk Management**

Another important management tool used to control a project, is risk management. The objectives of project risk management were defined in the theory chapter by the Project Management Institute (2017) as to increase the probability and/or impact of positive risks and to decrease the probability and/or impact of negative risks, in order to optimize the chances of project success.

In the result chapter the candidates from the NPRA explained that they practiced risk management by using PUS. It was also elaborated that the extent of how often this was executed varied between the candidates. Additionally, was it explained that PUS follows the project from early planning to the project termination, and that the tool was used to some extent during meetings. Although every candidate from the NPRA claimed that PUS is a great tool, some also mentioned that there are challenges involved with using it. The challenges mentioned was in relation to having the right competence and expertise to identify and mitigate uncertainties.

The candidates from Nye Veier claimed that risk management is one of the most important tasks in a project, and that they used a lot of resources on risk management. In addition, it was explained that Nye Veier established an uncertainty register early in the project, and that they updated this regularly throughout the project.

Considering that risk management is about identifying and mitigating risks in order to optimize the project's chances of success, it can be argued that both the NPRA and Nye Veier have recognized the potential benefits of risk management. This is endorsed by the candidates own description of risk management. It was, furthermore, explained that both the organizations utilized the risk management throughout the entire project. That being said, it was also identified that the extent of usage varied between the candidates in the NPRA. There could be several reasons for this. One reason could be that the candidates consider it as unnecessary, or that there are not enough time and resources. Nevertheless, can it be argued that it would be

beneficial to the NPRA to spend more time on risk management, in order to optimize the chance of project success as presented by PMI (2017). This is supported by one of the candidates form the NPRA, who explained that risk management is one of the areas where the NPRA has the greatest potential for improvement.

While there exist numerous benefits with proper risk management, it can also be argued that there exist several challenges with the project management tool. One of the challenges mentioned by the candidates was in relation to the comprehensiveness of the uncertainty analysis. Another challenge is to have personnel with the right knowledge and skills to identify risks that can have a potential impact on the project. These challenges and more, was also identified by Hussein (2018), who discovered several human-based challenges with risk management. It is therefore important to include the right personnel with the right competence, and to perform the identification phase of the risk management properly.

In addition, the candidates explained that they, in general, were quite satisfied with the risk management within their organization. The candidates from Nye Veier did however have a higher satisfactory level than the NPRA. This was based on the responses provided, where a candidate from Nye Veier explained that they had received lots of positive feedback from project partners and other organizations, while some of the candidates from the NPRA believed that there exists a potential for improving the risk management practice.

It can be argued that risk management is valued differently within the two organizations. This was also supported by a candidate from Nye Veier, who previously had worked in the NPRA, who stated “I feel that we have significantly better processes for handling risks in Nye Veier, than what my experience was in the NPRA. My experience from the NPRA was that managing uncertainty and risk was seen as something you had to in the last minute, and not something that was done because of the benefits it brought to the project.” This argument can on the other hand be classified as highly personal and might not be true for the NPRA as an organization. In addition, have the NPRA undergone a reorganization since this candidate worked in the NPRA, meaning that a lot of things can have changed. Nevertheless, can the difference in risk management satisfactory level, combined with the answers provided by the candidates, indicate that there exists a potential for improving risk management in the NPRA.

All in all, can it be deduced that risk management is a great project management tool that can be used to identify and mitigate uncertainties within a project. Thus, can it furthermore be

concluded that the NPRA and Nye Veier can achieve improved project management by continuously developing and perfecting the risk management throughout the project.

**Conflict Management**

The last project management tool presented is conflict management. It was in the theory chapter explained that "Good project managers realize that conflicts are inevitable, but that good procedures or techniques can help resolve them" (Kerzner H. R., 2013). It was furthermore explained that there exist several degrees of conflicts, and different approaches in how to solve them.

The results explained that conflicts were to be taken seriously and should be solved quickly. Furthermore, the candidates explained that conflicts should be handled at the lowest possible level. If the project managers were not able to solve the problem, a conflict in Nye Veier would be transferred to a conflict resolution board called PRIME. The candidates from Nye Veier elaborated that this resolution board worked proactive with project meeting two to four times a year, and that they had many positive experiences with this procedure. On the other hand, was it revealed by a candidate from Nye Veier that the organization still needed to create a better procedure to handle conflicts before they reached PRIME. In comparison, the NPRA utilized a conflict staircase, coupled with good procedures at handling conflicts at all levels. In both organizations, a conflict would be transferred to a higher level if the project managers were unable to solve the problem. The next step in the process would be an expert or a resolution board, which also worked proactively by having meetings and informal communication. In addition to this, concurred the candidates from the case study of E6 Soknedal with the overall strategy of the NPRA, and explained that this procedure worked in their project.

In relation to the answers presented by the candidates, it can be argued that the NPRA and Nye Veier are prioritizing conflict management as an important management strategy. This was endorsed by the candidates' explanation of the organizations' procedures for handling conflicts, which follows Kerzner (2013) statement about good project managers having procedures and techniques in order to resolve these conflicts. It was however, also discovered that Nye Veier had not the best procedure to handle conflicts at the lowest level. This can be argued as a severe problem as it is, according to their own strategy, where most of the conflicts are being handled. Moreover, are the NPRA a well-established organization which have, according to the candidates, developed a process for handling conflict together with the industry. This can

indicate that the NPRA have more experience regarding conflict management, and that they have had more time to optimize it.

The results revealed that the person responsible for handling the conflicts was the managers on the projects. It can therefore be argued that conflict management is a part of the project managers tasks, which is supported by Kerzner (2013) who explained several problem-solving aspects a project manager needs to aspire. It was furthermore disclosed that if the conflict escalated, the responsibility for resolving the conflict where transferred to an expert or a resolution board. This is in accordance with the degrees of seriousness of conflicts as explained by Lædre (2018). It can on the other hand be argued that leaving all this responsibility on the project manager can be negative, considering all the other responsibilities the project manager has. The conflicts might for example take the time away from other important task delaying the project, or not be given enough attention. It could therefore be argued that having an additional employee responsible for only handling conflicts might be beneficial to the projects. That being said, can it also be argued that by executing right project management, conflicts will not occur, making such an individual redundant.

It was furthermore explained that solving conflicts fast, informal, and at the lowest possible level was the best way to stop possible conflict escalations. This was supported by a candidate that explained that finding the cause and avoiding misunderstandings would be a great way to solve problems before they develop into serious conflicts. This is also supported by Kerzner (2013) who explained that risk management can be used in order to identify challenges, uncertainties, and reduce the possibility of the problem becoming more serious. This is, however, dependent on having a good project management team that are able to find and solve anomalies. If this does not work, the candidates explained that the organizations would utilize the expert, conflict resolution board, or PRIME. If nothing works, then a candidate from the NPRA said that they would prepare for going to court.

In addition to this, explained the candidates that the principle cause of conflicts are disagreements in relation to the contractual parts of finances, quality, and different contract interpretation. In addition, was personal conflicts, and the responsibility distribution explained as causes of conflicts. It can therefore be argued that a proactive approach to evaluate these elements could be of great benefit for the project manager in the risk assessment, in order to reduce the chance of a conflict arising.

In summary, a proactive approach to conflict management can reduce the causes of conflicts. It can furthermore be argued that both the NPRA and Nye Veier have a solid grasp over how to solve conflicts and how to deal with them in case they grow in degree of seriousness. That being said, can it also be deduced that Nye Veier needs to give more attention on how to solve problems at the lower levels in order to achieve improved project management.

### 6.1.3 Key Summary

In this sub-chapter was project management theory along with the two organizations´ project management strategy and tools compared to the executed project management. Moreover, have important project management tools and strategies been discussed in relation to what tools and strategies the organizations used and prioritized, what is recommended in the project management theory, and how the answers provided corresponded to actual execution of project management. This section will present the key discussions and conclusions regarding the research question.

When considering the most important project management tasks, the candidates supported the project management theory by claiming that the most important project management task is to deliver on the efficiency goals such as HSE, quality, cost, and time of the project. Thereby, matching Kerzner (2017)´s perception of the most important project objectives. The candidate's perception of important project management tasks is also supported by both Murphy (1974) and Chan (2004) who described several important project success factors.

The interview candidates mentioned several challenges to the project management in the two client organizations. A suggested solution that was presented in order to deal with these challenges was to use composite teams of people with the right resources. However, it became apparent that using composite teams was not the necessary the best solution for the smaller NPRA projects, and that the use of composite teams suited Nye Veier and larger NPRA projects better. It was also discussed that executing more uniform project management would be beneficial for the organizations. Developing contracts and internal guidelines with less room for interpretation was discussed as a solution in order to create a more uniform way of executing project management within the organization. This solution was however, by the project group, considered to have negative effects because every project is unique and therefore also demands adaptions to how it is managed. Moreover, was an establishment of creating arenas for more lesson learned across projects advised as a measure with great potential for both Nye Veier and the NPRA. The project group also suggested that creating firm organizational guidelines that

enable awareness of better collaboration, communication, and risk management as a possible approach to deal with these challenges.

When considering the candidates perception of the planning process was it discovered that the candidates from Nye Veier was more satisfied with the planning process, than what the NPRA candidates expressed. The planning process in the NPRA was perceived as being inefficient and it was discussed if the organization should adopt Nye Veier´s model in order to increase the efficiency. However, it was discovered that Nye Veier's model does not integrate the local communities in the same way as the NPRA. Being that the NPRA builds more local roads, it was concluded that the model of Nye Veier does not suit the NPRA. It was on the other hand suggested that the NPRA instead has to make the current planning process and its framework more efficient. The use of more governmental plans was discussed as a possible way for the NPRA to do so, without adopting Nye Veier´s model. Furthermore, was the use of positive incentives towards the local authorities considered to be a great measure to implement in order to create a better collaboration between the client and local authorities, ultimately leading to a more efficient planning process.

When contemplating on the two organizations approaches to staff the project organizations became it apparent that Nye Veier and the NPRA believe in different staffing-models. Nye Veier is perceived to be a "slim client" with little in-house competence, while the NPRA have all the required competence hired on a fulltime basis. It was suggested that using temporary hiring of project management staff would provide more flexibility to the project organization and an easier management of the personnel resources. On the other hand, believed the project group that having to temporary hire project management staff would lead to negative effects in the project organization, concerning communication, trust, and competence of the hired personnel. Moreover, was it discovered that the use of matrix structures in the project organizations could offer more flexibility and efficient use of resources, but that there exists a chance for employees being submitted to work-overload when working across projects, consequently affecting the quality of the executed project management. Additionally, was it discovered that the use of proper risk analysis, good project plans, and correct delegation of the work task, would facilitate for optimized personnel resource usage.

When deliberating on the link between the project charter and the PMD, it was discovered that a good link between these two documents is crucial in order for the project to produce a project output that realizes the intended project outcome. It was also discovered that there exist potential improvements concerning the link between the project charter and the PMD in the

NPRA. In order to ensure a good link between the project charter and the PMD recommended the project group that the project owner and the project manager together should collaborate more in the process when developing the project charter and PMD. This is believed to secure that the project´s intentions in the project charter is transferred to the PMD. Additionally, the project group believed that the project charter should be subjected to a quality check, before it is delivered from the project owner to the project manager.

In the topic related to how project management strategy compared to actual executed project management, it was discovered that the candidates experienced that the strategy corresponded to the execution. Furthermore, it was elaborated that the handbook R760 is used as an overall project management strategy in the NPRA, and that the PMD served as the project specific strategy. In comparison utilized Nye Veier also a PMD, but they did not have an overall project management strategy. Thus, was it concluded that the NPRA and Nye Veier's usage of the PMD was performed as intended, but that Nye Veier would benefit from incorporating an overall strategy in line with project management theory. It was however discovered that a candidate believed that Nye Veier had a more uniform project execution than the NPRA, indicating that there are some discrepancies between the answers.

It was furthermore discovered that the handbook R760 was mostly meant for the project managers and the project owner of a project in the NPRA, and that the candidates generally perceived the handbook´s content to be good, and a helpful tool in order to create a uniform way of executing project management. It was however also discovered that the structure of the handbook caused challenges regarding how elements and activities should be conducted. In addition to this was it revealed that the handbook could be perceived as too comprehensive and demanding for smaller projects. Thus, can it be concluded that there exist room for improving the handbook´s content and the way that it is used. It is therefore suggested that the handbook should be revised into a new outline where the activities are explained, and that it should be divided depending on the project´s monetary size.

From the discussion related to communication was it discovered that both the NPRA and Nye Veier highly valued communication as a project management tool. Furthermore, explained the candidates that clear and concise information together with informal communication as important measures in achieving good relationship and communication between the project participants. In addition to this was several challenges with communication identified regarding planning and miscommunication. Another finding was that the NPRA and Nye Veier generally experiences that the power distance within the hierarchy is low and that it is easy to talk to the

managers and coworkers. Finally, were different improvement measures discussed in relation to project theory. All in all, can it be concluded that the NPRA and Nye Veier concurs with project theory, and that they are utilizing communication as a management tool, in order to achieve improved project management.

In the section concerning trust was it revealed that both the NPRA and Nye Veier values trust highly, and that there generally was a high degree of trust internally in the organizations. In continuation, was it also presented several important elements about what one need to do in order to earn trust. It was also discovered that a recent reorganization had disrupted the organizational trust in the NPRA, and that Nye Veier and the NPRA had different level of trust in relation to the contractors. Thus, was it argued that it could be advantageous for the NPRA to increase their level of trust towards the contractor. Finally, was it concluded that by having good communication and a good relationship to the other project participants one would achieve a higher level of trust.

In respect to the part related to stakeholder analysis could it be argued that both the NPRA and Nye Veier understands the importance of analyzing the stakeholders in a project. It was furthermore revealed that the organizations conducted stakeholder analysis in the start of the project, and continuously during the project. This makes it possible to identify the different groups and their potential effect on the project, as well as notice changes in their behavior during the project. It was therefore concluded that a proper use of stakeholder analysis can be a valuable management tool for achieving improved project management.

In the section related to monitor and control of project work was it discovered that both Nye Veier and the NPRA use the PMD to monitor and control the project work. Furthermore, was it also revealed that some of the project management candidates used the PMD less than preferred, and that this could have a negative effect on projects. On another note, it was also disclosed that the organizations monitored the tactical aspects of time and cost similarly, but differed in their execution of quality control. As a result, was it concluded that it would be advantageous for the NPRA to incorporate less control in their quality surveillance. In addition, was it discovered that the organizations worked proactively in order to monitor the differences between planned and executed project management, and that the organization had a different approach in regard to making sure that the contractor upheld their end of the contract. Based on this, concluded the project group that that having both daily fines and positive incentives would carry greater benefits to the project. Finally, it was discovered that both the NPRA and Nye Veier experiences that the employees had the necessary authority, but that there were

restrictions in relation to finances. As a result, can it thus be concluded that there exists potential for Nye Veier, and especially the NPRA, regarding improvements in the use of the management strategy monitor and control.

In regard to risk management can it be argued that the NPRA and Nye Veier have realized the potential benefits of systematizing and evaluating risks. It was, furthermore, discovered that both the organizations attempt to utilize risk management throughout the entire project, but that the extent of usage varied between the candidates within the NPRA. It was concluded that it could be advantageous for the NPRA to spend more time on risk management. In addition to this, was it revealed that there exist several challenges with risk management. The candidates´ response to this was that by having people with the right competence during the risk identification phase, one could mitigate these challenges. As a result, can it be deduced that risk management is a great project management tool that can be used to identify and mitigate uncertainties within a project.

On the topic of conflict management was it disclosed that both Nye Veier and the NPRA prioritized conflict management as an important management strategy. It was furthermore clarified that it is the project manager, who is responsible for handling conflicts within the projects. That being said, was it also explained that Nye Veier did not have a uniform plan about who is responsible for handling conflicts on the projects. As a result, was it therefore argued that Nye Veier could benefit from implementing an organizational procedure of how they were to solve these types of conflicts. On another note, was it also revealed that if the conflict escalated, both of the organizations had procedures in place to cope with this. In addition to this was it also disclosed that the preferred approach to handling conflicts was to solve them as quick as possible, by using proper communication, risk management and other project management tools. It was therefore concluded that a proactive approach, where one mitigates the chance of a conflict, was the best solution.

## 6.2 How does the Clients Utilize Productivity Management, and How does This Affect the Organizations' Project Management?

The second research question in this master's thesis embraces the topic of productivity management. The reason why this topic can be considered an important aspect of this report, is because of its indistinct comparability to the problem statement. The purpose of the research question is furthermore to understand how the clients utilizes productivity management, and how it affects the project management of the organizations, which is in direct alignment to the problem statement. This sub-chapter will therefore present the findings on productivity management from the theory and the result chapter, before comparing the findings and discussing how this is relevant for achieving improved project management. This sub-chapter will furthermore be divided into the four sections of Supply Chain Management, Lean, BIM, and VDC, in order to present the discussion in a systematic order.

### 6.2.1 Supply Chain Management

Productivity management is a method used to analyze and understand where the production is slow, why it is slow, and how to make it more productive (Phusavat, 2013). One of the productivity management tools presented in the theory chapter was Supply Chain Management, which focuses on better communication between all elements of the supply chain.

The interviews revealed that neither Nye Veier nor the NPRA had particularly much knowledge about Supply Chain Management. Almost all of the candidates explained that they either did not know what it was or had a misconception about what it was.

The answers given by the candidates does therefore strongly indicate that supply chain management is not a part of the NPRA nor Nye Veier's project management strategy. One can however argue that the two organizations should adopt Supply Chain Management in order to reap the benefits provided by the method. One argument supporting this is presented by Akintoye (2000), who stresses the importance of quality, cost, delivery time, teamwork, co-operation and effective coordination in the supply chain, and that incorporating this strategy will reduce the amount of misunderstandings, miscommunication, and mistakes, ultimately decreasing the necessary resources and increasing the productivity. Love (1999), supports this by explaining that a dysfunctional supply chain can lead to dreadful repercussions such as time waste, unnecessary costs, increased misunderstandings, and rework.

However, one can also argue that as a client organization both Nye Veier and the NPRA do not need to focus on the supply chain, making this an unnecessary addition to the workload. This

was furthermore supported by some of the interview candidates who explained that the supply chain was something the contractor is responsible of. Other issues regarding the adoption of Supply Cain Management identified by Akintoye (2000) and Hundnukar (2013) was in relation to cultural differences, shortage of training and education, lack of involvement from the top managers, trust issues, commitment issues, stakeholder issues, etc.

Nevertheless, can Supply Chain Management be beneficial to both Nye Veier and the NPRA as it might increase the information flow between the different stakeholders within a project. Thus, can supply chain management furthermore lead to standardization of the supply chain, ensuring higher efficiency, a better product delivery, and ultimately be utilized as a tool to achieve improved project management.

### 6.2.2 Lean

Another productivity method presented in the theory chapter, was the Lean methodology. Lean was defined as to "develop the highest quality products, at the lowest cost, with the shortest lead time by systematically and continuously eliminate waste, while respecting people and the environment" (Cherrafi, et al,. 2016). Moreover, explained Wig (2014) in the theory chapter that Lean is about using different methods, principles, and tools to give the most value to the customer with minimal usage of resources. This part will be divided into several smaller headlines based on the different Lean sections presented in the theory and in the result chapter.

**Usage of Lean**

From the result chapter regarding Lean, explained the candidates from the NPRA that they did not use Lean as a strategy, but that they instead used some of the Lean principles unsystematically. "We have no definite Lean strategy, but we work on improving the efficiency of our projects and I believe we utilize many of the Lean methods, but without the systematic approach." The candidates from Nye Veier stated on the other hand that they utilized Lean as a strategy. "We use Lean in order to eliminate waste, and to create a streamline process in order to handle the different situations."

From the different responses one can notice that the candidates from both organizations explained that they facilitate for the use of productivity strategies and that they wish to improve their efficiency. However, they disagreed on the importance of utilizing Lean to achieve this. Advantages with using Lean as a strategy instead of cherry picking tools from the methodology, is that one gets a systematic approach to the implementation, "Lean project management differs from traditional project management not only in the goals it pursues, but also in the structure

of its phases, the relationship between the phases and the participants in each phase." (Ballard & Howell, Lean Project Management, 2003).

Nevertheless, explained the candidates from the NPRA that they have a project management strategy within their R760 handbook, where the candidates believed many of the Lean elements were included, or even specialized to the NPRA's way of working. This might according to Aluhuraiser (2017), be a method that is just as viable, as using Lean. "A number of companies have experiences challenges when implementing Lean. The key to success is the ability to identify the critical success factors regarding implementation and the organizational resources and capabilities, and then plan to strategize accordingly."

It can therefore be difficult to conclude which of these strategies are superior when evaluating them. Even so, one can from the results presented by the candidate deduce that a systematic approach has given the candidates from Nye Veier a better awareness over the organization's strategy, and thereby given the candidates a better understanding of how productivity management can contribute in improving project management on their projects. This can lead the argument in favor of implementing the Lean strategy in its complete form, and not only elements of it.

**Lean Challenges**

The implementation of Lean is a complicated process where multiple challenges needs to be addressed. It is therefore imperative to identify possible threats, barriers, and critical success factors that might hinder the implementation process. Some barriers explained in the theory chapter was organizational change, employees' willingness to change, top management commitment, skills and expertise, education and training, communication etc. (Alhuraish, 2017).

From the result it is possible to observe that some of the challenges related to the implementation of Lean in Nye Veier was, the organizational change, interorganizational teamwork, and priority issues. Thereby matching the challenges presented by Alhuraish (2017) This could indicate that Nye Veier is using more resources on increasing their productivity and have, as a result, discovered several limitations with the implementation process. The NPRA on the other hand did not experience any problems with utilizing Lean, which is understandable given that they have not made use of the strategy. That being said, explained the candidates that they utilized a few elements of the Lean methodology. This can indicate that the NPRA's approach might be less effective, considering that the NPRA has not experienced challenges

with the utilization of the productivity method. However, it might also indicate that they are experiencing less problems with their approach. It would therefore be difficult to conclude if the NPRA's strategy is working, and further research is required.

Nevertheless, does these results in comparison to the theory, indicate that Nye Veier is getting more feedback and that the candidates in this organization have a better understanding of both the benefits and the challenges with using Lean. It is for example explained in the theory chapter that having full support and dedication from the top management in an organization is vital for Lean to be implemented successfully (Alhuraish, et al,. 2017). This is supported by the candidates in Nye Veier, considering that they have Lean responsible employees dedicated to evaluating their projects and using this experience in order to affect the productivity management strategy in the whole organization, which ultimately can lead to improved project management.

**Last Planner**

In the theory chapter was Last Planner explained as a system created to reduce the amount of time wasted on poor planning, in order to get the work and production schedule under control. (Ballard G., 2000). In addition to this was Last Planner explained as a short term commitment among individuals or groups, where the purpose is to plan ahead in order to increase the participation, commitment, planning and learning outcome (Ballard & Howell, Lean Project Management, 2003).

Furthermore, was it in the theory chapter explained that Team planning, Interactive Blackboard plans, and Pull planning are important aspects of the Last Planner method. Team planning is about involving the people with the right knowledge in the correct phases (Ballard & Howell, Lean Project Management, 2003). Interactive Blackboard meetings is a technique where the project participants come together in order to generate concrete plans based on the Team planning principles (Statsbygg, 2018). Pull planning is about finalizing and creating the most efficient and productive project plans as possible. (Ballard & Howell, Lean Project Management, 2003).

In the result chapter, it became apparent that the candidates from the NPRA knew very little about the theory and reason behind the Last Planner method. That being said, did the project group deduce from the responses that some of the candidates exercised some of the principles from the Last Planner method, such as arts of the planning process and interactive blackboard meetings, in their projects. On the other hand, explained Nye Veier that they use the Last

Planner system i.e. planning, team planning, blackboard planning and pull planning in their projects. The candidates from Nye Veier elaborated this by explaining that they utilize Team planning by involving all the necessary people early in the planning process. “Nye Veier wish to involve the contractor early in the planning process in order for the contractor to help identify challenges, and to make use of their expertise to find the best solutions.”

When comparing the theory about the Last Planner method and the results presented by the candidates it has become apparent that Nye Veier is actively working on utilizing the concepts of the method, while the NPRA is not. One can therefore argue that Nye Veier will achieve increased productivity in relation to reducing the amount of time wasted with poor planning, and get the work and production schedule under control, as explained in the description of the Last Planner system. Another argument in Nye Veier’s favor is that one can by utilizing aspects of Team planning, Interactive Blackboard meetings, and Pull planning achieve greater and more productive plans. A candidate from Nye Veier confirmed this by explaining that they “utilized team planning in the sense that they involve all the necessary people early in the planning process, and by doing this could the contractor help identify challenges and to make use of their expertise to find the best solutions.”

It is, however, important to understand that while the NPRA explained that they did not utilize the Last Planner method, they did use parts of it. This could indicate that the NPRA believe that these strategies might be unnecessary, because the NPRA is already utilizing the optimal solution. On another note, could it also indicate that the candidates did not have enough knowledge on the subject, considering that the NPRA is utilizing Team planning to some extent in the ECI procurement method, which will be discussed in sub-chapter 6.3. Nevertheless, if one is to consider the project theory and the responses provided by Nye Veier, the NPRA would experience positive results by systematically introducing the Last Planner method.

**Other Lean Methods**

In addition to the Last Planner method were the interview candidates asked about other Lean tools. The first tool that the candidates was asked about was PDCA, which is four stage approach for continually improving the different processes, products or services and resolving problems (Mind Tools, 2017). The second Lean tool the candidates were asked about was the Root Cause Analysis, which is about retracing the steps that lead up to the event and try to understand why things happened the way they did, in order to mitigate the probability for it to happen again (Moore, 2007). The third tool the candidates were asked questions about was

Lean Six Sigma, which is a business strategy and methodology that increases process performance, and develops customer satisfaction, leadership, and bottom-line results by improving quality, speed and costs by applying the tools and techniques from both Lean and Six Sigma (Cherrafi, et al,. 2016) (Snee, 2010).

The results regarding the use of PDCA in the NPRA and Nye Veier showed that the candidates in the organization were rather oblivious about the method. Most of the candidates did not know what it was, and even after it was explained to them, the candidates still did not know if the organizations utilized it. That being said informed one candidate from each organization that they used the PDCA technique, making the project group question the validity of the answer about PDCA.

In relation to Root Cause Analysis was it discovered that only a few of the candidates had knowledge about the method, and those who did, explained that it was something used in relation to find the underlying cause of problems related to HSE.

From the results concerning Lean Six Sigma answered the candidates in unison that both the NPRA and Nye Veier did not use it. Few knew what it was, and those who did, explained that this was not something that the organizations prioritized, but that elements of it was included in their project management strategy through other names and procedures.

It can be deduced that neither of these three Lean tools are well known to the candidates. This can be a result of these methods being down prioritized compared to other techniques and tools. For example, does this seem to be the case with Lean Six Sigma which all of the candidates explained as not a part of the organization's productivity strategy. On another note, can it also indicate that both Nye Veier and the NPRA have not been able to fully implement these strategies into their organizations. The reason behind this argument is that there were candidates in both of the organizations who had knowledge about the Lean tool of PDCA and Root Cause Analysis. A possible reason for this might be the that difference in the terminology and names of the different techniques, have led to confusion about what each technique actually is about.

All three of these techniques can according to the theory be effective in relation to find and reevaluate problems in order to reduce waste and increase efficiency. It could therefore be in the best interest of both Nye Veier and the NPRA to increase the awareness of these Lean tools in their organizations and to focus on standardizing terms and procedures, this to create a unified understanding of what the different tools and methods entails.

### 6.2.3 BIM

A Building Information Model (BIM) is an accurate virtual model of a building or construction that can be used for planning, design, construction, and operation of the facility. If the AEC industry utilizes this model properly the projects can decrease project cost, increase productivity and quality, and reduce project delivery time (Azhar, et al., 2008).

This section will feature a discussion about the theoretical benefits of BIM, and how this correspond to the Norwegian road client's experience of using BIM presented in the results chapter. In order to accomplish this, will this section be divided into three parts of BIM usage, Level of Development, Access to the BIM.

**BIM Usage**

The results presented by the interview candidates of both Nye Veier and the NPRA indicates that the organizations are currently using BIM and that they have high ambitions about the use of the method in the near future. It was however also indicated that BIM is still in the implementation phase, considering that multiple candidates explained that older projects were still in the process of changing from the traditional paper-based drawings to model based ones.

In respect to the answers provided by the candidates in relation to usage of BIM, one can argue that the NPRA and Nye Veier both concur with the benefits provided in the productivity management theory. A candidate from the NPRA and Nye Veier even went as far as to explain that they are including BIM requirements in the contracts, forcing this digital shift on the projects. Thus, indicating that the organization have acknowledged the advantages BIM can provide for the productivity.

This forceful implementation can be argued as both a positive and a negative approach. It might be considered positive because it can speed-up the implementation process, leading to the possibility of reaping the benefits quicker. While it on the other hand, can be considered negative as it can increase the necessity for reeducation, burdening the project and ultimately leading to lower productivity. That being said, even if one chooses a fast and forceful, or a slow and steady implementation, the introduction of BIM can be concluded as a positive measure in consideration to increasing the productivity, and ultimately be an asset in achieving improved project management.

**Level of Development**

A BIM model is a sophisticated model with information about different element, such as, a CAD model with information regarding the physical and functional characteristics and project life cycle, data about the supplier, and operation and maintenance procedures, cost estimates and project schedules and more (Azhar, et al., 2008). In addition to this can a BIM have different sophistication level as presented in The Level of Development, which is a references tool intended to improve the quality of communication about the characteristics of elements in the models (BIM Forum, 2019).

The candidates from both the NPRA and Nye Veier explained that the ambition is to use BIM from the start of the project, and further transferee it to the operation maintenance phase. In order for the model to be used like this, the candidates explained that the Level of Development needed to be high. Thus, is the BIM supposed to contain all the necessary elements needed to both build the product, and maintain and operate it after its completion. It can furthermore be argued that the clients currently practice the LOD 300, but that their ambition is to reach the LOD 400.

When comparing the organizations understanding of BIM to the theory, it is clear that the perception is in alignment. As a result, can it based on the theory be argued that the NPRA and Nye Veier are going to experience the benefits provided by utilizing BIM in the future.

**Access to the BIM**

BIM provides faster and more effective processes because information is easily shared. The use of BIM also facilitates for better design solutions because building proposals can be analyzed and simulated, enabling improved and innovative solutions (Azhar, et al., 2008).

It was in the result discovered that the candidates perceived that they had all the necessary access to the visualization model. Furthermore, it was discovered that the candidates from the E6 Soknedal project did not have access to the full BIM, only the visualization model. Moreover, presented the candidates from Nye Veier that it was written in the contract that they should be able to access the full BIM if necessary.

Considering that BIM is about sharing information, having complete access to the BIM can be perceived as necessary if one is to fully utilize the benefits of the model. The results provided by the candidates from the NPRA indicated however that they did not have complete access to the BIM. This can therefore be argued as a hindrance to perfect implementation of the BIM. On the other hand, indicated one of the candidates that having complete access was unnecessary

for the client organizations, considering their role in the project. Nevertheless, does it seem like having complete access to the BIM can be beneficial in relation to utilizing all the benefits provided by BIM, leading to better productivity management, and ultimately improved project management.

All in all, can it be concluded that by utilizing BIM, the client organizations can increase their control of the project, which can increase the productivity, and ultimately achieve improved project management.

### 6.2.4 VDC

In addition to Supply Chain Management, Lean and BIM, is VDC a strategy which can be used in order to increase the productivity. The principle of VDC is to use an integrated, multi-disciplinary, performance based, virtual building model of design-construction projects to support explicit and public business objectives (Kunz & Fischer, 2012). In order to do this, the VDC strategy utilizes and add together several tools and strategies, such as BIM, POP, ECI (Kunz & Fischer, 2012).

In the result chapter it was discovered that neither of the candidates in the NPRA nor Nye Veier had much knowledge about VDC. However, they explained that this is something the organizations are working on implementing for future projects. Furthermore, explained a candidate from the NPRA that the organization have experimented with using VDC on a few projects, and that they mostly have had positive experiences with it.

The answers presented by the candidate strongly indicated that VDC previously has not been a part of the NPRA or Nye Veier's project management strategies. The answers do, however, indicate that this is something both of the organizations are working on implementing. Thus, this can mean that the organizations concur with project management theory about the benefits related to implementing VDC as a productivity strategy. This was supported by the candidate from the NPRA who explained that "9 out of 10 people participating in VDC have been giving a positive feedback, […]."

That being said, one can argue that implementing VDC carries a few challenges that needs to be considered in order to fully utilize the benefits of the method. One challenge presented by a candidate was that "[…] the 10th person indicated that it was time consuming with lots of waiting time, if there were too many people in the room." Possible solutions to this could be to utilize the Lean techniques and educate the employees better or utilize project managers' expertise to direct the flow of the conversation, minimizing the waiting times.

An argument given by a candidate from Nye Veier against the use of VDC "is that it requires the employees to meet in one room, which can be difficult if they are in different geographic locations. In addition, does it require a lot of technical equipment which can make VDC quite costly to implement." This is however in direct opposition to what was presented in the theory chapter where Kam (2013) explained that VDC enables multi-disciplinary cooperation, cost saving, and that the use of the productivity management tool can add more value to the projects.

It can therefore be argued the while VDC has presently not been fully implemented in the NPRA or Nye Veier, it can be advantageous for both of the organizations to continue implementing the strategy in order to increase the productivity. Ultimately, leading to better collaboration, shortening construction duration, and better error detection, which can be important elements in achieving improved project management.

### 6.2.5 Key Summary

In this research question have four different productivity methods been discussed in relation to the project management theory, the results presented by the candidates, and how these methods can help to achieve improved project management.

It was concluded that an introduction of Supply Chain Management can be beneficial to both Nye Veier and the NPRA as it might increase the information flow between the different stakeholders within a project. Furthermore, was it established that Supply Chain Management can lead to a standardization of the supply chain, and ensure higher efficiency and better product delivery, and ultimately be utilized as a tool to achieve improved project management.

It became apparent that Nye Veier had a good understanding of the productivity management tool Lean, while the NPRA did not. It was furthermore discovered that Nye Veier utilized the Lean strategy and had dedicated personnel who worked on the implementation of the method, while the NPRA chose to focus on their own management strategy in the form of R760. While it could be argued that these productivity methods can be equally successful, it seemed like implementing Lean as a strategy was more successful in relation to the candidates understanding and knowledge about productivity management. This became apparent when the candidates were asked about the Last Planner method, considering that the NPRA had little knowledge about the benefits of the productivity management tool, while it was a really important element of the productivity strategy to Nye Veier. Nevertheless, from the answers regarding the Lean tool of Root Cause Analysis and PDCA, does it seem like Nye Veier still have a long way to go in relation to getting all the employees on the same education level on

Lean. In the same sense that the NPRA had modest knowledge about Last Planner, they also had a modest amount of knowledge about the other Lean tools. It can therefore be argued that the NPRA could benefit from changing strategy to one that focuses on a more uniform implementation of the different productivity strategies.

It was furthermore concluded that both the NPRA and Nye Veier are using BIM in their projects and have high ambitions of utilizing it even further in the future. Furthermore, was it discovered that both organizations concurred with project theory about the importance of having detailed BIMs in order to use it to its full potential. Nevertheless, was it also discovered that not all the candidates had complete access to the BIM, reducing the potential benefit of a BIM.

In addition to this, indicated some of the candidates that the path to utilizing BIM is not without challenges. One of the challenges presented was that there is a lack of standardization in relation to BIM, which can make it difficult to transfer model-requirements across projects, thereby decreasing the effectiveness of the implementation process. Nevertheless, the candidate explained that solutions to these challenges are being worked on, signifying that the implementation of BIM is going strong.

Another discovery was that VDC has not been fully implemented in the NPRA or Nye Veier, and that it can be advantageous for both of the organizations to continue implementing the strategy in order to increase the productivity.

All in all, it can be concluded that by utilizing Supply Chain Management, Lean, BIM, and VDC, the client organizations can increase their control of the project, better collaboration, shortening construction duration, which can increase the productivity, and ultimately be a link to achieve improved project management.

## 6.3 What Parameters Affect the Project Delivery Method, and How does the Project Delivery Method Influence the Project Management?

The third research question in this master´s thesis incorporates the question of what parameters that affect the project delivery method, and how the chosen project delivery method influences the project management. Recognizing this is crucial in order to answer the problem statement on how to achieve improved project management for the two road client organizations. This sub-chapter will, for the sake of simplicity, be divided into three sections, whereas the first section will discuss procurement methods, the second contract structures, and finally a discussion of other existing project delivery methods that could be utilized by the road clients.

### 6.3.1 Procurement Method

This section will discuss the clients´ utilized procurement methods, the parameters affecting the choice of procurement method, and finally how the chosen procurement method influences the project management.

**Utilized Procurement method**

It was in section 3.6.1 Procurement method, presented that the traditional procurement method used for road projects in Norway was an open quantity based tender competition, with the lowest price being the only award criteria (Lædre, 2006). It was also shown that the industry recently had started a shift towards the use of procurement methods that are functionality-based and values the most economically advantageous tender (NPRA, 2019). This is supported by the paper´s result, where it was presented that the NPRA traditionally had been using open tender competitions with quantified specification of work, and that it was not until recently that the organization had shifted towards pre-qualifications and competitive dialogue. Moreover, did Nye Veier confirm that the organization only utilized the procurement method of BVP.

**Parameters Affecting the Choice of Procurement Method**

The theory showed that the rationale of the ECI methods, BVP and CD, was that the contractors, by being involved in the planning phase, could use their construction experience to give the client inputs on solutions that could improve the product´s quality (Song, et al., 2009). Furthermore, Wondimu (2018) stated that the use of ECI is beneficial to projects with the following properties: complex, have a significantly degree of uncertainty, when the client has little in-house competence, when a project can benefit from innovative solutions, and when the client is unaware of what is really needed in order to complete the project. One candidate from

the NPRA supported this by stating "In simple projects with little risk, can traditional open tender competitions be used, however in complex projects with a high degree of uncertainty is a competitive dialoged much more suiting." Moreover, was the market situation mentioned as a parameter affecting the choice of procurement method, because it would influence the number of contractors joining the competition. Nye Veier, on the other hand, mentioned complexity, size, the client´s requirements on project price, quality, and solutions to be parameters affecting the choice of procurement method. Additionally, claimed one candidate that on reason for selecting BVP was that it reduced the client´s risk by giving the contractor the responsibility.

Based on this, does it appear that the result presented by the candidates corresponds to the PDM theory. It can therefore be suggested that the parameters affecting the choice of procurement method are the project´s complexity, uncertainty, risk distribution, inhouse client´s competence, need for innovative solutions, client's requirement on project price, quality, and solution. It can be argued that the organizations competence and portfolio affect the procurement method. The NPRA is a client with broad competence who execute smaller projects below 100 million to large projects with 17 billion NOK. It is therefore argued that the difference in project also provides needs for different ways of procuring. Furthermore, was it discovered that a CD requires considerable competence and resources of the client, while the BVP demanded less resources and in-house competence. This is possibly one reason why Nye Veier, as a "slim client" only use the BVP method. Additionally, is the portfolio of Nye Veier more similar in size and complexity, making it easier to have one procurement method.

**The Chosen Procurement Method´s Influence on the Project Management**

The theory presents some challenges following the ECI-methods BVP and CD. One challenge was that the ECI methods requires a comprehensive cultural change when implementing to organizations that are accustomed to traditional procurement methods (Wondimu, 2018). Additionally, Wondimu (2018) claimed that good teamwork was necessary in the ECI, and that the lack of this would prevent the development of good solutions. Furthermore, required the use of Competitive Dialogue more resources earlier in the project, making the need for organizational support for using ECI important (Wondimu, 2018). Moreover, was it presented that BVP demand less resources for the client in the procurement phase, as the client only review simple project proposals from the contractors (Wondimu, 2018).

On the other hand, claimed Wondimu (2018) that the client gained better project control with a CD, than in projects using traditional procurement methods, and that it would facilitate for

better trust and communication between the contractor and client, leading to better collaboration of the involved parties in the project. Wondimu (2018) also presented that a BVP, in comparison to a traditional procurement method, provides the client with more innovative solutions, earlier project risk identification, and that contractor and client get a good relation early in the project. This was presented as to facilitate for better collaboration in the execution phase. This was supported by the contractor´s project manager on the E6 Soknedal who stated that "I believe that a competitive dialogue would be more suiting for the E6 Soknedal project because we as a contractor would be able to contribute with our experience, making the project cheaper, of better quality, safer and faster to build." Additionally, believed the project manager that they had better solutions, but that the traditional way of procuring did not give them the opportunity to implement these solutions.

These benefits were supported by the NPRA candidates who stated that it is important to involve contractors early, in projects with a high degree of uncertainty. Another candidate also stated that "We had a project where we used competitive dialogue, and we would never have come up with the chosen solution on our own. It is too early to know for certain that this has made the project cheaper and faster to execute, but we think it does." Finally believed the candidates from the NPRA that procurement methods that facilitate for the contractor to work on solutions in the proposal would produce benefits. This because, the contractor is more familiar with the project from the start, making the contractor better suited to price the project more accurately, ultimately giving positive effects in the execution phase regarding collaboration and trust.

The candidates from Nye Veier also supported Wondimu (2018) about the benefits provided by a BVP and explained that the procurement method facilities early relationship building with the contractors, and thereby selecting the contractor who is best suited for the job. The candidates also alleged that a BVP gives the possibility for not only awarding the contractor based on price, but that it also facilitated for the contractor to focus on their previous experience, leading to a better end-product. Finally did the BVP, according to the candidates, enable a better understanding in the distribution of the project risk. This because the BVP considers the contractor´s handling of the client´s risk as one of the award criteria, thereby supporting Wondimu (2018) who stated that the project risks are identified earlier in the project with the use of a BVP.

As discussed, does the theory and the result from the interview candidates correspond well. That being said, one could ask how does the chosen procurement method influence the

management of the project? The answer to this could be as presented by Wondimu (2018), the NPRA and Nye Veier, that the use of ECI procurement methods provides a better collaboration, trust, and communication earlier in a project, than what a traditional procurement method does. Communication and trust were in section 3.4.1 and 3.4.2 described as crucial project management tools in order to succeed with a project. It can therefore be suggested that the use of ECI will facilitate for better collaboration, communication, and trust in the project, and thereby also improving the project management.

The procurement method CD provided, as expressed by Wondimu (2018), a better project control and solutions to the project. It was however discovered that the CD demands much coordination and resources in the procuring phase of a project in order for the contractor and the client to come up with good solutions. This can imply that this method is quite demanding regarding the project management.

On the other hand, the results indicate that BVP did not require much resources from the client. This can thereby imply that the management of this procuring process require less resources for the client compared to a traditional procurement method or a CD. This result underlines one possible reason for why Nye Veier as a "slim client" only use the BVP as their procurement method. Additionally, claimed both Wondimu (2018) and Nye Veier that the BVP presents the possibility to identify the project risks earlier in the project. Nye Veier also stated that the organization distributed the responsibility for the client´s risk to the contractor. This could furthermore provide less unforeseen events as the project progresses, and therefore arguably demand less management for the client. It could also be implied that the use of a BVP makes the risk management simpler, than in a traditional procurement method. The final influence the BVP have on the project management is, according to the candidates from Nye Veier, that it makes it harder for the contractor to demand changes in the contract. This, because the specification of work is functionality based instead of the traditional quantity based. One could therefore entail that less changes in the contract, makes the management of the project less demanding for the client.

### 6.3.2 Contract Structure

The following section will discuss the client´s utilized contract structures and the parameters affecting the choice of contract structure. Finally, will it follow a discussion on challenges resulting from the chosen contract structure, and how this influence the project management.

**Utilized Contract Structures**

In section 3.6.2 Contract Structure, was it presented that the contract structures in the Norwegian construction industry mainly was divided into execution contracts and the D&B contract structure (Gullhaug & Sangolt, 2016). The NPRA claimed that the organization traditionally had been using execution contracts, but that they in the recent years had experienced a shift toward the use of more D&B contracts. Nye Veier on the other hand stated that they only used D&B contracts.

**Parameters Affecting the Choice of Contract Structure**

According to Lædre (2006), will the client in an execution contract keep the risk associated with the design and engineering of the project, as well as the coordination between the designer and the contractor. It was discovered that execution contracts were to be used in projects with high complexity where "business as usual" would not be sufficient, and that the use of execution contracts did not expedite for involvement of the contractors in the early stages of a project (Lædre, et al., 2006). This was supported by the contractor on the E6 Soknedal project who claimed that they as a contractor should have been involved earlier in the planning phase. Considering that they had tried to suggest better solutions, but that there was no time to get the solutions approved.

Moreover, was it presented by Lædre (2006) that the use of a D&B allows the contractor to be involved at an early stage in the project, which facilitates for the contractor to use its expertise and knowledge regarding solutions on how to execute a project (Lædre, et al., 2006). However, Lædre (2006) also presented that the contractor takes more risks associated with the design and coordination of the project. The candidates from both the NPRA and Nye Veier supported Lædre (2006) when claiming that project uncertainty and risk, together with the complexity of the project are parameters affecting the choice of contract structure.

With this in mind, why do the NPRA use execution contract and D&B, while Nye Veier only use D&B? This could arguably be because Nye Veier has a different project organization than the NPRA considering that Nye Veier is a "slim client", and do not possess the same in-house competence as the NPRA. They consequently have to use a contract structure that transfer much of the workload from the client to the contractor. This is, as Lædre (2006) presented, what the D&B does when transferring the design and coordination, and its associated risks to the contractor. Based on this, one could ask why the NPRA, with such a broad competence, choose to use more D&B structures on their projects. One of the reasons might be that a D&B fits the

large projects with a high degree of uncertainty better, because it reduces the client´s responsibility of uncertainty and risk. Another reason might be the fact that the NPRA, due to the recent reorganization, to some degree, have lost the broad competence and that the use of D&B therefore suits the overall organization.

**Challenges as a Result of the Chosen Contract Structure, and its Influence on the Project Management**

It was in section 3.6.2 Contract Structure described that the chosen contract structure sets prerequisites for the responsibility regarding the design and engineering of the project (Gullhaug & Sangolt, 2016). It is the client who is responsible for the design and engineering in the execution contracts of prime- and multiple prime contract structures, while the contractor is responsible for the design and engineering when using a D&B contract structure (Lædre, et al., 2006).

The candidates from the NPRA acknowledged that the use of execution contract structures provided challenges to the project management regarding the client´s risk connected to project quantities and the design of the project. However, it was also stated that a D&B could bring severe challenges to the management if changes regarding the project work were needed. Furthermore, believed the candidates form the E6 Soknedal project that many discussions, conflicts, and additional work involving the design of the project could have been prevented had there been used a D&B, instead of an execution contract structure. The responsibility of the design also provided, according to the candidates, more risk to the client and more work connected to the coordination between the consultants designing the project and the contractor executing the project work. On the other hand, stated one candidate from the NPRA that a D&B contract did not automatically fix the challenges regarding different interpretations of the contract between the client and the contractor.

Furthermore, was it in the result chapter presented that the candidates from Nye Veier had not experienced any issues because of the chosen contract structure. However, one candidate from Nye Veier supported the opinion, stated by the NPRA, that changes in the contract could cause challenges for the project management in a D&B contract structure. Nevertheless, claimed another candidate from Nye Veier that the chance of changes to occur in the contract is marginal in a Design & Build compared to an execution contract structure. This is because the D&B contract is functionality based. The candidates from Nye Veier furthermore substantiated their belief on the D&B contract structure, when stating that many of the employees in Nye Veier had previously worked at the NPRA and used execution contracts. The candidates furthermore

claimed that they have only experienced positive experience with utilizing the D&B contract structure.

With this theory and result in mind, how does the chosen contract structure affect the project management? It is clear that an execution contract will provide more risk and uncertainty, regarding the design and coordination between the contractor and consultant, for the client. It is therefore obvious that, seen from the client´s perspective, the use of a D&B contract structure will decrease the potential issues and challenges for the management of the project. However, one can argue that a D&B contract can cause severe challenges for the project management in the execution phase of the project if changes occur because of poor project description. On the other hand, does the D&B contract structure provide properties that could reduce the demand for managemental intervention, and arguably be less challenging. This because the D&B provides the contractor with more responsibility, which according to some of the candidates, would prevent challenges with conflicts and rework.

One factor greatly affecting the project management is, as previously discussed, the client´s in-house competency. This can be further prostrated to the organization's competency and expertise regarding the utilized contract structures. From previous research, it was discovered that there existed potential for improving the level of expertise in a D&B contract structure in the NPRA (Skaara & Liland, 2019).

The result showed that the candidates from the NPRA believed they had great expertise in using execution contract. On the other hand, acknowledged the candidates from the NPRA that their expertise in using a D&B is not the greatest. This was not a surprising result, considering the project group´s suspicion from the previous research, and the fact that the NPRA only recently started utilizing D&B contracts on a larger scale. The candidates from the NPRA believed that this rapid shift towards increased use of D&B had caused many of the employees in the NPRA to become uncertain on how to fully reach the potential of a D&B structure. Moreover, did the candidates from Nye Veier also recognize that there existed possible improvements when using the D&B structure. This result was by the project group more surprising, considering that the candidates from Nye Veier stated that the use of D&B is a substantial part of the organization´s strategy. One would therefore think that Nye Veier had a great experience with using a D&B. The reason for this lacking D&B expertise is, according to the candidates, that Nye Veier is a four-year-old organization and thereby have not had enough time to build experience. This is furthermore supported in the result that show that the extensive use of D&B in the Norwegian road construction industry started only half a decade ago. This being said, believed some of the

candidates from Nye Veier that they had experienced a steep learning curve, and that the organization had built some experience and understanding of the D&B contract structure.

One can therefore suggest that there exist challenges with the expertise when utilizing a D&B structure for both the NPRA and Nye Veier. In consideration to this, one could ask, how the level of this expertise could be increased? In order to answer this question, one must understand that the use of D&B in Norwegian road project is something that is new, and that time will contribute to build better expertise. However, the project group believe that one approach is to hire employees with experience with the D&B structure from the building industry. By mixing the expertise from experienced employees in the traditional way of executing road projects and employees with experience with the D&B structure, the project group believe that the overall expertise in using a D&B structure in road projects will increase.

The project group believe that increasing the expertise on D&B structures will have many positive effects for the project management. Moreover, is it suggested that this will cause less misunderstanding and conflicts between the client and the contractor, better understanding of the project risk and its distribution, better communication between the client and the contractor, and faster decision-making. Additionally, will an improved expertise in the D&B structure result in better utilization of the contract, making it easier for the project management to exploit project resources, and better understanding of the responsibility areas in the D&B. This will finally ease the project management when pursuing the projects efficiency goals of time, cost, and quality.

### 6.3.3 Utilized PDM Versus other PDMs

From the theory and the result chapter it became noticeable that the two most used contract structures are execution- and Design & Build contracts. Furthermore, was it discovered that the procuring methods of traditional open tender competition, competitive dialogue, and best value procurement was the most utilized methods. However, both in the theory and in the result was IPD and DBFO mentioned as other project delivery methods. The question that arises is therefore how the extensively utilized methods compare to methods that are not utilized to the same extent, and how these affect the project management.

The result showed that the only organization using an IPD was Nye Veier, and that it was only used as a pilot project. The theory claimed that an IPD is a project delivery approach that integrated people, systems, business structures and practice into a process that harness the talents and insights of all participants. This will optimize the project result, increase value to

the owner, reduce waste, and maximize efficiency through the phases of design and construction (The American Institute of Architects, 2007). It was also described in the theory chapter that an IPD, similar to a CD, gives room for negotiation between the project participants, but that it unlike a CD, also gives room for negotiation and changes in the project work during the execution phase.

As presented previously, one concern explained by the NPRA and Nye Veier was that possible changes in the project work in a D&B could cause substantial hazards, as it would be costly. One can therefore suggest that, by using an IPD instead of a D&B, the management of unforeseen events that demand changes in the project work will be "smoother" as the IPD allows, and to a larger degree, facilitates for change throughout the project. On the other hand, was it in the theory chapter presented that an IPD demands a high degree of trust between the project participants, and that the involved participants must understand that collaboration will benefit the whole project. It was also discovered that the IPD demands early contractor involvement and increased planning effort, with the intention of decreasing the resources used in the execution phase (The American Institute of Architects, 2007). When considering these properties, one can suggest that the use of an IPD is more challenging to manage and demands more resources in the early phases of a project than what a D&B with a BVP does. Based on this, one could suggest that the IPD as a project delivery method is not optimal for the client organization Nye Veier, as they consider themselves as a "slim-client" with little in-house competence.

Another project delivery method mentioned in the theory and the result chapter was the DBFO, which was revealed to only be used by the NPRA in a minority of the projects. In section 3.6.2, the DBFO was described as similar to the D&B, with the difference being that the project owner leaves the responsibility regarding financing and operations of the facility to the contractor (Lædre, et al., 2006). The contractor´s responsibility of financing and operating the project are two properties that, on the contrary of an execution structure, D&B and IPD, allows the client to perform less control of the contractor. The rationale behind this, is that because the contractor is responsible for financing and operating the project, it will be in the contractor´s best interest to choose quality solutions that will keep the costs of project operations down to a minimum. Seen from a project management perspective, one can suggest that a DBFO will lead to less demand for the client to do control work in the execution phase of a project, compared to execution and D&B contracts. Additionally, can it be argued that a DBFO will ease the clients project management, because it is the contractors who develops a project proposal with pricing,

meaning that the client does not need to develop a detailed project cost estimate. However, one can suggest that, similar to a D&B, the DBFO requires more resources and management in the start-up phase when developing the project scope than what a DBB structure does. This, in order to avoid unforeseen events that can cause necessary changes in the project work during the execution phase.

### 6.3.4 Key Summary

This section will provide a summary of the most important discussions and conclude what parameters that affect the project delivery method, and how the project delivery method influences the project management.

The parameters affecting the choice of project delivery method are the project´s complexity, size, uncertainty, risk distribution, the market situation, client´s competence, need for innovative solutions, and the client's requirement on project price and quality. These parameters were also acknowledged to be the reason for why the NPRA, with a broad competence and varied portfolio, chose its procuring methods to be open tender competitions and a few projects with CD. Nye Veier on the other hand, chose to only use BVP considering that it demands less resource, which arguably suited the organization better because they are a "slim client" with little in-house competency and a more uniform portfolio. It was also discovered that the use of an execution contract, over a D&B, demand more resources and follow-up by the client, therefore suiting the competency of the NPRA, but not the "slim client" Nye Veier.

When discussing how the project delivery method affect project management it was discovered that the use of ECI will provide a better collaboration, trust, and communication earlier in the project, thereby facilitating for better project management. It was also noticed that the use of CD demands much coordination and resources in order to develop good solutions, implying that the project management of this procuring method can be more challenging. The BVP was on the other hand argued as a method demanding less resources, with fewer challenges regarding project management. Another discovery was that the BVP facilities for understanding and distributing the client´s risk earlier in the project. It was therefore implied that the use of a BVP makes the risk management for the client easier than in a traditional procurement method. The final encounter on the BVP regarding project management was that this, would entail less changes in the contract, making the management of the project less demanding for the client.

It was discovered that the use of execution contracts structures provides more risks for the client, regarding the coordination between the contractor and consultant. Furthermore, it was

discovered that the D&B contract structure brings properties that could reduce the demand for managemental intervention, and thereby less challenging regarding the management of conflicts and supplementary contract work. Moreover, was the use of IPD and DBFO discussed as two contract structures that could affect the project management. The IPD was suggested to bring positive effects when managing unforeseen changes in the project work, but that the use of IPD also demanded more management of resources in the early phases of a project. The DBFO was on the other hand described as a contract structure facilitating for less client surveillance on the contractor. Furthermore, was it discovered that changing the project scope in a DBFO could cause severe challenges. However, it was revealed that the DBFO required less client resources, arguably providing an easier project management for the client.

Another finding was that there exist a potential in increasing the organizations´ expertise on the D&B and that this would cause, fewer misunderstandings and conflicts between the client and the contractor, better understanding of the project risk and its distribution, better communication between the client and the contractor, and faster decision-making. In addition, would this lead to the organization taking better advantage of the contract, making it easier for the project management to exploit project resources, and understanding the different responsibility areas of the D&B. Thereby making it easier for the project management to achieve the crucial task of meeting the project´s efficiency goals. One approach for increasing the client´s expertise in the D&B was to hire employees from the building industry, while at the same time using the existing road client competence.

## 6.4 How does the NPRA and Nye Veier Compare Regarding Project Management?

The fourth research question undertakes a comparison between project management in the NPRA and Nye Veier based on what have been discussed in the three previous research questions. The purpose of this question is therefore to evaluate and highlight the findings, and present them in a systematic outline, in order to demonstrate how project management is executed differently, similarly and in the same way, between the two organizations. This sub-chapter will furthermore serve as an introduction to the next research question where recommendations for improving project management will be presented.

In the discussion related to research question one, was it revealed that the NPRA and Nye Veier executed the planning process quite differently. The NPRA had a political system with lots of bureaucracy, while Nye Veier had the ability to make more decisions without too much political involvement. Furthermore, explained the candidates that they experienced the NPRA's process to be less efficient, but that it carried other benefits that were arguably lost with Nye Veier's mandate. On the other hand, was the different project manager tasks similar between the two organizations, which can indicate that many of the same project management elements are the same for the NPRA and Nye Veier. That being said, was it disclosed differences in the organizations´ project management strategy. The NPRA used the handbook R760 as an overall organizational project management strategy, while Nye Veier did not have an overall project strategy. Nevertheless, explained both organizations that they utilized PMD as a project specific project management strategy, and that it worked well.

The next discovery was in relation to the importance of the human relationship elements, such as communication and trust, to the clients. These elements can be observed and argued as highly important, considering that the candidates mentioned them repeatedly during the interviews. It can therefore be argued that the project management tools of communication and trust lies at the core of both the NPRA and Nye Veier. This became especially apparent in the candidates answers about the stakeholder analysis, project managers decision making authority, risk management, and conflict management.

That being said, was it also discovered that there existed several differences in the execution of the communication and trust between the two organizations. One of the most important differences was about the organization's surveillance of the contractors, where it was

discovered that the NPRA executed a much higher degree of surveillance than Nye Veier. This was consequently argued as a result of the different degree of trust the two organizations gave the contractors. Another difference was in relation to the satisfaction level about risk management. On this matter was it discovered that the candidates from Nye Veier were generally more satisfied with the execution of risk management than the candidates from the NPRA, indicating the that there exists improvement potential.

In continuation to the findings related to the importance of trust and communication, revealed the discussion that collaboration was valued quite highly by the two organizations. This was explained by the candidates in the sense that both the NPRA and Nye Veier understood and agreed with the benefits of having a broad project team. That being said was it also disclosed that the two organizations had a different approach to achieve this. The main difference discussed was that the two organizations had different mandates and therefore executed the staffing and the composition of the project organizations differently. In addition to this, was it also revealed that both organizations believed that a uniform client organization would be beneficial in order to reduce misunderstandings and the discrepancies between the departments, establishing higher trust and better communication between the project participants. Another discovery in relation to collaboration, was that both the NPRA and Nye Veier experiences minor challenges when working with the stakeholders in the project. That being said, experienced the NPRA more challenges with the municipalities in the planning phase, than Nye Veier.

In respect to productivity management was it discovered that the NPRA and Nye Veier answered the same concerning supply chain management, BIM and VDC, indicating that the two organizations are relatively equal on these aspects. There was however a large difference between the two organizations in relation to Lean. The results from the discussion displayed that the NPRA was not using Lean as a systematic method for improving productivity, while Nye Veier did. Thus, can it be indicated that the two organizations utilized productivity management tools different from one another.

The findings regarding project delivery methods revealed that the NPRA and Nye Veier had a different take on which procurement method that was the most suitable one. The NPRA utilized the traditional procurement method of open tender competitions with price as the main award criteria, while Nye Veier utilized the BVP method. It was furthermore discovered that the NPRA had less collaboration in the procurement method than Nye Veier. That being said, had

both of the organizations relatively similar methods for identifying which parameter that affected the choice of procurement methods.

In consideration to the choice of contract structures, was it discovered that Nye Veier and the NPRA chose similar contract structures when executing the projects. In continuation to this, was it also disclosed that the preferred contract structure for both the organizations was a D&B, even though it was explained that the NPRA traditionally had utilized the execution contract structure. In addition to this, was it explained that parameters such as size of the project and risk allocation affected the choice of contract structure.

The two organizations have a different perception about what is the best method for achieving improved project management, especially in the way that they execute project management. Yet, the study also indicated numerous similarities between the organizations. To conclude, the two organizations have their individual strengths, but they can learn from each other's differences, which could lead to improved project management for both organizations.

## 6.5 What Recommendations for Improving Project Management in the NPRA and Nye Veier Exist Based on the Findings of This Research?

This sub-chapter will present the project group´s recommendations for improving project management in the two client organizations of Nye Veier and the NPRA. The recommendations will follow the same structure as how the theory, result and the previous discussion have been presented. This implies that the first section will involve general project management, in addition to its strategies and tools. The second section will include recommended measures regarding the clients' productivity management, while the third section will provide recommendations about the clients' project delivery methods. Moreover, will these sections present recommendations to each client organization individually, in addition to recommendations that apply for both clients. The proposals will use the previous discussed research questions as a basis. Thus, will this sub-chapter not provide additional discussion about what?", "how?" and "why?", but instead give a brief presentation on the discussed aspects. The tables in this sub-chapter presents recommendations, suggested approaches for achieving the recommendations, and finally the reasoning behind them.

### 6.5.1 Recommendations for Improving General Project Management, its Strategy, and Tools

Table 11 Improving General Project Management – Both Clients

| **Recommendations for Both Client Organizations** | | |
|---|---|---|
| **Recommendation** | **Suggested Approach** | **Reasoning Behind Recommendation** |
| **More uniform project management.** | • Reorganization to stronger unified divisions based on discipline. | Creating a clearer client in the way they execute project management will bring benefits both internally and externally. The project group also believe that a uniform way of managing projects within the client organization will cause less misunderstandings of what requirements the client sets towards the contractor. |
| **More lessons-learned across projects.** | • Facilitate for fixed venues where project management experiences in the organization can be shared. | Shared lessons-learned across projects can provide measures in order to mitigate the chance of a challenge from reoccurring. |
| **More collocation between the client and the contractor.** | • The client´s should facilitate for the contractor to collocate project offices with the client's project office. | The project group believe that the use of collocation will facilitate for better communication and more informal communication. This will provide stronger personal bonds across the two organizations, ultimately leading to more trust and therefore collaboration. |
| **Improve internal and external communication.** | • Establish informal communication channels.<br>• Establish clear communication. | Establishing informal communication channels is important in order for the parties to clarify the information before it is formalized in writing. This will mitigate the chance for |

| | | |
|---|---|---|
| | • Strive to communicate only important information.<br>• Utilize BIM as a communication tool. | misunderstandings. The same applies for clear communication channels. Striving to communicate only important information will ease the task of handling the information. Finally, will the utilization of BIM as a communication tool make visualizations easier, and thereby mitigate the chance for miscommunication. |
| **Increase the level of trust between the client and the contractor.** | • Perform the mentioned recommendation regarding collocation and communication.<br>• Create more awareness about the importance of start-up meetings and collaborative meetings.<br>• Facilitate for repeated business. | Both theory and result prove that good communication enable a high level of trust. Start-up and collaborative meetings that focus on how to interact on the human aspect is crucial in order to expedite trust between the client and the contractor. Finally, will facilitating for repeated business between the client and contractor, according to the theory and result, give the possibility for establish long-term relationships with a high degree of trust and good collaboration. |
| **Improve risk management.** | • Develop more firm guidelines for risk management.<br>• Having a more proactive approach on possible contractual disagreement. | Developing firmer guidelines that facilitate for a proactive approach on possible contractual disagreements, is believed to mitigate the chance for such conflicts occurring. The contractual disagreement is believed to include disagreements connected to finance, quality, responsibility distribution, and interpretation of the contract. Moreover, does the project group believe that such guidelines would increase the possibility for handling the risk properly, and in that way ease the conflict management. |
| **Improve resource management.** | • Develop a framework of control, which secures that the matrix structures in the project organization does not provide the employee work-overload. | Monitoring the individual´s workload in a matrix structure is believed to be difficult. Furthermore, can work-overload harm the quality of the executed project management, thereby potentially threating the project success. |

Table 12 Improving General Project Management – NPRA

| Recommendations for the NPRA | | |
|---|---|---|
| **Recommendation** | **Suggested Approach** | **Reasoning Behind Recommendation** |
| **More support functions for the project manager.** | • Utilize composite project teams. | The result revealed that project managers in the NPRA in some projects had to be their own contract advisor, communication advisor, and project controller. By utilizing composite project teams can it be argued that the chance of not having the right resources will be mitigated. It is also believed that composite teams will facilitate for improved project manager execution of important project management tasks. |
| **A more efficient planning process.** | • Start the project planning earlier and do tasks more simultaneously.<br>• Use more governmental plans<br>• Incentives towards the local plan authorities | It is believed that starting the project planning earlier and to perform the processes in the planning phase more simultaneously, will provide a more efficient planning of the project. However, the project group suggests that governmental plans are important in order to succeed with this approach. It is also believed that the NPRA should employ positive incentives towards local plan authorities in order to develop a positive culture between the NPRA and the local plan authority. |
| **Securing a better link between the project charter and the PMD.** | • More collaborative work between the project owner and the project manager when developing the project charter and the PMD.<br>• Quality assurance of the project charter before it is handed over to the project manager | It was discovered that there exist improvement potentials related to securing the link between the project charter and the PMD. It was concluded that a PMD must transfer the project charter´s intended project outcome into specific project output goals, in order for achieving project success. The project group believe that the presented approaches will secure that the project manager fully understands the project owner's intention with the project. |
| **Revise the handbook R760.** | • Divide the handbook into two, depending on the projects monetary size<br>• Describe the project management tasks more specific | There exists a perception within the NPRA that the handbook R760 is too comprehensive with too many requirements for smaller projects. Although some candidates believe that this is only a misinterpretation of what the handbook really requires, the project group find it beneficial to divide the handbook. This can cause less misinterpretations of the handbook and mitigate the chance of unnecessary project management work. It was also discovered that the handbook only provides bullet points when presenting the project management tasks. The project group suggests that specifying the task better will lead to a more uniform, and possible improved execution of project management whiting the NPRA. |

| | | |
|---|---|---|
| **Increase level of internal trust.** | • Improving the information flow from the top managers. | Some candidates claimed that lack of information from top managers in the recent reorganization stirred the employees´ level of trust towards the organization. It is therefore suggested that this information flow must be improved, in order to avoid similar events. |
| **Increase level of trust towards the contractor.** | • Earn trust by showing trust.<br>• Collocation.<br>• Informal communication.<br>• Develop contracts with less room for interpretation. | It was discovered that the NPRA have a lower trust towards the contractor than Nye Veier. Furthermore, was it revealed that the utilization of execution contracts possibly demands more client surveillance and control. The project group therefore believe that showing more trust towards the contractor can facilitate for better collaboration. However, it is important to recognize that the client should not show "unconditional" trust, and that this depends on the specific project. It was also discovered that failed collaborative meetings often are due to different interpretation of the contract between the client and the contractor. The client should therefore investigate the possibility of developing contracts that decreases the chance for different interpretation. |
| **More use of positive incentives towards the contractor.** | • Develop contracts that open up for the use of more positive incentives, instead of only using incentives to control the contractor. | It was not discovered from the result that the NPRA used positive incentives in order to control the planned project execution to the actual project performance. However, this was something Nye Veier used and had positive experience with. The project group therefore suggest that the NPRA should adopt more positive incentives to the contracts. |
| **Decrease decision-making time in the execution phase of a project.** | • Increase the maneuverability in relation to the decision-making authority, for the client´s construction managers. | The result showed that the decision-making process in the execution phase of NPRA projects was perceived as slow by some candidates. The results showed furthermore that this could be solved by increasing the maneuverability of the construction managers. This is supported by the project group, who believe that giving the construction manager more maneuverability will lead to less waiting time. However, a line that separate which issues that can and cannot be decided at the construction manager´s level, must be determined. |
| **Improve risk management.** | • Develop stronger guidelines that sets requirements to the use of PUS. | It was discovered discrepancies on how and how frequently the project uncertainty control tool PUS was used. The project group therefore suggest that the NPRA develops stronger guidelines to the use of PUS, in order to increase the quality of conducted risk management and to make the risk management more uniform within the organization. |

Table 13 Improving General Project Management – Nye Veier

| Recommendations for Nye Veier | | |
|---|---|---|
| **Recommendation** | **Suggested Approach** | **Reasoning Behind Recommendation** |
| **Improve project organization staffing and resources.** | • Strive for repeated business/framework agreement of a consultant firm when hiring temporary employees.<br>• Require that some personnel from the consultant firm previously have been engaged in a project for Nye Veier. | During the discussion, the project group discovered that Nye Veier´s project organization is based on utilizing temporarily hired consultants. The discussion, furthermore, revealed that this involved several negative repercussions to the communication, level of trust, and the consultant´s competence. In order to mitigate these factors, the project group suggest that Nye Veier strive for repeated business with specific consultants. The project group acknowledge that such agreements have an expire date, due to regulation of public procurement. It is also suggested that Nye Veier require that some personnel from the consultant firm previously have been engaged in a project for Nye Veier. These measures are believed to facilitate for better communication, trust, and securing the right competence. |
| **Develop a general project management strategy.** | • Develop an overall project management strategy similar to the NPRA´s handbook R760. | The reasoning behind developing a firm overall project management strategy for the organization is due to the candidates request for a more uniform way of executing project management. Developing a project management strategy will facilitate for a more uniform project management and improving the quality of project management. |
| **Improve internal information flow.** | Develop communication- and information flow plans for internal use. | It was discovered that the project managers of Nye Veier believed the communication and the information flow from the top managers should be improved. The organization is therefore advised to develop stronger guidelines in order to secure a better information flow between the project managers and the top management. |
| **Improve conflict management.** | Develop procedures for managing conflicts at the lowest level. | It was discovered that Nye Veier did not have a well-defined procedure to handle conflicts at the lowest level. This is by the project group considered as a severe challenge as it is where most of the conflicts are being handled. It is therefore advised that the organization develop well defined procedures for managing conflicts at the lowest level. |

### 6.5.2 Recommendations for Improving Productivity Management

Table 14 Improving Productivity Management – Both Clients

| Recommendations for Both Client Organizations | | |
|---|---|---|
| **Recommendation** | **Suggested Approach** | **Reasoning Behind Recommendation** |
| **Implement Supply Chain Management.** | • The clients should arrange learning courses on what Supply Chain Management is, what the benefits are, and how it can be adapted to the organization.<br>• The client organizations should appoint employees or hire consultants to develop organizational specific guidelines for utilizing Supply Chain Management. | The project group believe that the two clients should implement supply chain management. This will, according to theory, provide a higher efficiency regarding quality, cost, delivery time, teamwork, cooperation, and effective coordination. Furthermore, will the use of Supply Chain Management reduce the amount of misunderstandings, miscommunication, and mistakes, leading to increased productivity, and ultimately improved project management. |
| **Improve the utilization of the BIM potentials.** | • Create BIM standards in the construction contracts.<br>• Broader BIM accessibility. | It was discovered that the two client organizations should realize the BIM potential to a larger extent. Furthermore, does the project group believe that the suggested approaches would help the clients in fulfilling the BIM potentials better. This was also argued to facilitate for increased productivity, and ultimately be an asset in achieving improved project management |
| **Extend the implementation of VDC and improve the VDC process.** | • Utilize the ECI procurement methods to achieve increased application of VDC<br>• Develop guidelines on how to keep the VDC sessions efficient. | The result chapter exposed that VDC was only used to a small degree within the client organizations. VDC is an approach for implementing Lean to the design phase of a construction project. The project group therefore believe that the two client organizations would benefit greatly by extending the use of VDC. Based on this suggest the project group that the client organizations should acknowledge that the ECI facilitates for increased application of VDC. Furthermore, revealed the result that maintaining the VDC sessions efficient is a challenge. It is therefore suggested that the clients develop guidelines on how to properly and efficiently execute the VDC process. |

Table 15 Improving Productivity Management – NPRA

| Recommendations for the NPRA | | |
|---|---|---|
| **Recommendation** | **Suggested Approach** | **Reasoning Behind Recommendation** |
| **Implement the Lean methodology.** | • Dedicated employees working with implementing Lean in the organization.<br>• Top management supporting the implementation of Lean.<br>• Employee involvement when developing the organization´s Lean strategy and approach.<br>• Systematic Lean education and training for employees. | The result showed that the NPRA does not utilize the Lean methodology, but that they instead perform an unsystematic "cherry-picking" of methods and tools similar to Lean. Although utilizing tools, similar to Lean, can be argued as a viable alternative, it is believed by the project group, and supported by theory, that the organization should implement a more systematically approach. Implementing the Lean methodology and terminology is therefore seen as beneficial for the organization in order to increase the productivity. Furthermore, were several parameters discussed as important barriers for the implementation of Lean. |

Table 16 Improving Productivity Management – Nye Veier

| Recommendations for Nye Veier | | |
|---|---|---|
| **Recommendation** | **Suggested Approach** | **Reasoning Behind Recommendation** |
| **Improve the systematization of the Lean methodology.** | • Understand what Lean implies for the organization.<br>• Develop a systematic approach on how to implement Lean.<br>• Employee involvement when developing the organization´s Lean strategy and approach.<br>• Systematic Lean education and training for employees. | The result revealed that Nye Veier have dedicated Lean personnel in order to fully implement the methodology. However, the result showed that there also exist several challenges with the implementation of Lean in Nye Veier. Considering that Lean is presented as a great tool for reducing waste in the theory chapter, the project group suggest that the organization should increase the awareness and education level of the employees in relation to Lean. |

### 6.5.3 Recommendations for Improving Project Management in terms of PDMs

Table 17 Improving Project Management in terms of PDM - Both Clients

| Recommendations for Both Client Organizations | | |
|---|---|---|
| **Recommendation** | **Suggested Approach** | **Reasoning Behind Recommendation** |
| **Increase the organization´s and employees´ competence of using a D&B.** | • Hire employees with experience with the D&B contract structure from the building industry. | The result disclosed that the candidates from the NPRA and Nye Veier believed that there existed potential in the application of D&B contract structure. The challenges were perceived to be lack of organizational and individual expertise to the specific contract structure. It was furthermore discussed that a higher competence in the D&B can provide positive effects to the project management. It was also suggested that better expertise about the D&B would result in taking better advantage of the contract, making it easier for the project management to exploit project resources and understanding the different responsibility areas that the D&B sets prerequisites for. The project group believe that these positive effects can be realized by increasing this competence. Ultimately will a higher competence lead to an easier pursuit in achieving the most important project task, and the project´s efficiency goal. One can therefore conclude that a higher competence of the D&B contract structure will facilitate for the organizations to achieve improved project management. |

Table 18 Improving Project Management in terms of PDM - NPRA

| Recommendations for the NPRA | | |
|---|---|---|
| **Recommendation** | **Suggested Approach** | **Reasoning Behind Recommendation** |
| **More extensive use of CD as the procurement method.** | • Utilize the in-house competence as a strategy to extend the application of CD.<br>• Increase the awareness of CD by educating the employees. | The result revealed that both the client and the contractor believed that CD carries positive impacts to the projects. However, the project group suggest that the clients, to a larger extent, must understand these positive impacts in order to gain more top management support. Although the CD demands much resources, the project group recommend that the NPRA use more CD, because it suits the in-house competence of the NPRA well. |
| **Investigate the possibility for implementing IPD.** | • Trying out IPD as a pilot project. | It was suggested that the IPD might not suit the “slim client” Nye Veier. However, it can be suggested that the NPRA, with their extensive in-house competence, should investigate and attempt an IPD as a pilot project. Another reason for this is that an IPD facilitates better for project changes in the execution phase. This was by the candidates from the NPRA believed to be a challenge with the D&B contract structure. The project group therefore suggest that an IPD can be an approach to avoid this problem. |

### 6.5.4 Key Summary

The suggested recommendations presented in this sub-chapter are based on the existing project management theory, the result from the interviews, and the project group's substantiated evaluation. The project group does therefore conclude that the presented recommendations will facilitate for improving the two clients´ execution of project management. Moreover, is it acknowledged that many of the recommendations applies for both the organizations. It is therefore advised that the two clients should cooperate in order to develop approaches to accommodate the suggested recommendations, this to share the expenses that follows such organizational development.

# 7. Conclusion

Previous research has revealed that the field of project management has in the recent years received more attention from the industry, acknowledging that there exists a need for professionalization of project management. Furthermore, are fewer projects completed within budget and/or meeting original goals and business intent than previous years, creating significant monetary loss for the organizations, and emphasizing the industry´s need for professionalized project management. Additionally, will the implementation of the right tools and strategies contribute to a better execution of project management, ultimately improving the project delivery. As a continuation to these statements, was it in this master´s thesis investigated how to achieve improved project management based on existing theory and interviews with professionals from Norwegian road clients.

## 7.1 How does Recognized Project Management Theory and the Organization´s Project Management Strategy Correspond to the Actual Executed Project Management?

When considering how the recognized project management theory correspond to the executed project management, it was discovered that the elements that corresponded to both organizations were, the most important project management tasks, the use of composite teams, communication, trust, and stakeholder analysis. On the other hand, was the elements concerning uniform execution of project management, and lessons-learned within the organization, found to not correspond with project theory. In addition, was it found that there exist discrepancies between the two clients in relation to the link between the project charter and the PMD, the organizational project management strategy, monitor and control, risk management, and conflict management. Thus, can it be concluded that the project management theory overall corresponds well to the clients' executed project management, but that there exist improvement potentials.

## 7.2 How does the Clients Utilize Productivity Management, and How does This Affect the Organizations' Project Management?

In relation to how the clients utilize productivity management, and how it affects the organizations´ project management, it was revealed that an introduction of Supply Chain Management can be beneficial to both Nye Veier and the NPRA. This can lead to a standardization of the supply chain, ensure higher efficiency and better product delivery. It was furthermore discovered that the NPRA could benefit from implementing Lean, and that Nye

Veier still have improvement potentials. Moreover, was it concluded that the clients are utilizing BIM in their projects and have high ambitions for further development. Another discovery was that VDC has not been fully implemented in the NPRA or Nye Veier, and that it can be advantageous for both of the organizations to continue implementing the strategy. All in all, it can be concluded that by utilizing Supply Chain Management, Lean, BIM, and VDC, the clients can increase their control of the project, better collaboration, shortening construction duration, which can increase the productivity, and ultimately be a link to achieve improved project management.

## 7.3 What Parameters Affect the Project Delivery Method, and How does the Project Delivery Method Influence the Project Management?

Regarding what parameters affecting the project delivery method, and how the project delivery method influence the project management, is was concluded that the project´s complexity, size, uncertainty, risk distribution, the market situation, client´s competence, need for innovative solutions, and the client's requirement on project price and quality, were parameters affecting the choice of PDM. It was furthermore concluded that the NPRA, with its broad in-house competence, should increase the application of CD, while the BVP fits Nye Veier's slim client organization. When discussing how the project delivery method affect project management it was discovered that the use of ECI will provide a better collaboration, trust, and communication earlier in the project, thereby facilitating for enhanced project management. It was also discovered that the BVP and D&B would simplify the client´s project management by introducing fewer risks for the client, compared to the traditional PDM. Furthermore, was it suggested that an IPD would bring positive effects to the project management, but that the use of IPD also demanded more management of resources in the early phases of a project. Moreover, was DBFO also argued to provide benefits to the project management. It was also found that the clients should increase the D&B competence, and that this would simplify the project management´s crucial task of delivering on the project´s efficiency goals. All in all, can it be concluded that the clients have improvement potentials in the utilization of the project delivery method, and that this would facilitate for achieving improved project management.

## 7.4 How does the NPRA and Nye Veier Compare Regarding Project Management?

With respect to how Nye Veier and the NPRA compare regarding project management, it was disclosed that there exist numerous differences between the clients. Thus, indicates this that the two organizations have different perceptions about what is the best method for achieving improved project management. Nevertheless, does the research also show that there are several

similarities between the organizations. It can therefore be concluded that the two organizations both have their individual strengths, but also that they can learn from each other's differences, which ultimately could lead to improved project management for both of the organizations.

## 7.5 What Recommendations for Improving Project Management in the NPRA and Nye Veier Exist Based on the Findings of This Research?

When considering what recommendations that exist for improving project management in the NPRA and Nye Veier, it was found several suggestions that the project group believe would benefit the clients. It was also suggested that the clients should implement the following recommendations in relation to project management. More uniform project management, more lessons-learned, more collaboration, improve communication, increase the level of trust, and improve risk- and resource management. Furthermore, were some recommendations, specific for the NPRA presented as, more support functions for the project manager, more efficient planning process, securing a better link between the project charter and the PMD, revise the handbook R760, increase level of trust, more positive incentives, and decrease decision-making time. The recommendations for Nye Veier, was on the other hand, presented as to improve project organization staffing and resources, develop a general project management strategy, improve internal information-flow, and to improve conflict management.

Moreover, was it in relation to productivity management suggested that both of the clients should implement Supply Chain Management, Improve the utilization of the BIM, and improve the implementation of VDC. Additionally, was it recommended that the NPRA should implement the Lean methodology and that Nye Veier should improve the systematization of the Lean methodology.

Finally, was it, regarding the clients´ project delivery method, recommended that both clients should increase the clients' and employees' competence of using D&B. It was also recommended that the NPRA should increase the application of the CD procurement method and investigate the possibility of implementing IPD.

All in all, can it be concluded that there exist several recommendations for the two client organizations, in addition to specific recommendations for the individual client. Consequently, can accomplishing these recommendations contribute to achieve improved project management.

## 7.6 How to Achieve Improved Project Management

Based on the findings in this master´s thesis, the answer to the problem statement **How to Achieve Improved Project Management** is that the project management must improve on the following five aspects:

1. The first aspect is that the executed project management must be in compliance with project management theory.
2. The second aspect is that project management should utilize productivity management tools in order to improve the productivity.
3. The third aspect is that improving the utilization and selecting the most appropriate project delivery method will provide benefits to the project management.
4. The fourth is that organizations should learn from each other in order to diminish their individual weakness and take advantage of each other´s strengths.
5. The fifth and final aspect is to realize the project management shortcomings and to implement measures in order to solve these limitations.

By successfully implementing and completing these five aspects one should be able to reach higher efficiency, better execution, and ultimately achieve improved project management.

## 7.7 Further Research

This master's thesis has uncovered several interesting results in relation to how project management is executed and exposed several discoveries that should be explored further. The purpose of this sub-chapter will therefore be to present recommendations that the project group believe are the most prominent ones for further research.

In relation to the findings of this report was it discovered that the NPRA and Nye Veier organized the project organization differently. Although it was found that the different methods of organizing carried both negative and positive properties, the authors recommend that further research is conducted in order to establish the optimal method for project staffing.

It was also revealed that the two client organizations had recently undergone or was currently conducting a reorganization. In relation to this was it explained that these reorganizations had affected, amongst other, the NPRA's level of trust, and Nye Veier's conflict management. The authors of this report do therefore suggest that an in-depth study of the effect that these reorganizations had on the clients, should be conducted in future research.

Furthermore, the paper concluded that the NPRA should divide the handbook R760 into two separate handbooks, depending on the monetary size of projects. However, it was not concluded any specific suggestions on how to revise the R760. The project group therefore recommend future research on how to separate R760 into two individual handbooks, where interfaces regarding project size and description of the project management tasks are defined.

In continuation did the research discover that Nye Veier did not have an overall project management strategy, similar to the NPRA´s R760. It was furthermore concluded that having an overall project management strategy provide several benefits to the organizations. The project group consequently suggests that it should be performed further investigations on how to develop an organizational project management strategy for Nye Veier.

Regardless of the findings about the importance of executing a bureaucratic process where the interests of all the involved actors are protected, the project group believe that future research should explore how the efficiency of the planning process in the NPRA can be improved, while simultaneously preserving the local authorities' interests.

It was found that the NPRA did not utilize Lean as a productivity tool, but hat the client instead utilized their own productivity management through the usage of different tools and strategies incorporated into the R760. Future studies should therefore entail an in-depth investigate about

how the NPRA's productivity strategy is in comparison to Lean, and the advantageous and disadvantageous the implementation of Lean would have on the client.

Additionally, was it discovered that Nye Veier was utilizing Lean as a productivity management strategy, and that the client had successfully implemented several of the tools and strategies. That being said, was it also discovered that there existed improvement potential for the client, indicating that further research should be conducted in order to thoroughly investigate the implementation process of Lean in Nye Veier.

Another area that might prove important for future research is the client´s implementation strategy of BIM and VDC. Both BIM and VDC was in this paper concluded to carry various benefits to the project management. However, the research revealed that the clients had improvement potentials in order to fulfill the capabilities of BIM and VDC. Because of this, it is recommended future investigation on the clients' implementation strategies to secure a successful implementation of the productivity tools.

It was discovered that the NPRA possess a substantial in-house competence and that client is utilizing D&B contract structures. Furthermore, was it discovered that an IPD suits client with significant in-house competence, while on the other hand a D&B requires less in-house competence. This result warrant further investigation on how the NPRA could utilize its in-house competence in an IPD and take advantage of the presented benefits of the PDM. The project group also believe that the properties of a D&B is not optimal for the vastly in-house competence of the NPRA, and that it is necessary to further investigate why the NPRA have chosen the D&B to be an extensive part of the organization's project delivery method.

This research has mostly been based on interviews and a literature review, in order to answer the problem statement. Thus, future studies should aim to replicate the results in a larger and more extensive case study, where the solutions are verified or disproven. In addition to this, could it also be beneficial to utilize a questionnaire in order to get a broader and more statistical overview of the project management in Norwegian road clients.

The final research topic that the project group advise to investigate in a future research, is an in-depth study regarding the implementation of the recommended suggestions. This is an interesting topic for future research considering that this will determine the effect these recommendations had on the clients, and if they ultimately aided the clients in achieving improved project management.

# 8. References


1. Abudi. (2013). *Manageing communications effectively and efficiently.* New Orleans, LA: Project Management Institute .
2. Ahmad, S. B. (2018, April 30). Labour productivity statistics: a reality check for the Norwegian construction industry. *International Journal of Construction Management*, pp. 39-52.
3. Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). A Survey of Supply Chain Collaboration and Management in the UK Construction Industry. *Erupean Journal of Purchasing and Supply Management 6*, pp. 159-168.
4. Alarcon, L. F., Mandujano, M. G., & Mourgues, C. (2013). *Analysis of Implimention of VDC from A Lean Respective: Literature Review.* Unknown.
5. Alhuraish, I., Robeldo, C., & Kobi, A. (2017). A Comparative Exploration of Lean Manufactoring and Six Sigma in Terms of Their Critical Success Factors. *Journal of Cleaner Production 164*, pp. 325-337.
6. Anskaffelser. (2019). *Offentleg Privat Samarbeid (OPS)*. Retrieved May 24, 2020, from https://www.anskaffelser.no/hva-skal-du-kjope/bygg-anlegg-og-eiendom-bae/offentleg-privat-samarbeid
7. Arditi, D., & Gunaydi, H. M. (1997). Total Quality Management in the Construction Process. *International Journal of Project Management 15*, pp. 235-243.
8. asae. (2009). *Qualitative Interview Pros and Cons*. Retrieved October 24, 2019, from https://www.asaecenter.org/resources/articles/an_plus/2016/january/qualitative-interview-pros-and-cons
9. Azhar, Nadeem, Mok, & Leung. (2008). *Building Information Modeling (BIM): A New Paradigm for Visual Interactive Modeling and Simulation for Construction Projects.*
10. Azhar, S. (2011, July). Building Information Modeling (BIM): Trends, Benefits, Risks, and Challanges for the AEC Industry. *Leadership and Management in Engineering*, pp. 241-252.
11. Aziz, R. F., & Hafez, S. M. (2013). Applying Lean Thinking in Construction and Preformance Improvment. *Alexandria Engineering Journal 52*, pp. 679-695.
12. Badampudi, Wohlin, & Petersen. (2015). *Experiences from using snowballing and database searches in systematic literature studies*. Retrieved October 17, 2019, from https://www.researchgate.net/publication/300721124_Experiences_from_using_snowballing_and_database_searches_in_systematic_literature_studies
13. Ballard, G. (2000). *The Las Planner System of Production Control.* Birmingham: University of Birmingham Research Archive.

14. Ballard, G. (2019). *Takt Planning and the Last Planner System.* Retrieved from BI: https://www.bi.no/globalassets/forskning/senter-for-byggenaringen/lc-arrangement/lc-no-seminar-11-4-19_ballard_takt-planning-and-lps.pdf

15. Ballard, G., & Howell, G. (2003). Lean Project Management. *Building Research and Information*, p. 14.

16. Ballard, G., & Howell, G. A. (1994 - upd. 2003). *An update on Last Planner.* 11th Annual Conf., International Group for Lean Construction.

17. Ballard, G., & Tommelein, I. (2012, March-June). Lean Management Method for Complex Projects. *The Engineering Project Organizaion Journal*, pp. 85-96.

18. Berger, A. (1997, April 1). Continues Improvment and Kaizen: Standarization and Organizational Design. *Journal of Manufacturing Thechnology Management*, pp. 110-117.

19. BI Norwegian Business School. (2019). *Hvorfor prosjektledelse?* Retrieved April 3, 2020, from https://www.bi.no/studier-og-kurs/kurs/masterprogram/prosjektledelse/

20. Bicheno, J., & Holweg, M. (2016). *The Lean Toolbox - a handbook for lean transformation (fifht edition).* Buckingham: PICSIE Books.

21. BIM Forum. (2019). *LEVEL OF DEVELOPMENT (LOD) SPECIFICATION PART I & COMMENTARY.* BIM Forum.

22. Boeard of Life Science Division on Earth and Life Studies. (2003). *Sharing Publication-Related Data and Materials: Responsibilities of Authorship in the Life Sciences.* Washington: The National Academic Press.

23. Bolman, L. G. (2013). *Reframing organizations: artistry, choice, and leadership.* San Francisco : Jossey-Bass.

24. Brady, T., Rush, H., Hobday, M., Davis, A., Probert, D., & Banerjee, S. (1997). Tools for technology management: an academic perspective. *Technovation*, pp. 417 - 426.

25. Bryman, A. (2016). *Social Research Methods.* Oxford: Oxford University Press.

26. Burati Jr, J. L., Farrington, J. J., & Ledbetter, W. B. (1992). Causes of Quality Deviation inDesign and Construction. *Journal of Construction and Engineering Management*, pp. 34-49.

27. Business Dictionary. (2019, December 10). *Stakeholder*. Retrieved from Business Dictionary: http://www.businessdictionary.com/definition/stakeholder.html

28. Byggeindustrien. (2018). *Produktiviteten i bygg og anlegg falt med ti prosent*. Retrieved Desember 12, 2019, from http://www.bygg.no/article/1340868

29. CADLearning. (2016). *Understanding the Difference Between BIM and CAD*. Retrieved from Autodesk: https://knowledge.autodesk.com/support/revit-products/learn-explore/caas/video/youtube/lesson/143344-courseId-100332.html

30. Cambridge dictionary. (2019). *Trust*. Retrieved 11 10, 2019, from https://dictionary.cambridge.org/dictionary/english/trust

31. Cantone, G. (1998). Experimental Models for Validating Technology. *Credits: Zelkowitz, M. V. and Wallace, D. R - Experimental Models for Validating Technology.* Rome, Italy: University of Rome Tor Vergata.

32. Chan, Scott, & Chan. (2004, February). Factors Affecting the Success of a Construction Project. *Journal of Construction Engineering and Management*, pp. 153-155.

33. Cherrafi, A., Elfezazi, S., Chiarini, A., Mokhlis, A., & Benhida, K. (2016). The Integration of Lean Manufactoring, Six Sigma and Sustainability: A Literature Review and Future Research Directions for Developing a Specific Model. *Journal of Cleaner Production 139*, pp. 828-846.

34. Constructing Excellence and Pinsent Mason LLP. (2011). *Infastructure in the New Era.* Constructing Excellence and Pinsent Mason LLP.

35. Creative Safety Supply. (n.d.). *Plan-Do-Check-Act (PDCA Cycle)*. Retrieved from Creative Safety Supply: https://www.creativesafetysupply.com/glossary/pdca-cycle/

36. Dainty, A. J., Cheng, M.-I., & Moore, D. R. (2005). Competency-Based Model for Predicting Construction Project Managers Preformence. *Journal of Management in Engineering - ASCE*, pp. 2-9.

37. Dr. Yeoh Ker-Wei, J. (2019, April). Productivity Benchmarking Using DEA. *CE5805 DfMA and Productivity Analysis (7) Lecture Slide*. Singapore, Singapore: National University of Singapore.

38. Edum-Fotwe, F., & McCaffer, R. (2000). Developing Project Management Competancey: Perspective from the Construction Industry. *International Journal of Project Management 18*, pp. 111-124.

39. Engebø, A. (2019, September). Research Methodology. *NTNU - Lecture*. Trondheim, Trønderlag, Norway: NTNU.

40. Engebø, A., Lædre, O., Ypung, B., Larssen, P. F., Lohne, J., & Klakegg, O. J. (2020, March). Collaborative project delivery methods: a scoping review. *Journal of Civil Engineering and Management*, pp. 278–303.

41. Forbord, F. F. (2019). *Praktisk Prosjektledelse i Statens Vegvesen.* NTNU.

42. Getuli, V., Ventura, S. M., Capone, P., & Ciribini, A. L. (2016). A BIM-based Construction Supply Chain Framework for Monitoring Progress and Coordination of Site Activities. *Creative Construction Conference*, pp. 542-549.

43. Gripsrud, G., Olson, U. H., & Silkoset, R. (2016). *Metode og Dataanalyse* (3 ed.). Oslo: Cappelen Damm Akademisk.

44. Gullhaug, & Sangolt. (2016). *Byggherreforskriften med kommentarer* (1. edition ed.). Oslo: Gyldendal.

45. Gullhaug, G., & Sangolt, K. (2016). *Byggherreforskriften.* Oslo: Gyldendal.

46. Haavaldsen, T., Lohne, J., & Lærde, O. (2012). *On Assesment of Sustainability.* NTNU.

47. Hart, R. (2017, July 28). *When should DMAIC be your go-to problem-solving tool?* Retrieved from TRACC: https://traccsolution.com/blog/dmaic-problem-solving/

48. Hoezen, M., Rutten, J. v., Voordijk, H., & Dewulf, G. (2010, November). Towards better customized service-led contracts through the competitive dialogue procedure. *Construction Management and Economics*, pp. 1177-1186.

49. Hofstede, G. (1884). *Culture's Consequences.* Newbury Park, California: SAGE Publication Inc.

50. Hundnukar, M., Jakhar, S., & Rathod, U. (2013). Factors Affecting Colaboration in Supply Chain: A Literatur Review. *Procedia - Social and Behavioral Science*, p. 11.

51. Hussein, B. (2018). *The Road to Success.* Fagbokforlaget.

52. Ibbs, W., Nguyen, L. D., & Lee, S. (2005). Quantified Impacts of Project Change. *ASCE Library*, p. 8.

53. Ibrahim, A. M., & Dimick, J. B. (2018). Writing for Impact: How to Prepare a Journal Article. *Medical and Scientific Publishing*, pp. 81-92.

54. Investopedia. (2019, July 14). *Productivity*. Retrieved from Investopedia.com: https://www.investopedia.com/terms/p/productivity.asp

55. Iqubal, S., Choudhry, R. M., Holschemacher, K., Ali, A., & Tamosaitiene, J. (2015). Risk Management in Construction Projects. *Thechnological and Economical Development of Economy 21*, pp. 65-78.

56. J., V. (2005). *An Introduction to Total Productive Maintance (TPM).* The Plant Maintance Resource Center.

57. Johannessen, Ø. (n.d.). *PDCA – Plan Do Check Act*. Retrieved from pdca.no: https://pdca.no/

58. Johnsson, J. (1996). *Construction Site Productivity Measurments.* Lulea University of Technology.

59. Josephson, P. -E., & Hammarlund, Y. (1999). The Causes and Costs of Defects in Construction - A Study of Seven Building Projects. *Automation in Construction 8*, pp. 681-687.

60. Kadefors, A. (2004). Trust in project relationships - inside the black box. *International Journal of Project Management*, pp. 175-182.

61. Kam, C., Senaratna, D., McKinney, B., Xiao, Y., & So, M. (2014). The VDC Scorecars: Formulation and Validation. *(CIFE) - Center for Integrated Facility Engineering*, p. 27.

62. Kam, C., Senaratna, D., Y. X., & McKinney, B. (2013). *The VDC Scorecard: Evaluation of AEC Projects and Industry Trends.* Stanford, CA: Stanford University.

63. Kerzner, H. R. (2013). *Project Management - A Sytems Approach to Planning, Schedualing, and Controlling* (11. Edition ed.). New York, NY: Wiley.

64. Kerzner, H. R. (2017). *Project Management - A System Approach to Plannin, Scheduling and Controlling (12th edition).* Wiley.

65. Khanzode, A., Fischer, M., Reed, D., & Ballard, G. (2006). A Guide to Applying the Principles of Virtual Design and Construction (VDC) to the Lean Project Delivery Process. *(CIFE) - Center for Integrated Facility Engineering*, p. 47.

66. Klein, J. (2020, 03 19). *koronavirus-pandemien i 2020*. Retrieved from Store Norske Leksikon: https://sml.snl.no/koronavirus-pandemien_i_2020

67. Krafcik, J. F. (1988). *Triumph of the Lean Production System.* Sloan Management Review.

68. Kunz, J., & Fischer, M. (2012). *Virtual Design and Construction: Themes, Case Studies and Implementation Suggestions.* Stanford, CA: CIFE, Stanford University.

69. Lencioni, P. (2002). *The Five Dysfunction of a Team* (1. Edition ed.). New York,NY: Jossey-Bass.

70. LetsBuild. (2017). *LetsBuild*. Retrieved December 13, 2019, from https://www.letsbuild.com/blog/recognising-bim-roles-project-cycle

71. Lovdata. (2016). *Forskrift om offentlige anskaffelser*. Retrieved March 25, 2020, from https://lovdata.no/dokument/SF/forskrift/2016-08-12-974#KAPITTEL_2

72. Love, P. E., Li, H., & Mandal, P. (1999). Rework: A Symptom of a Dysfunctional Supply-Chain. *European Journal of Purchasing and Supply Management 5*, pp. 1-11.

73. Love, P., Guansekaran, A., & Li, H. (1998). Concurrent Engineering: A Strategy for Procuring Construction Projects. *International Journal of Project Management*, p. 13.

74. Lædre, O. (2006). *Valg av kontraktstrategi i bygg- og anleggsprosjekt.* Trondheim: NTNU.

75. Lædre, O. (2018). Disputes and dispute resolution board. Trondheim: NTNU.

76. Lædre, O. (2018). Sensitivity Analysis. *Profitability Analysis*. Trondheim, Norway: NTNU.

77. Lædre, O., Austeng, K., Haugen, T. I., & Klakegg, O. J. (2006, July). Procurement Routes in Public Building and Construction Projects. *Journal of Construction Engineering and Management*, pp. 689-696.

78. Maurer, I. (2010). How to build trust in inter-organizational projects: The impact of project staffing and project rewards on the formation of trust, knowledge aquisition and product innovation. *nternational Journal of Project Management*, pp. 629-637.

79. Mcfadden, B. (n.d.). *What is 5S?* Retrieved from Graphic Products: https://www.graphicproducts.com/articles/what-is-5s/

80. Mentzer, DeWitt, Keebler, Min, Nix, Smith, & Zacharia. (2001). Defining Supply Chain Management. *Journal of Business Logistics*, pp. 1-25.

81. Metier OEC. (n.d.). *Prosjektledelse blir stadig mer populært ved NHH*. Retrieved April 3, 2020, from https://www.prince2.no/fagstoff-maler/prosjektledelse-blir-stadig-mer-populaert-ved-nhh/

82. Mind Tools. (2017). *Plan-Do-Check-Act (PDCA)*. Retrieved from mindtools.com: https://www.mindtools.com/pages/article/newPPM_89.htm

83. Mohagheghi, P., & Conradi, R. (2007, January). Quality, Productivity and Economic Benefits of Software Reuse: A Review of Industrial Studies. *Journal of Empirical Software Engineering*, p. 55.

84. Moore, R. (2007). *Selecting the Right Manufacturing Improvment Tools.* Elsevier.

85. Murphy, D., Baker, B., & Fisher, D. (1974). *Determinants of Project Success.* Chestnut Hill: Management Institute.

86. Mørsh, Y. A. (2010). *Guidelines for report-writing.* Trondheim: NTNU - Norwegian University of Science and Technology.

87. NAO - National Audit Office. (2005). *Improving Public Services Through Better Construction.* The Comptroller and Auditor General.

88. NDLA. (2018). *TONE - strategi for kildekritikk*. Retrieved October 25, 2019, from https://ndla.no/nb/subjects/subject:14/topic:1:185701/resource:1:169741

89. Nilsen Norman Group. (2016). *Hierarchy of Trust: The 5 Experiential Levels of Commitment*. Retrieved December 13, 2019, from https://www.nngroup.com/articles/commitment-levels/

90. Norsk senter for forksningsdata. (n.d.). *NSD - Norwegian Centre for Research Data*. Retrieved March 26, 2019, from https://nsd.no/nsd/english/

91. Norwegian Government. (n.d.). *Nye Veier AS (new roads)*. Retrieved from regjeringen.no: https://www.regjeringen.no/en/dep/sd/organisation/subordinate-enterprises/new-roads-nye-veier-as/id2412797/

92. Norwegian Institute of Public Health. (2020, 03 23). *Fakta om viruset og sykdommen*. Retrieved from FHI - Folkehelseinstituttet: https://www.fhi.no/nettpub/coronavirus/fakta/fakta-om-koronavirus-coronavirus-2019-ncov/

93. NPRA. (2019, October 23). Senior Advisor.

94. NTNU. (2020). *Structuring your text - Structuring the assignment*. Retrieved from NTNU - Norwegian University of Science and Technology: https://www.ntnu.edu/sekom/structuring-an-assignment

95. NTNU. (2020). *TBA4530 - Project Management and Construction Engineering, Specialization Project*. Retrieved from NTNU: https://www.ntnu.edu/studies/courses/TBA4530/2019#tab=omEmnet

96. Nye Veier. (2018). *Årsrapport.* Kristiansand, Vest-Agder: Nye Veier.

97. Nye Veier. (2019). *Ofte stilte spørsmål*. Retrieved November 24, 2019, from https://www.nyeveier.no/om-nye-veier/ofte-stilte-spoersmaal

98. Nye Veier. (n.d.). *Om oss*. Retrieved May 28, 2020, from https://www.nyeveier.no/om-oss/

99. Odeck, J. (2018). The principals of benefit-cost analysis . *Economics of transport infrastructure*. Trondheim, Norway: NTNU.

100. Olofosson, O. (n.d.). *History of Quality Management*. Retrieved from World Class Manufacturing: https://world-class-manufacturing.com/Sigma/history.html

101. Oxford Dictionary. (2020). *Communication*. Retrieved from Lexico: https://www.lexico.com/definition/communication

102. Paul, S. C., Tay, Y. W., Panda, B., & Tan, M. J. (2018). Fresh and Hardened Propperties of 3D Printing Cementitious Materials For Building and Construction. *Archives of Civil and Mechanical Engeineering*, p. 8.

103. Pavan, M., & Todeschini, R. (2009). *Multi-criteria Decition Making*. Retrieved from ScienceDirect: https://www.sciencedirect.com/topics/mathematics/multi-criteria-decision-making

104. Pheng, L. S., & Teo, J. A. (2004). Implimenting Total Quality Management in Construction Frims. *Journal of Management in Engineering - ASCE*, pp. 8-15.

105. Phusavat, K. (2013). *Productivity Management in an Organization - Measurment Analysis.* Bangkok: ToKnowPress.

106. Project Management Institute (PMI). (2017). *PMBOK Guide.* Global Standerds.

107. Project Management Institute. (2016). *PMI´s Pulse of the Profession - The high cost of low performance.* Newtown Square, Pennsylvania: Project Management Institute.

108. Prosjekt Norge. (2008). *Statens Vegvesen*. Retrieved May 28, 2020, from http://v1.prosjektnorge.no/index.php?pageId=404

109. Prosjekt Norge. (2015). Samtidig Prosjektering. *BA2015 Veileder*, p. 16.

110. Rahman, S. H., Endut, I. R., Faisol, N., & Paydar, S. (2014). The Importance of Collaboration in Construction Industry from Contractors Perspective. *Procedia - Social and Behavioral Sciences 129*, pp. 414-421.

111. Rajkumar. (2010). *Art of communication in project management* . Washington, DC: Project Management Institute .

112. Regjeringen. (2012, Oktober 3). *NOU 2012: 16 - Samfunnsøkonomiske analyser*. Retrieved from Regjeringen.no: https://www.regjeringen.no/no/dokumenter/nou-2012-16/id700821/sec6

113. Regjeringen. (2019). *Hva er statens prosjektmodell?* Retrieved May 28, 2020, from https://www.regjeringen.no/no/tema/okonomi-og-budsjett/statlig-okonomistyring/ekstern-kvalitetssikring2/hva-er-ks-ordningen/id2523897/

114. Royal Literary Fund. (Unknown). *Whats a Literature Review*. Retrieved from rlf.org.uk: https://www.rlf.org.uk/resources/what-is-a-literature-review/

115. Samset, K. (2017). *Prosjekt i tidligfasen.* Fabokforlaget.

116. Scociology Central. (Unknown). *Focused (Semi-structured) Interviews*. Retrieved October 26, 2019, from http://www.sociology.org.uk/notes/methfi.pdf

117. Scott, S., Molenaar, K., Gransberg, D., & Smith, N. (2006). *Best-Value procurement Methods for Highway Construction Projects.* Washington, DC: National Cooperative Highway Research Program.

118. Serpella, A. F., Ferrada, X., Howard, R., & Rubio, L. (2014). Risk Management in Construction Projects: A Knowledge-based Approach. *Procedia - Social and Behavioral Svienves 119*, pp. 653-662.

119. Simplify My Training. (2014, May 24). *Advantages and disadvantages of case studies*. Retrieved from LinkdIn: https://www.slideshare.net/SimplifyMyTraining/advantages-and-disadvantages-of-case-studies

120. Singapore - Building and Construction Authority. (Unknown). *Design for Manufacturing and Assembly (DfMA) - Prefabricated Prefinished Volumetric Construction.* Singapore - Building and Construction Authority.

121. Skaara, E. E., & Liland, P. (2019). *How Improved Project Management Can Contribute to a Better Project Delivery.* Trondheim: NTNU.

122. Skoie, H. (2020, February 17). *Forskning*. Retrieved from Store Norske Leksikon: https://snl.no/forskning

123. Snee, R. D. (2010). Lean Six Sigma - Getting better all the time. *International Journal of Lean Six Sigma*, pp. 9-29.

124. Song, L., Mohamed, Y., & AbouRizk, S. M. (2009, January). Early Contractor Involvement in Design and Its Impact on Construction Schedule Performance. *Journal of Management in Engineering*, pp. 12-20.

125. Stanley, R., & Thurnell, D. (2014). The Benefits of, and Barriers to, Implementation of 5D BIM for Quantity Surveying in New Zealand. *Australasian Journal of Construction Economics and Building*, pp. 105-117.

126. Statens vegvesen. (2017). E6 Soknedal. Trondheim.

127. Statens vegvesen. (2017). *Statens vegvesen*. Retrieved September 12, 2019, from https://www.vegvesen.no/en/the-npra/about-us/about-the-npra

128. Statens vegvesen. (2019). *Om Statens vegvesen*. Retrieved November 10, 2019, from https://www.vegvesen.no/om+statens+vegvesen/om+organisasjonen/om-statens-vegvesen

129. Statistisk Sentralbyrå. (2018). *Produktivitetsfall i bygg og anlegg*. Retrieved from ssb.no: https://www.ssb.no/bygg-bolig-og-eiendom/artikler-og-publikasjoner/produktivitsfall-i-bygg-og-anlegg

130. Statsbygg. (2018). *Lean Metodikk i Praksis.* Bergen: Statsbygg.

131. Statsbygg. (2019, October 22). *Om Oss*. Retrieved from Statsbygg.no: https://www.statsbygg.no/Om-Statsbygg/

132. Store Norske Leksikon. (2017, May 22). *Produktivitet*. Retrieved from snl.no: https://snl.no/produktivitet

133. Store Norske Leksikon. (2019, 09 24). *Kvalitativ Metode*. Retrieved from Snl.no: https://snl.no/kvalitativ_metode

134. Store Norske Leksikon. (2019, 09 24). *Kvantitativ Metode*. Retrieved from snl.no: https://snl.no/kvantitativ_metode

135. Store Norske Leksikon. (2019, July 17). *Prefabrikasjon*. Retrieved from snl.no: https://snl.no/prefabrikasjon

136. Tang, L., Shen, Q., & Cheng, E. W. (2010). A review of studies on Public-Private Partnership projects in the construction industry. *International Journal of Project Management*, pp. 683-694.

137. Taso, C. C., Tommelein, I. D., E. S., & Howell, G. A. (2004). Work Structure to Achieve Integrated Prduct-Process Design. *Journal of Construction Engineering and Management - ASCE*, pp. 780-789.

138. The American Institute of Architects. (2007). *Integrated Project Delivery: A Guide.* AIA.

139. The Quest Worlwide Toolbox Series. (1999). Verkyg for Lean Produktion. In W. &. Jones, *The Lean Toolbokx* (p. 151). Stockholm: Lean Forum.

140. The University of Queensland. (2019). *Literature reviews - common problems*. Retrieved October 25, 2019, from https://www.uq.edu.au/student-services/learning/lit-reviews-common-problems

141. Turner, J. (2009). *Handbook of Project Based Management: Leading Strategic Change in Organizations* (Third Edition ed.). New York, NY: McGraw-Hill.

142. University of South Carolina. (2019). *Literature Review: Purpose of a Literature Review*. Retrieved October 25, 2019, from https://uscupstate.libguides.com/c.php?g=627058&p=4389968

143. Vaeenma. (2015, May 02). *Supply Chain Diagram*. Retrieved from Depositphotos: https://depositphotos.com/71812313/stock-photo-supply-chain-diagram.html

144. Valen, M. S., Olsson, N., Moum, A., Andersen, B., Klakegg, O. J., Holden, E., . . . Lohne, O. L. (2013). *Beste Praksis Prosjektledelse.* NTNU.

145. Vegdirektoratet. (2016). *Kometansekrav til Prosjektlederrollen - Vedlegg til Håndbok R760.* Statens Vegvesen.

146. Vegdirektoratet. (2018). *Styring av Vegprosjekter - Håndbok R760.* Statens Vegvesen.

147. Veidirektoratet. (2016). *Kompetansekrav til Prosjekteierrollen - Vedlegg til Håndbok R760.* Statens Vegvesen.

148. Venkatesh, J. (2005, October 20). An Introduction to Total Productive Maintenance (TPM). *The Plant Maintenance Resource Center*, p. 18.

149. Vrijhoef, R., & Koskela, L. (2000). The Four Roles of Supply Chain Management in Construction. *European Journal of Purchaising and Supply Management 6*, pp. 169-178.

150. Wheelan, S. A. (2010). Effective Team Members. In *Creating Effective Teams* (pp. 53-76). SAGE Publications Inc.

151. Wig, B. B. (2014). *Lean - Ledelse for Lærende Organisasjoner.* Oslo: Gyldendal.

152. Wondimu, P. A. (2018). Early Contractor Involvement Approaches for Public Project Owners. Trondheim, Norway: NTNU.

153. Woo, L. H., Tommelein, I. D., & Ballard, G. (2012). Design of am Infastruture Project Using a Point-Based Methology. *Journal of Management in Engineering - ASCE*, pp. 291-299.

154. World Health Organization. (2020). *Novel Coronavirus (2019 nCovid) - Situation Repport 1*. WHO.

155. Wæhle, E., & Dahlum, S. (2018, April 20). *Case-studie*. Retrieved from Store Norske Leksikon: https://snl.no/case-studie:

156. Yu, H., Al-Hussein, M., Al-Jibouri, S., & Teyles, A. (2013). Lean Transformation in a Modular Building Company: A Case for Implementation. *Journal of Management in Engineering*, pp. 103-111.

157. Zelkowitz, M. V., & Wallace, D. R. (1997). Experimental Models for Validating Technology. *Information and Software Technology*, pp. 735-743.

# 9. Appendix

## Appendix 1 – Pre-study interview guide (Lean)

### Lean Construction

• Hvilke Lean-teknikker (strategier og verktøy) er de viktigste/mest hensiktsmessige i BAE-næringen? Hvorfor? Just in time, Involverende Planlegging, Bakover planlegging, Last Planner.

- Hvilke Lean-teknikker legger dere mest fokus på i kursene deres? Hvilke Lean- teknikker fokuserer dere på, på de forskjellige kursnivåene? (gult, grønt, svart Belte) Hvorfor?

- Hvilke Lean-tekniker er godt etablert i bygge- og anleggsbransjen i dag? Hvorfor?
- Hvilke Lean-teknikker tror du BEA-næringen vil ha størst nytte av å benytte i

  fremtiden? Hvorfor?

- Hva tenker du om Lean Six Sigma?
- Prosjektlederperspektivet: Er det strategier som er enklere å implementere/styre enn andre? Hvorfor?

- Finnes det hindringer/vanskeligheter som gjør Lean vanskelig å implementere i bygge og anleggsbransjen?

### Grunner til at Lean ikke fungerer

1. Mangel på ledelse
2. Mangel på involvering
3. Manglende utholdenhet
4. Manglende kompetanse

- - Har dere noen prosedyrer på å forenkle implementering? (Spill/Case/evt. andre metoder)
- - Funker disse metodene? (Ingeniører/arbeidere/etc. som skal lære dette)
- - Har du hørt om DfMA?

# Appendix 2 – NSD Research Approval

## NSD sin vurdering

Skriv ut

**Prosjekttittel**
How to Achieve Improved Project Management - A Study of Two Norwegian Road Projects

**Referansenummer**
576740

**Registrert**
17.01.2020 av Preben Liland - prebenli@stud.ntnu.no

**Behandlingsansvarlig institusjon**
Norges teknisk-naturvitenskapelige universitet NTNU / Fakultet for ingeniørvitenskap / Institutt for bygg- og miljøteknikk

**Prosjektansvarlig (vitenskapelig ansatt/veileder eller stipendiat)**
Olav Torp, olav.torp@ntnu.no, tlf: 93422673

**Type prosjekt**
Studentprosjekt, masterstudium

**Kontaktinformasjon, student**
Preben Liland, prebenli@stud.ntnu.no, tlf: 91613772

**Prosjektperiode**
15.01.2020 - 10.06.2020

**Status**
28.01.2020 - Vurdert

**Vurdering (1)**

**28.01.2020 - Vurdert**
Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet 28.01.2020 med vedlegg, samt i meldingsdialogen mellom innmelder og NSD. Behandlingen kan starte.

MELD VESENTLIGE ENDRINGER
Dersom det skjer vesentlige endringer i behandlingen av personopplysninger, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. Før du melder inn en endring, oppfordrer vi deg til å lese om hvilke type endringer det er nødvendig å melde:
https://nsd.no/personvernombud/meld_prosjekt/meld_endringer.html

Du må vente på svar fra NSD før endringen gjennomføres.

TYPE OPPLYSNINGER OG VARIGHET
Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 10.06.2020. Data med personopplysninger vil oppbevares for etterprøvbarhet inntil 30.09.2020. Opplysningene vil oppbevares internt ved behandlingsansvarlig institusjon.

LOVLIG GRUNNLAG
Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte kan trekke tilbake. Lovlig grunnlag for behandlingen vil dermed være den registrertes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a.

PERSONVERNPRINSIPPER

NSD vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:

- lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen
- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke viderebehandles til nye uforenlige formål
- dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
- lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER
Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: åpenhet (art. 12), informasjon (art. 13), innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18), underretning (art. 19), dataportabilitet (art. 20).

NSD vurderer at informasjonen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

FØLG DIN INSTITUSJONS RETNINGSLINJER
NSD legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32).

Microsoft SharePoint er databehandler i prosjektet. NSD legger til grunn at behandlingen oppfyller kravene til bruk av databehandler, jf. art 28 og 29.

For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og eventuelt rådføre dere med behandlingsansvarlig institusjon.

OPPFØLGING AV PROSJEKTET
NSD vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.

Lykke til med prosjektet!

Kontaktperson hos NSD: Marita Ådnanes Helleland
Tlf. Personverntjenester: 55 58 21 17 (tast 1)

# Appendix 3 - NSD Declaration of Consent

## Vil du delta i forskningsprosjektet

## *"How to Achieve Improved Project Management – A Study of Norwegian Road Clients"?*

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å kartlegge praktisk prosjektledelse opp mot teori. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

**Formål**
Formålet med prosjektet er å undersøke hvordan prosjektledelsesstrategier og verktøy blir benyttet i praksis, og sammenligne dette med teori. Oppgaven skal også undersøke hvordan prosjektledelse mellom byggherre og entreprenør blir gjennomført, for så å sammenligne prosjektledelsespraksis i byggebransjen. Til slutt er formålet med oppgaven og komme med mulige forslag til forbedring, slik at «forbedret» prosjektledelse kan oppnås.

Problemstilling:
How to Achieve Improved Project Management – A study of Norwegian Road Clients

Forskningsspørsmål:

- Hvilke parametere påvirker gjennomføringsmodellen i prosjektet?
- Hvordan samsvarer teori med praksis av ledelse mellom byggherre og entreprenør?
- Sammenligning av byggebransjen, kartlegging av effekten av dagens ledelsesstrategier og komme med fremtidig anbefaling basert på funn.

Prosjektet gjennomføres som en masteroppgave i samarbeid med NTNU.

**Hvem er ansvarlig for forskningsprosjektet?**
Norges teknisk-naturvitenskapelige universitet, Institutt for bygg- og miljøteknikk er ansvarlig for prosjektet.

**Hvorfor får du spørsmål om å delta?**
Du har blitt spurt om å delta i dette prosjekt grunnet din ekspertise og erfaring innen prosjektledelse i BAE-bransjen. Vi har mottatt dine kontaktopplysninger gjennom vår veileder, Olav Torp.

**Hva innebærer det for deg å delta?**
Hvis du velger å delta i dette prosjektet innebærer det et intervju, hvor studentene vil kartlegge din og organisasjonens gjennomførelse av prosjektledelse. Informasjonen vil bli registrert gjennom bruken av notater og lydopptak for enklere transkribering.

**Det er frivillig å delta**
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykke tilbake uten å oppgi noen grunn. Alle opplysninger om deg vil da bli anonymisert. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

**Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger**
Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

- Det er kun prosjektgruppen som vil ha tilgang til personopplysningene dine.
- Navn, alder, kjønn og andre personopplysninger, med unntak av stilling, vil ikke bli oppgitt i rapport. Personopplysningene vil kun bli behandlet internt av prosjektgruppen og holdes adskilt fra materiale som skal publiseres.
- Etter publikasjon vil ikke deltageren kunne bli gjenkjent av tredjepart.

**Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?**
Prosjektet skal etter planen avsluttes 10.06.2020. Alle personopplysningene vil bli slettet etter prosjekts slutt og når masteroppgaven er godkjent. Opplysningene vil bli beholdt frem til masteroppgaven er godkjent, grunnet etterprøvbarhet. Opplysningene vil bli sikret etter samme prosedyre som under gjennomførelsen av prosjektet. Alle opplysningene dine vil bli slettet innen 30.09.2020.

**Dine rettigheter**
Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg,
- å få rettet personopplysninger om deg,
- få slettet personopplysninger om deg,
- få utlevert en kopi av dine personopplysninger (dataportabilitet), og
  å sende klage til personvernombudet eller Datatilsynet om behandlingen av dine personopplysninger.

**Hva gir oss rett til å behandle personopplysninger om deg?**
Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra Norges teknisk-naturvitenskapelige universitet, Institutt for bygg- og miljøteknikk har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

**Hvor kan jeg finne ut mer?**
Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:

- Norges teknisk-naturvitenskapelige universitet, Institutt for bygg- og miljøteknikk ved Olav Torp, tlf: 93422673.
- Vårt personvernombud: Thomas Helgesen
- NSD – Norsk senter for forskningsdata AS, på epost (personvernтjenester@nsd.no) eller telefon: 55 58 21 17.

Med vennlig hilsen

| Olav Torp | Endre Eikeland Skaara | Preben Liland |
|---|---|---|
| Prosjektansvarlig (Forsker/veileder) | *Student* | *Student* |

## Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet «How to Achieve Improved Project Management – A Study of Norwegian Road Clients», og har fått anledning til å stille spørsmål. Jeg samtykker til:

- ☐ å delta i observasjonsstudium
- ☐ å delta i intervju
- ☐ at mine personopplysninger lagres etter prosjektslutt, til etterprøvbarhet

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet, ca. 10.06.2020

---

(Signert av prosjektdeltaker, dato)

# Appendix 4 - Overview of Studied Articles

| | Søkeord | Artikkrlnavn | Prosjektledelse eller Produktivitet? | Lest av Endre | Lest av Preben | Anbefaling | Comments | Sammendrag |
|---|---|---|---|---|---|---|---|---|
| 1 | Project management in the construction industry | Rework: A symptom of a dysfunctional supply-chain | Prosjektledelse og Produktivitestledelse | x | | Ja | | x |
| 2 | Project management in the construction industry | The causes and defects in construction, Astudy of seven building projects | Prosjektledelse | x | | tja | | x |
| 3 | Project management in the construction industry | Causes of Quality deviations in design and construction | Prosjektledelse | x | | ja | | x |
| 4 | Google Scholar:<br>Competency + Project Manager + Construction | Competency-Based Model for Predicting Construction<br>Project Managers´Performance | Prosjektledelse | | x | Ja | | x |
| 5 | Project management in the construction industry | Concurrent Engeneerin: a strategy for procuring construction | Prosjektledelse | x | | Nei | | |
| 6 | Project management in the construction industry | DEveloping project managemetn competancy: perspectives from the construction industry | Prosjektledelse | x | | tja | | x |
| 7 | Kilde fra "Beste praksis prosjektledelse" | Design of an Infrastructure Project Usinga Point-Based Methodology | Prosjektledlese | | x | Ja | | x |
| 8 | Total productive maintenance construction | An Introduction to Total Productive Maintance (TPM) | Produktivitetsledelse | x | | tja | | |
| 9 | Total quality management construction | Implimenting Total Quality Management in Construction Firms | Produktivitetsledelse | x | | ja | | x |
| 10 | ---------- | R760 Styring av vegprosjekter | Prosjektledelse | x | x | ja | | x |
| 11 | Total productive maintenance construction | Total Quality managemetn in the Construction process | Produktivitetsledelse | x | | nja | | |
| 12 | supply chain management construction | The four roles of supply chain management in construction | Produktivitetsledelse og Prosjektldelse | x | | ja | | x |
| 13 | supply chain management construction | The importance of collaboration in construction industry from contractors perspective | Produktivitetsledelse og Prosjektldelse | x | | Nja | Bør leses sammen | x |
| 14 | supply chain management construction | A survey of supply chain collaboration and management in the UK construction industry | Produktivitetsledelse og Prosjektldelse | x | | Nja | | x |
| 15 | supply chain management construction | A Bim based construction supply chain framework for monitoring progress and coordination of site activities | Produktivitetsledelse | x | | tja | Litt utenfor men relevnt | x |
| 16 | Appendix in R760 | Kompetansekrav til prosjektlederrollen | Prosjektledelse | | x | Ja | | x |
| 17 | DfMA | Fresh And Hardened properties of 3d printable cementitious materials for building and construction | Produktivitetsledelse | x | | Nei | Noe av innholdet er relevant | |
| 18 | lean construction management | Lean Project Management | Produktivitetsledelse og Prosjektldelse | x | | nja | Litt itdatert, men inneholder mye relevnt | |
| 19 | Kilde fra "Beste praksis prosjektledelse" | Lean management methods for complex projects | Produktivitetsledelse og Prosjektldelse | | x | Ja | | x |
| 20 | six sigma in construction | The integration of lean manufactoring, six sima and sustainability: a literature review and future directions for developing a spcific model | Produktivitetsledelse | x | | Ja | | x |
| 21 | Kilde fra "Beste praksis prosjektledelse" | Quantified Impacts of Project Change | Produktivitetsledelse og litt Prosjektldelse | | x | Nei | Tar for seg faktorer som påvirker arbeids-produktivitet. Fokusrer mest på metoder som entreprenør kan bruke for å bevise kostnader mtp endringer i prosjekt, som byggherre må stå til ansvar for. | |
| 22 | Kilde fra "Beste praksis prosjektledelse" | Work Structuring to acheive Integrated Product-Process Design | Prosjektledelse | | x | Ja | Case som tar for seg utfordringer med Design/Bid/Build som kanskje ikke hadde oppstått i en Design/Build kontrakt. | x |
| 23 | six sigma in construction | A comparative exploration of lean manufactoring and six sigma in terms of their critical success faktors | Produktivitetsledelse | x | | Tja | Meget relevant i forhold til forskningen, men noe av innholdet kommer litt på kanten av og til med tanke på at det\ skal være relevant til byggebransjen | x |
| 24 | Kilde fra "Beste praksis prosjektledelse" | Infrastructure in the New Era - Executive summary | Prosjektledelse og Produktivitestledelse | | x | Ja | | x |
| 25 | Kilde fra "Beste praksis prosjektledelse" | Improving Public Services through better construction | Prosjektledelse | | x | Ja | Tar for seg hva byggherreorganisasjoner i UK må fokusere på for å bedre prosjektleveranse | x |
| 26 | Pensum | The road to success | Prosjektledelse og Produktivitestledelse | x | x | ja | | x |
| 27 | Bok | Project Management - A system Approach to Planning, Schedualing and Controlling | Prosjektledelse | | x | Ja | | x |
| 28 | Pensum | Forprosjekt - Knut Samset | Prosjektledelse og Produktivitestledelse | x | x | ja | | x |
| 29 | Pensum | Assessment for sustainability | Produktivitet | x | x | ja | | x |
| 30 | Master oppgave | Praktisk prosjektledelse Statens vegevesen | Prosjektledelse | x | x | tja | Innholdet er relevant, men er meget meningsbasert. Selve case studien, kan være aktuell, men den er veldig liten så jeg vet ikke egentlig hvor solid den er? | x |
| 31 | lean construction management | Applying lean thinking in construction and performance improvement | Produktivitetsledelse | x | | NEI | Skrevet veldig matematisk, vod å lese, alt er stegvis. Men den inneholder tiltider noen gode opplysninger. | |
| 32 | Bok | PMI-bok | Prosjektledelse | x | x | JA | | x |
| 33 | supply chain management construction | Factors affecting collaboration in supply chain: A literature review | Prosjektledelse | x | | tja | | |
| 34 | VDC Stanford | A Guide to Applying the Princiiples of Virtual Design and Construction (VDC) to the Lean Project Delivery Process | Produktivitetsledelse | | x | Ja | | x |
| 35 | VDC Stanford | The VDC Scorecard: Formulation and Validation | Produktivitetsledelse | | x | Ja | | x |
| 36 | VDC Stanford | Analysis of the implementation of VDC from a lean perspective: Literature review | Produktivitetsledelse | | x | Ja | | x |
| 37 | Risk management construction | Risk management in construction projects | Projsektledelse og Produktivitetsledelse | | x | Ja | | x |
| 38 | Risk management construction | Risk management in construction projects: a knowledge-based approach | Projsektledelse og Produktivitetsledelse | | x | Ja | | x |
| 39 | ---------- | Samtidig prosjektering | Projsektledelse og Produktivitetsledelse | | x | Nei | | |

# Appendix 5 – Interview Guide Nye Veier

**Intervjuobjekt nr:**

**Organisasjon:**

**Stilling:**

**Informasjon:**

- Dette er et semistrukturert intervju, med mulighet for oppfølgingsspørsmål.
- Intervjuet er tiltenkt at skal vare cirka en time.
- Alle intervjuobjekter må signere informasjonsskriv før intervjuet starter.

## Kontraktstrategi og gjennomføringsstrategi:

- Hvilken kontrakt- og gjennomføringsstrategi har dere brukt/bruker dere i Nye Veier?
- Hvilke parametere påvirker gjennomføringsmodellen i prosjektet?
- Har du god ekspertise i entrepriseformene som blir benyttet?
- Er det noen utfordringer som har oppstått på grunn av valgt entrepriseform som kunne vært unngått med å velge en annen entrepriseform?
- Har det vært utfordringer med lokale myndigheter i planleggingen av prosjektene? (Kommunen vil ha mer lokal tilpasning/nytte)

## Anskaffelsesmetode:

- Hvilken anskaffelsesmetode er brukt i prosjektene?
- Hvilke parametere påvirker valget av anskaffelsesmetode?
- Hva har den valgte anskaffelsesmetoden betydd for prosjektene? (Billigere, bedre kvalitet, tidsbruk etc.)

## Prosjektledelse - Strategier og verktøy

**Overordnet spørsmål:**

- **Hva er det viktigste oppgavene innen prosjektledelse?**
- **Hva er utfordringene knyttet til prosjektledelse?**
- **Hvordan organiserer og bemanner dere prosjektene?**

## Kommunikasjon:

- Hva betyr kommunikasjon for deg?
- Hvordan kommuniserer du med dine medarbeidere? Både internt i din organisasjon og med andre samarbeidspartnere?
- Hvordan synes du kommunikasjonen både internt og eksternt er på prosjektene?
- Hva gjør du for sikre god kommunikasjon i prosjektene?

- Kommer nødvendig informasjon tydelig frem i prosjektene?
- Finnes det forbedringspotensialer når det gjelder kommunikasjon i organisasjonen?
- Hvordan påvirker hierarkiet kommunikasjonen? Er det vanskelig å snakke med lederen? (Power Distance)

**Tillit:**

- **Hvordan jobber dere med å oppnå tillit innenfor prosjektledelsen og styringen?**
- Føler du at resten av ledelsen har tiltro til deg og ditt arbeid?
- Har du tillit til resten ledelsen?
- Har du tillit til Nye Veier som organisasjon?
- Har du tillit til organisasjonens samarbeidspartnere? (Entreprenør/konsulent)
- Har du tillit til dine arbeidskollegaer? Både interne og eksterne.
- Hva gjør du for å oppnå tillit til interne og eksterne parter i prosjektet?

**Prosjektplanlegging:**

**Hvordan planlegger dere prosjektene?**

- Finnes det utfordringer knyttet til prosjektordren for de ulike prosjektene? (Tilstrekkelig definert, mangler osv.)
- Hvordan oppleves planleggingsprosessen i prosjektene til Nye Veier? (Ikke grundig nok?, for grundig?, langtrukket etc.)
- Oppleves det utfordringer med tredjeparter under planleggingen? (Kommunen etc.)
- Har det vært problemer med samarbeidspartnere under planleggingen av prosjekter?
- Hvordan har disse problemene blitt håndtert?
- Har dere nødvendige ressurser på prosjektet (Nok folk, plass, materialer, økonomi, er planen gjennomførbar)
- Hva gjør Nye Veier i planleggingsfasen for å sikre at prosjektet har nok ressurser?
- Har dere noen prosjektledelsesstrategi?
- Hvordan samsvarer prosjektledelsesstrategien med praktisk prosjektledelse
- Hvordan samsvarer teori med praksis av ledelse mellom byggherre og entreprenør? ( Hvilke verktøy blir brukt, hva er intensjonen for bruken av verktøyet, hvordan blir verktøyet brukt, evaluering av effektiviteten av verktøyet, etc.)

**Overvåkning og styring**

- Brukes sentralt styringsdokument (eller lignende) aktivt i prosjektet? (Kvalitetsplan)
- Fungerer dokumentet etter intensjonen?
- Hvordan håndterer dere stakeholderne i prosjekterer?
- Har alle stakeholderne i prosjektene blitt analysert?
- Hvilke metoder bruker dere for å overvåke og styre tid, kostnad og kvalitet i prosjektet?
- Hvordan sammenligner dere faktisk prosjektytelse mot planlagt prosjektytelse?

- Hvilke tiltak gjøres for å styre prosjektytelsen ved avvik?
- Hvordan er beslutningsevnen på prosjektet? (Tar ting tid, frem og tilbake på beslutninger, osv.)

**Risiko- og usikkerhetsstyring:**

- **Hvordan jobber dere med usikkerhetsstyring**
- Hvordan håndterer dere risiko? Systematiseres den?
- Har denne systematiseringen fungert som ønsket? Er det mangler eller forbedringsmuligheter?
- Har du/dere en proaktiv måte å håndtere risiko og usikkerhet?

**Konfliktstyring:**

- **Hvordan jobber dere med konfliktstyring**
- Hvilke konflikter oppstår typisk på prosjekter?
- Finnes det en prosedyre for å håndtere konflikter?
- Hvem er ansvarlig for å håndtere konfliktene?
- Hvordan unngås konflikteskalering?

**Produktivitetsledelse – Verktøy og strategier**

**Supply Chain Management:**

- **Bruker Nye Veier Supply Chain Management?**
- Hvordan foregår forsyningskjeden på dette prosjektet? Informasjon, penger, etc (i sammenheng med arbeidet til Nye Veier)
- Hvem er ansvarlig for forsyningskjeden?
- Er forsyningskjeden blitt formidlet og forstått av alle involverte?
- Har det oppstått noen problemer med forsyningskjeden? Forsinkelser, kvalitets problemer, misforståelser, feilleveranser/utførelse, logistikkutfordringer etc.

**Lean:**

- **Benytter dere Lean i prosjektene, i så fall hvordan?**
- Legger Nye Veier til rette for effektiviseringsstrategier
- Har dere en egen «Lean-ansvarlig» på dette prosjektet? (Evt. i organisasjonen).
- Har dere opplevd noen utfordringer med bruken av Lean?

**Last Planner**

- Benyttes det bakover planlegging?
- Hvilke typer planer benyttes på dette prosjektet? (Hoved-fremdriftsplan, kontrollplan og styringsplan) + (utkikksplan, detaljplan, ukeplan og dagsplan)

**PDCA**

- Bruker dere PDCA (Planlegg, Gjennomfør, Kontroller, Handle), eller liknende?
- Hvordan blir dette benyttet i Nye Veier?

**Involverende Planlegging**

- Blir alle nødvendige parter inkludert i planleggingen av prosjektene? (blir kommunen inkludert, blir sluttbrukerens tanker og ideer vurdert, etc.? Eksempel fra entreprenørens side - Blir alle inkludert i planleggingen? (Prosjekteringsleder, prosjektleder, anleggsleder, forman, bas, arbeider)
- Hvorfor/hvorfor ikke?
- Hvordan gjennomføres dette?

**Root Cause Analysis**

- Etter evaluerer dere prosjektene?
- Benytter dere RootCause Analysis eller andre teknikker for å finne bakenforliggende årsaker for problemer? Eller for bakenforliggende årsaker for positiv utvikling?
- Benyttet dere for eksempel «5 x Hvorfor» som verktøy til å finne disse årsakene?

**Lean Six Sigma:**

- Hva slags type kvalitetssikring og analyseringsmetoder benytter Nye Veier?
- Har du kjennskap til DMAIC og TQM?
- Hvordan er DMAIC og TQM blitt benyttet?
- Hvordan driver organisasjonen/du med systematisk kvalitetsevaluering og forbedring?

**Building Information Modeling:**

- Har det blitt benyttet BIM på prosjektene?
- Hvordan er BIM blitt benyttet? Er den tilnærmet lik de ferdige prosjektene? (Digital Tvilling/som bygget)
- Hvem kan se BIM modellen? Har alle tilgang?
- Er modellen så detaljert at arbeidstegninger kan produseres rett fra modellen?

**Virtual Design and Construction:**

- Bruker Nye Veier VDC, i så fall hvordan?
- Hvordan er din kjennskap til VDC?
- Hvordan fungerte bruken av VDC? (Utforinger og erfaringer)

# Appendix 6 – Interview Guide NPRA

**Intervjuobjekt nr:**

**Organisasjon:**

**Stilling:**

**Informasjon:**

- Dette er et semistrukturert intervju, med mulighet for oppfølgingsspørsmål.
- Intervjuet er tiltenkt at skal vare cirka en time.
- Alle intervjuobjekter må signere informasjonsskriv før intervjuet starter.

## Kontraktstrategi og gjennomføringsstrategi:

- Hvilken kontrakt- og gjennomføringsstrategi har dere brukt/bruker dere i SVV?
- Hvilke parametere påvirker gjennomføringsmodellen i prosjektet?
- Har du god ekspertise i entrepriseformene som blir benyttet?
- Er det noen utfordringer som har oppstått på grunn av valgt entrepriseform som kunne vært unngått med å velge en annen entrepriseform?
- Har det vært utfordringer med lokale myndigheter i planleggingen av prosjektene? (Kommunen vil ha mer lokal tilpasning/nytte)

## Anskaffelsesmetode:

- Hvilken anskaffelsesmetode er brukt i prosjektene?
- Hvilke parametere påvirker valget av anskaffelsesmetode?
- Hva har den valgte anskaffelsesmetoden betydd for prosjektene? (Billigere, bedre kvalitet, tidsbruk etc.)

## Prosjektledelse - Strategier og verktøy

**Overordnet spørsmål:**

- **Hva er det viktigste oppgavene innen prosjektledelse?**
- **Hva er utfordringene knyttet til prosjektledelse?**
- **Hvordan organiserer og bemanner dere prosjektene?**
- **Hva mener du SVV kan gjøre bedre når det gjelder prosjektledelse?**

## Håndbok R760:

- Hva tenker du om innholdet i R760?
- Brukes denne aktivt i din arbeidshverdag?

- Finnes utfordringer knyttet til bruken av R760 når det gjelder størrelsen av prosjekt? (For mye «retningslinjer» for et lite prosjekt, mens den kanskje ikke er tilstrekkelig for store prosjekt?)
- Finnes det store gap mellom teorien i R760 og den prosjektledelsen som faktisk blir gjennomført i praksis? (Fra tidligere er det blitt sagt erfaring trumfer bruken av R760. Det er også blitt sagt at teorien som er brukt i R760 er basert på tidligere erfaring, dermed vil håndboka i mange tilfeller henge bak i utviklingen)
- Hvordan kan disse utfordringene fikses?
  (Fra tidligere intervjuer er det blitt sagt at informasjonen i R760 er veldig generell og kan derfor være vanskelig å følge fordi det ikke i detalj står hva som skal gjøres. Dette har vært et problem spesielt for nyansatte)

**Kommunikasjon:**

- Hva betyr kommunikasjon for deg?
- Hvordan kommuniserer du med dine medarbeidere? Både internt i din organisasjon og med andre samarbeidspartnere?
- Hvordan synes du kommunikasjonen både internt og eksternt er på prosjektene?
- Hva gjør du for sikre god kommunikasjon i prosjektene?
- Kommer nødvendig informasjon tydelig frem i prosjektene?
- Finnes det forbedringspotensialer når det gjelder kommunikasjon i organisasjonen?
- Hvordan påvirker hierarkiet kommunikasjonen? Er det vanskelig å snakke med lederen? (Power Distance)

**Tillit:**

- **Hvordan jobber dere med å oppnå tillit innenfor prosjektledelsen og styringen?**
- Føler du at resten av ledelsen har tiltro til deg og ditt arbeid?
- Har du tillit til resten ledelsen?
- Har du tillit til SVV som organisasjon?
- Har du tillit til organisasjonens samarbeidspartnere? (Entreprenør/konsulent)
- Har du tillit til dine arbeidskollegaer? Både interne og eksterne.
- Hva gjør du for å oppnå tillit til interne og eksterne parter i prosjektet?

**Prosjektplanlegging:**

**Hvordan planlegger dere prosjektene?**

- Finnes det utfordringer knyttet til prosjektordren for de ulike prosjektene? (Tilstrekkelig definert, mangler osv.)
- Hvordan oppleves planleggingsprosessen i prosjektene til SVV? (Ikke grundig nok?, for grundig?, langtrukket etc.)
- Oppleves det utfordringer med tredjeparter under planleggingen? (Kommunen etc.)
- Har det vært problemer med samarbeidspartnere under planleggingen av prosjekter?
- Hvordan har disse problemene blitt håndtert?
- Har dere nødvendige ressurser på prosjektet (Nok folk, plass, materialer, økonomi, er planen gjennomførbar)

- Hva gjør SVV i planleggingsfasen for å sikre at prosjektet har nok ressurser?
- Har dere noen prosjektledelsesstrategi?
- Hvordan samsvarer prosjektledelsesstrategien med praktisk prosjektledelse
- Hvordan samsvarer teori med praksis av ledelse mellom byggherre og entreprenør? ( Hvilke verktøy blir brukt, hva er intensjonen for bruken av verktøyet, hvordan blir verktøyet brukt, evaluering av effektiviteten av verktøyet, etc.)
- Hvordan tar SVV høyde for utnyttelsen av systemer og hjelpemidler. (det kan bli for mange systemer, for mye rapportering, vanskelig å få sammenheng.)
-

**Overvåkning og styring**

- Brukes sentralt styringsdokument (eller lignende) aktivt i prosjektet? (Kvalitetsplan)
- Fungerer dokumentet etter intensjonen?
- Hvordan håndterer dere stakeholderne i prosjekterer?
- Har alle stakeholderne i prosjektene blitt analysert?
- Hvilke metoder bruker dere for å overvåke og styre tid, kostnad og kvalitet i prosjektet?
- Hvordan sammenligner dere faktisk prosjektytelse mot planlagt prosjektytelse?
- Hvilke tiltak gjøres for å styre prosjektytelsen ved avvik?
- Hvordan er beslutningsevnen på prosjektet? (Tar ting tid, frem og tilbake på beslutninger, osv.)

**Risiko- og usikkerhetsstyring:**

- **Hvordan jobber dere med usikkerhetsstyring**
- Hvordan håndterer dere risiko? Systematiseres den?
- Har denne systematiseringen fungert som ønsket? Er det mangler eller forbedringsmuligheter?
- Har du/dere en proaktiv måte å håndtere risiko og usikkerhet?

**Konfliktstyring:**

- **Hvordan jobber dere med konfliktstyring**
- Hvilke konflikter oppstår typisk på prosjekter?
- Finnes det en prosedyre for å håndtere konflikter?
- Hvem er ansvarlig for å håndtere konfliktene?
- Hvordan unngås konflikteskalering?

**Produktivitetsledelse – Verktøy og strategier**

**Supply Chain Management:**

- **Bruker SVV Veier Supply Chain Management?**
- Hvordan foregår forsyningskjeden på dette prosjektet? Informasjon, penger, etc (i sammenheng med arbeidet til SVV)
- Hvem er ansvarlig for forsyningskjeden?
- Er forsyningskjeden blitt formidlet og forstått av alle involverte?
- Har det oppstått noen problemer med forsyningskjeden? Forsinkelser, kvalitets problemer, misforståelser, feilleveranser/utførelse, logistikkutfordringer etc.

**Lean:**

- **Benytter dere Lean i prosjektene, i så fall hvordan?**
- Legger SVV til rette for effektiviseringsstrategier?
- Har dere en egen «Lean-ansvarlig» på dette prosjektet? (Evt. i organisasjonen).
- Har dere opplevd noen utfordringer med bruken av Lean?

**Last Planner**

- Benyttes det bakover planlegging?
- Hvilke typer planer benyttes på dette prosjektet? (Hoved-fremdriftsplan, kontrollplan og styringsplan) + (utkikksplan, detaljplan, ukeplan og dagsplan)

**PDCA**

- Bruker dere PDCA (Planlegg, Gjennomfør, Kontroller, Handle), eller liknende?
- Hvordan blir dette benyttet i SVV?

**Involverende Planlegging**

- Blir alle nødvendige parter inkludert i planleggingen av prosjektene? (blir kommunen inkludert, blir sluttbrukerens tanker og ideer vurdert, etc.? Eksempel fra entreprenørens side - Blir alle inkludert i planleggingen? (Prosjekteringsleder, prosjektleder, anleggsleder, forman, bas, arbeider)
- Hvorfor/hvorfor ikke?
- Hvordan gjennomføres dette?

**Root Cause Analysis**

- Etter evaluerer dere prosjektene?
- Benytter dere RootCause Analysis eller andre teknikker for å finne bakenforliggende årsaker for problemer? Eller for bakenforliggende årsaker for positiv utvikling?
- Benyttet dere for eksempel «5 x Hvorfor» som verktøy til å finne disse årsakene?

**Lean Six Sigma:**

- Hva slags type kvalitetssikring og analyseringsmetoder benytter SVV?
- Har du kjennskap til DMAIC og TQM?
- Hvordan er DMAIC og TQM blitt benyttet?
- Hvordan driver organisasjonen/du med systematisk kvalitetsevaluering og forbedring?

**Building Information Modeling:**

- Har det blitt benyttet BIM på prosjektene?
- Hvordan er BIM blitt benyttet? Er den tilnærmet lik de ferdige prosjektene? (Digital Tvilling/som bygget)
- Hvem kan se BIM modellen? Har alle tilgang?
- Er modellen så detaljert at arbeidstegninger kan produseres rett fra modellen?

**Virtual Design and Construction:**

- Bruker SVV VDC, i så fall hvordan?
- Hvordan er din kjennskap til VDC?
- Hvordan fungerte bruken av VDC? (Utforinger og erfaringer)

**Siste spørsmål:**

Har du noen andre prosjektledere i Statens vegvesen som vi kan kontakte for intervju?

# Appendix 7 – Interview Guide Contractor

**Intervjuobjekt nr:**

**Organisasjon:**

**Stilling:**

## Kontraktstrategi

- *Hvilken kontraktstrategi har dere erfaring med i forbindelse med vegprosjekt?*
- *Har du god ekspertise i entrepriseformene som blir benyttet?*
- *Er det noen utfordringer som har oppstått på grunn av valgt entrepriseform som kunne vært unngått med å velge en annen entrepriseform?*

## Anskaffelsesmetode:

- *Hvilken anskaffelsesmetode er brukt i deres vegprosjekter?*
- *Har du som prosjektleder en foretrukket anskaffelsesmetode i vegprosjekt?*
- *Hva har den valgte anskaffelsesmetoden betydd for prosjektene? (Billigere, bedre kvalitet, tidsbruk, bedre samhandling)*

## Prosjektledelse - Strategier og verktøy

**Overordnet spørsmål:**

- ***Hva er det viktigste oppgavene innen prosjektledelse?***
- ***Hva er utfordringene knyttet til prosjektledelse?***
- ***Hvordan organiserer og bemanner dere prosjektene?***
- ***Hva mener du organisasjonen kan gjøre bedre når det gjelder prosjektledelse?***

## Kommunikasjon mellom byggherre

- *Hva betyr kommunikasjon i jobbsammenheng for deg?*
- *Hvordan kommuniserer du med dine medarbeidere? Både internt i din organisasjon og med byggherre?*
- *Hvordan synes du kommunikasjonen både internt og eksternt (byggherre) er på prosjektene?*
- *Hva gjør dere for sikre god kommunikasjon i prosjektene?*
- *Kommer nødvendig informasjon tydelig frem i prosjektene?*
- *Finnes det forbedringspotensialer når det gjelder kommunikasjonen mellom dere og byggherren?*
- *Hvordan påvirker hierarkiet kommunikasjonen? Er det vanskelig å snakke med lederen? (Power Distance)*

**Tillit mellom byggherre:**

- ***Hvordan jobber dere med å oppnå tillit i forholdet med byggherren?***
- *Føler du at byggherren har tillit til organisasjonen.*
- *Har du tillit til byggherren?*
- *Har du tillit til organisasjonens samarbeidspartnere? (Under entreprenører/konsulenter)*
- *Har du tillit til dine arbeidskollegaer? Både interne og eksterne.*
- *Hva gjør du for å oppnå tillit til interne og eksterne parter i prosjektet?*

**Prosjektplanlegging:**

- *Hvordan oppleves forarbeidet som byggherren har gjort i de tidligere fasene før dere kommer på banen?*
- *Oppleves det utfordringer med tredjeparter under byggingen av prosjektet? (Kommunen etc.)*
- *Har det vært problemer med samarbeidspartnere under byggingen av prosjektet?*
- *Hvordan har disse problemene blitt håndtert?*
- *Hvordan opplever du byggherrens bemanning på prosjektet?*
- *Har dere noen prosjektledelsesstrategi?*
- *Hvordan samsvarer prosjektledelsesstrategien med praktisk prosjektledelse?*
- *Hvordan samsvarer samarbeidsdokumentene som er utarbeidet av byggherren og organsiasjonen med praktisk gjennomførelse?*

**Overvåkning og styring**

- *Hvordan håndterer dere stakeholderne i prosjekterer?*
- *Har alle stakeholderne i prosjektene blitt analysert?*
- *Hvilke metoder bruker dere for å overvåke og styre tid, kostnad og kvalitet i prosjektet?*
- *Hvordan sammenligner dere faktisk prosjektytelse mot planlagt prosjektytelse?*
- *Hvilke tiltak gjøres for å styre prosjektytelsen ved avvik?*
- *Hvordan oppleves byggherrens beslutningsevne på prosjektet? (Tar ting tid, frem og tilbake på beslutninger, osv.)*

**Risiko- og usikkerhetsstyring:**

- ***Hvordan jobber dere med usikkerhetsstyring? Og hvordan fungerer dette sammen med byggherrens usikkerhetsstyring?***
- *Hvordan håndterer dere risiko? Systematiseres den?*
- *Har denne systematiseringen fungert som ønsket? Er det mangler eller forbedringsmuligheter?*
- *Har dere en proaktiv måte å håndtere risiko og usikkerhet?*

**Konfliktstyring:**

- ***Hvordan jobber dere med konfliktstyring?***
- *Hvilke kontraktslige konflikter oppstår typisk på vegprosjekter?*
- *Hvordan oppleves prosedyren for å håndtere konflikter?*
- *Hvem er ansvarlig for å håndtere konfliktene?*
- *Hvordan unngås konflikteskalering mellom byggherre og organisasjonen?*

**Produktivitetsledelse – Verktøy og strategier**

**Supply Chain Management:**

- ***Bruker dere Supply Chain Management?***
- *Hvordan foregår forsyningskjeden på dette prosjektet? Informasjon, penger, etc*
- *Hvem er ansvarlig for forsyningskjeden?*
- *Er forsyningskjeden blitt formidlet og forstått av alle involverte?*
- *Har det oppstått noen problemer med forsyningskjeden? Forsinkelser, kvalitets problemer, misforståelser, feilleveranser/utførelse, logistikkutfordringer etc.*

**Lean:**

- ***Benytter dere Lean i prosjektene, i så fall hvordan?***
- Legger dere til rette for effektiviseringsstrategier?
- Har dere en egen «Lean-ansvarlig» på dette prosjektet? (Evt. i organisasjonen).
- *Har dere opplevd noen utfordringer med bruken av Lean?*

**Last Planner**

- Benyttes det bakover planlegging?
- *Hvilke typer planer benyttes på dette prosjektet? (Hoved-fremdriftsplan, kontrollplan og styringsplan) + (utkikksplan, detaljplan, ukeplan og dagsplan)*

**PDCA**

- *Bruker dere PDCA (Planlegg, Gjennomfør, Kontroller, Handle), eller liknende?*
- *Hvordan blir dette benyttet hos dere?*

**Involverende Planlegging**

- *Blir alle nødvendige parter inkludert i planleggingen av prosjektene? (blir kommunen inkludert, blir sluttbrukerens tanker og ideer vurdert, etc.? Eksempel fra entreprenørens side - Blir alle inkludert i planleggingen? (Prosjekteringsleder, prosjektleder, anleggsleder, forman, bas, arbeider)*
- *Hvorfor/hvorfor ikke?*
- *Hvordan gjennomføres dette?*

**Root Cause Analysis**

- Etter evaluerer dere prosjektene?
- Benytter dere RootCause Analysis eller andre teknikker for å finne bakenforliggende årsaker for problemer? Eller for bakenforliggende årsaker for positiv utvikling?
- Benyttet dere for eksempel «5 x Hvorfor» som verktøy til å finne disse årsakene?

**Lean Six Sigma:**

- Hva slags type kvalitetssikring og analyseringsmetoder benytter organisasjonen?
- Har du kjennskap til DMAIC og TQM?
- Hvordan er DMAIC og TQM blitt benyttet?
- Hvordan driver organisasjonen/du med systematisk kvalitetsevaluering og forbedring?

**Building Information Modeling:**

- *Har det blitt benyttet BIM på prosjektene?*
- *Hvordan er BIM blitt benyttet? Er den tilnærmet lik de ferdige prosjektene? (Digital Tvilling/som bygget)*
- *Hvem kan se BIM modellen? Har alle tilgang?*
- *Er modellen så detaljert at arbeidstegninger kan produseres rett fra modellen?*

**Virtual Design and Construction:**

- *Bruker dere VDC, i så fall hvordan?*
- *Hvordan er din kjennskap til VDC?*
- *Hvordan fungerte bruken av VDC? (Utforinger og erfaringer)*

## Appendix 8 – Plan for Case study Visits

**Plan for visiting construction site – E6 Soknedal:**

| Week | Date |
|---|---|
| 10 | Wednesday 4. March<br>Thursday 5. March |
| 11 | Wednesday 11. March<br>Thursday 12. March |
| 12 | Wednesday 18. March<br>Thursday 19. March |
| 13 | Wednesday 25. March<br>Thursday 26. March |
| 14 | Wednesday 1. April |
| 15 | Easter holiday |
| 16 | Wednesday 15. April |
| 17 | Wednesday 22. April |
| 18 | Wednesday 29. April |

# Appendix 9 – Case Guide

### Parameters for selecting Contract Structure

- Se om alle i prosjektet forstår entrepriseformen
- Se på oppdeling av prosjektet. Har dette en innvirkning på dette prosjektet? (flere kontrakter) Kunne dette vært unngått ved større kontrakter? Er dette bedre?
- Se på samhandling og integrering når det gjelder å starte tidlig eller utsette prosjektet. Hva gir best resultat?
- Se på parameterener. Hvilke parametere påvirker prosjektet? (størrelse, entreprise, økonomi og finansiering. Etc)
- Se på valg av kontrakt strategier. (Utfjordinger som kunne vært ungår, ved bruk av annen strategi?)

### Forhold som påvirker valg av kontraktstrategi (Lædre, 2006)

- Investeringskostnad for byggherre.
- Kostnadsusikkerhet for byggherre.
- Driftskostnad for byggherre.
- Usikkerhet knyttet til driftskostnad.
- Gjennomføringstid.
- Framdriftsusikkerhet for byggherre.
- Kvalitet på produktet.
- Kvalitetsusikkerhet for byggherre.
- Fleksibilitet i investeringstakt.
- Fleksibilitet i gjennomføring.
- Fleksibilitet i produktspesifikasjoner.
- Samarbeid med leverandør.
- Tilfredshet hos framtidig eier og brukere.

### Parameters for selecting Procurement method

- Se på anskaffelsesmetoden som er brukt
- Se på parameteren som på virker valg av anskaffelse metode.
- Se på betydningen av anskaffelsesmetoden på prosjektet. (billigere? Bedre kvalitet? Etc.)

### Communication

- Se på hvordan hierarkiet påvirker kommunikasjonen i prosjektet
- Er det sømløs kommunikasjon
- Se på hvordan informasjonen blir delt. Kommer en tydelig fram fra samtaler og/eller andre kommunikasjonsmidler?

**Trust**

- Se på hvordan tillitten er blant de ansatte
- Se på tilliten blant samarbeidspartnere

**Project Planning**

- Se på ekspertisen i prosjekt organisasjonen. (er den bred, er den spesifikk. Er den utfyllende nokk, etc.)
- Se på samarbeidsnivå både internt og mellom eksterne arbeidspartnere
- Se på HMS planen (HMS, klima og miljø, minimere kostnader, minimere ulemper for vei bruker, minimere ekspropriasjon)
- Se på bruken av R760
- Se på hvordan planleggingen gjennomføres
- Se på hvordan plassering i forhold til eksisterende veier har påvirket valget av de nye veiene. Større logistikk utfordringer? Billigere? Dyrere? Mer planlegging?
- Se på ressursbruk. Er det nok ressurser tilgjengelig?

**Success Criteria/Factors**

- Se på prosjektlederens evne til å se det store bilde (fokuserer prosjektlederen fornye på spesifikke detaljer?)
- se på tidsbruken
- se på evnen til å handle og å arbeide systematisk
- se på beslutningsevnen i prosjektet. Tar ting lang tid? Er det mye venting? Hvem tar avgjørelsene? Er det mye frem og tilbake? Kan prosjektleder ta alle nødvendige avgjørelser?
- Se på hvordan ledelsen viser seg på prosjektet. Er prosjekt leder tilstedte?
- Se på delegering av oppgavene. Gjør ledelsen nokk arbeid til å få et eierskaps forhold til prosjektet?

**Monitor and Control**

- Se på prosjektbestilling og kontrakter og se om de er vel definert. Er den brukt? Fungerer den?
- Se på kvalitetsplanen og sentralt styringsdokument
- Se på prosjektets Stakeholder analyse. Er dette litt gjort? Er det grundig nokk?
- Se på håndteringen av stakeholderne
- Se på metode for overvåkning av tid, kostnad og kvalitet
- Se på hvordan prosjektet evaluerer rapportere overvåke og styrer prosjektet.
- Se på hvordan ytelsen på prosjektet er i forhold til planen
- Se på hvordan de ansatte håndterer avvik mellom plan og faktisk ytelse

**Risk and Uncertainty Management**

- Blir usikkerhet satt i system? (Risk matrise eller liknende)
- Se på om de ansatte er proaktive i henhold til mulig risiko og usikkerhet
- Se på hvordan de ansatte håndterer usikkerhet.
- Se på hva de ansatte gjør for å identifisere usikkerhet, og hva de gjør for å minimere / eliminere den
- Se på om bedriften overvåker tiltakene de iverksetter

**Conflict Management**

- Se på hva ledelsen gjør for å unngå konflikter
- Se på hva ledelsen gjør for å løse konflikter
- Se på bedriftens overordnede plan for å løse/unngå konflikter. (blir personer med ulike synspunkt satt sammen eller puttet fra hverandre)
- Er konfliktløsning /håndtering en del av prosjekt planleggingen.

**Supply Chain Management**

- Se på planlegging av logistikk
- Se på forsyningskjeden og hvordan den foregår
- Finn ut hvem som er ansvarlig
- Observer om det er noen problemer med forsyningskjeden
- Se på informasjonsflyten av forsyningskjeden

**Building Information Modeling (BIM)**

- Se på hvordan BIM blir brukt
- Finn ut av hvem som har tilgang til BIM modellen
- Se på hvilke goder/problemer BIM tar med seg. (raskere gjennomføring, billigere? Etc.)
- Blir BIM brukt i FDV? Hva skjer med modellen når bygget ferdigstiller?
- Se på forståelsen av BIM blant de ansatte. Blir modellen brukt på møter, i samtaler, annet?

**Virtual Design and Construction (VDC)**

- Er det gjennomført VDC?
- Se på forståelsen knyttet til VDC
- Se på fordeler/ulemper med VDC

**Lean**

- Last Planner
  Se om det benyttes bakover planlegging
- Se hvilke planer som benyttes (Hoved-fremdriftsplan, kontrollplan og styringsplan) + (Utkikksplan, Detaljplan, ukeplan, dagsplan) LEAN

**PDCA**

- Hvordan kontrollerer bedriften systematisk planlegging etter prinsippet – Planlegg, Gjennomfør, Kontroller, Handle

**DfMA**

- Benytter bedriften prefabrikkering?
- Til hvilken grad?
- Hvorfor?

**Involverende Planlegging**

- Blir alle inkludert i planleggingen? (Prosjekteringsleder, prosjektleder, anleggsleder, forman, bas, arbeider)
- Hvorfor/hvorfor ikke?
- Hvordan gjennomføres dette?

**5S**

- Se på bedriftens evne til å følge 5s prinsippene
- Sort, set in order, shine, standardize and sustain
- Sorter, Systematisere, Rydde, Standardisere, Opprettholde

**Kaizen – kontinuerlig forbedrelse**

- Prosess orientert
- Små forbedringer som gjennomføres kontinuerlig på alle arbeidsoppgaver
- avhengig av alle i bedriften (arbeidere og ledere)

**Root Cause Analysis**

- 5 x Hvorfor
- Se på bedriftens evne til å fine bakgrunnen til problemene. Evaluerer de ansatte arbeidet som er blitt gjort?

**7 Waists**

- Se på bedriftens evne til å evaluere om en aktivitet er «sunn». Det betyr om bedriften følger de 7 +1 rekkefølge stegene som må gjennomføres før en aktivitet kan starte
- Foregående aktivitet ferdig, 2. Nødvendig material er på plass 3. Tilgang på nødvendig verktøy, 4. Tilgang på nødvendig personale, 5. Nødvendig informasjon er innhentet, 6. det er tilstrekkelig arbeidsplass til å utføre arbeidet, 7. ytre forutsetninger er på plass, +1. HMS

## Appendix 10 – Framework for Mapping Information in the Case Study

Contract Structure & Project Delivery Method

| **Parameters for selecting Contract Structure** | **Interview** | **Observation** | **Other** |
|---|---|---|---|
| | | | |

Procurement method

| **Parameters for selecting Procurement method** | **Interview** | **Observation** | **Other** |
|---|---|---|---|
| | | | |

Project Management Tools and Strategies

| **Tool** | **Interview** | **Observation** | **Other** |
|---|---|---|---|
| Communication | | | |
| Trust | | | |
| Project Planning | | | |
| Monitor and Control | | | |

| | | | |
|---|---|---|---|
| Risk and Uncertainty Management | | | |
| Conflict Management | | | |

Productivity Management Tools and Strategies

| **Tool** | **Interview** | **Observation** | **Other** |
|---|---|---|---|
| Supply Chain Management | | | |
| Lean | | | |
| Lean Six Sigma | | | |
| Building Information Modeling (BIM) | | | |
| Virtual Design and Construction (VDC) | | | |

# Appendix 11 – Summery of the Project Manager's Task Described in Handbook R760

### Stage 1: Project Identification

The project owner is the only one with responsibility in the Project Identification stage.

### Stage 2: Project Planning

The goals for the project manager in the project planning phase are to understand the projects intended effectiveness and impact. The project manager must additionally

**Goals**

- Understanding the project´s intended effectiveness and impact.
- Develop prerequisite goals regarding the administrations safety and environment policy.
- Develop project output goal, linked to a realistic cost estimation.
- Develop realistic framework for project progress, with dependencies and slack.
- Develop project goals that meets the demands described in the project order and the current norms and guidelines.
- Develop a realistic total cost estimation for the project

**Success factors:**

- Describe project success factors linked to project goals. The success factors must be based on the overall discovered insecurities in the project, including a stakeholder analysis and review of lessons learned from similar completed projects.
- Measures to secure that the critical success factors are achieved must be developed. This must then be linked up to the specific project´s execution strategy and control basis.

**Frame conditions:**

- Describe frame conditions regarding the project's safety and environment requirements.
- Describe important interfaces based on the stakeholder analysis, project goal and overall project uncertainties.

**Execution strategy**

- Develop strategy to handle project uncertainties.
- Develop contract strategy based on the project´s goals, uncertainties and order.
  - Organizing and staffing
- Develop organization- and staffing strategy. This involves a description of the project organization map, staff resource plan showing both up- and downsizing in the staff, responsibilities of all involved parties, and uncertainties regarding the project organization development.

**Communication strategy**

- Develop a communication strategy for the project, based on risk evaluation and mapping of stakeholders and interfaces.

**Project control basis**

  - Scope of work and changes
- Describe the project´s scope of work as precis and quantitative as possible.
- Establish routines for managing changes and detect possible consequences for the project effectiveness and impact due to the changes.
  - Project breakdown structure
- Divide the project into manageable tasks based on the project- and contract strategy.
  - Economy
- Develop cost estimate involving all the costs of the project.
  - Project progress
- Develop a plan for the project progress, involving the whole project execution. The plan must consist of activities involving risk, milestones, dependencies and slack. The progress plan must be quality checked as realistic and at the same time secure that safety and environment requirements in the project are met.

**Quality**

- A quality plan describing how the project will work to make sure that satisfactory quality is achieved must be made.
- Make sure that the basis-data for the existing situation is quality checked.

- Routines for handling deviations must be developed.
- Approve the mapping of critical processes/activities in the project.
- Facilitate transfer of experience in the transition from one project phase to another.

**Stage 3: Project Execution**

The Project Managers responsibility in the project execution stage is:

**Goals**

- Manage the project toward stipulated project goals linked to given frame conditions so that goal conflicts are avoided.
- Consider if deviation in the project output will have consequences for other goals.
- Execute measures if goal conflict occurs and at the same time report to the project owner.
- If necessary, assist project owner with an exit strategy.

**Frame conditions:**

- Secure that the described interfaces are handled in a satisfactory matter.
- Make sure that all safety and environment requirements are followed.
- Make sure that the project execution is done accordingly to decided requirements in the zoning plan.
- Participate in meetings with the supplier. E.g. Start-up and coordination meetings.

**Execution strategy**

- Establish routines for managing uncertainties.
- Contracting and contract management

- Provide the project organization with access to necessary basis-data.
- Secure that the administrations current guidelines (template) for the tender process is used for all procurements in every phase.
- Quality check the tender-basis before the tendering competition is announced.
- Complete a total cost estimation before announcement of the tendering.
- Make sure that the engineering manager, construction manage the contract in line with tender- and contract requirements.
    - Organizing and staffing

- Distribute responsibilities and tasks in the project.
- Execute work-management in such a way that it secures an effective, competent and interacting project organization.
- Secure correct organizing and staffing at all time.
  - Communication
- Follow-up the project´s communication strategy.
- Have a continuous focus on identifying opportunities for reputation management.
- Identifying opportunities for negative mention in the media that can affect the project´s goal achievement and the administration´s reputation.

**Project control basis**

- Scope of work and changes
- Secure that changes in the framework conditions, scope of work and legally binding documents (Zoning plan) is identified, documented and handled accordingly to the project´s goals.
- Submit changes that can affect the project´s goal achievement to the project owner at an early time. This to make sure that there is a reasonable chance for the project owner to influence the outcome of the changes.
  - Safety and environment
- Secure that uncertainties and critical processes linked to safety and environment is identified and handled in a satisfactory manner.
  - Economy
- Make sure uncertainties attached to the economy is identified and right measures are made to handle them.
- Follow up the budget, accounting, and economical forecasts on a contract- and project level.
- Make a full review of the cost estimate. The cost estimate´s focus must lie on the remaining uncertainty and decisions that affects both the outcome and effectiveness/impact of the project.
  - **Project progress**
- Secure that uncertainties regarding project progress are identified and handled in a proper way.

- Keep track of the project´s progress plan and its most extensive uncertainties, dependencies and slack.

- **Quality**

- Continuously follow up and upgrade the project´s quality plan and mapping of critical processes, regarding safety and environmental issues.
- Secure that all decisions are based on sufficient interdisciplinary assessments and involving.

**Stage 4: Project Termination**

The Project Managers responsibility in the project termination stage is:

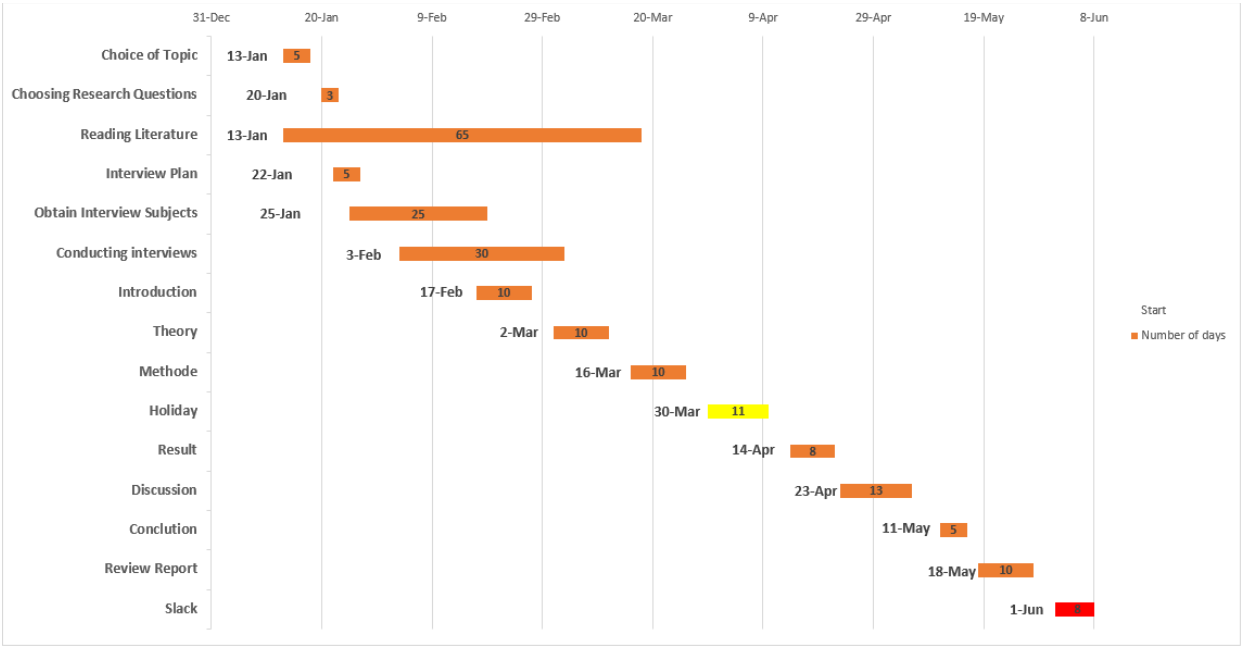
**Project Handover**

- Complete a full overview of the project delivery and secure that the content in the overview is clarified with the road owner
- Keep the project owner up to date on the status for project handover.
- Develop a final report within 6 months after the termination of the project.
- Develop and signing of a handover protocol.
- Make sure the project is downsizing its staffing according to plan.

Convey lessons learned to the next phase.

# Appendix 12 – Project Timeline

## Original Timeline




## Revised Timeline