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**FACULTY OF SCIENCE AND TECHNOLOGY**  
**MASTER THESIS**

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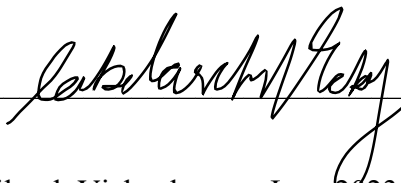
## Preface

This Master Thesis marks the end of a master studies and is written by the Teknisk Naturvitenskapelige Faculty (TN) by The University of Stavanger (UiS). This document is an independent work written during the spring of 2023.

This thesis serves the purpose of explore which challenges and experiences there are when implementing Lean at The Norwegian Coastal Administration (The Norwegian Coastal Administration) Developing Department, as well as looking into possibilities for digitizing this. The initial plan was to dive into different projects in different planning and implementing phases, but with the projects being far away, and my fulltime work as an engineer, this would become a problem. Therefore, the thesis is being transformed into a theoretical one, including a Case Study regarding the planning group.

I want to thank The Norwegian Coastal Administration for providing me with resources and insight into different projects and departments internally, during a semester out of the ordinary. By this I mean the decision I made in April 2022 to accept a fulltime job at the development department at The Norwegian Coastal Administration in Lofoten (Northern Norway), were I now live and work fulltime in addition to being a full-time student at UiS.

I also want to thank my supervisor provided by UiS, Dina Zhenisovna Kairbekova, for guiding me and supporting me through the master thesis with great advice and feedbacks. This is a supervisor with great understanding within the topics, which I am happy and lucky for having during my master thesis.



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Abilasch Vicknakumar, June 2023.

## Summary

In response to the recent decline in productivity within the construction industry, there has been a growing focus on digitizing projects and processes to streamline operations. This has led to the introduction of Lean as a methodology and new way of thinking in the industry. The aim of this thesis is to address the main question regarding Lean's applicability and implementation.

*“How can Lean implementation and digitization be optimized in a public administration context? An exploration of challenges and experiences at The Norwegian Coastal Administration Development Department.”*

To gather information on this topic, a literature review was conducted, complemented by interviews with individuals involved in various stages of projects at The Norwegian Coastal Administration (NCA). These individuals possess knowledge of Lean principles and frequently utilize digital tools to enhance efficiency in their daily tasks.

While Lean has been a central aspect of corporate governance in Japan, particularly at Toyota Motor Corporation (TMC), its adoption in the construction industry has been at varying degrees. However, consistent positive outcomes have been observed in various projects that have embraced Lean's philosophy and principles.

The application of Lean in project-based production varies from company to company, with TMC primarily focusing on its implementation in production engineering. External organizations like Lean Construction play an active role in facilitating the transition of Lean methodologies between different companies. The Last Planner System (LPS), a core component of Lean Construction, is employed for project planning and management.

In this thesis, specific attention is given to the interpretation of the Last Planner System known as Involving Planning (IP), which is implemented by Veidekke AS in numerous projects. The experiences and insights gained from Veidekke's use of IP serve as a basis for drawing parallels and identifying strategies for implementing Lean in a public administration context, such as the Norwegian Coastal Administration.



Continuous efforts are being made to explore digitalization of Lean principles in the public administration sector, aiming to enhance its manageability. This includes the adoption of digital tools and aids to streamline work processes. To successfully integrate Lean into an organization, it is crucial to understand that it is both a methodology and a mindset that should be embraced by leaders and workers alike. Developing a culture of improvement and fostering worker maturity, in terms of knowledge and results, are essential prerequisites for progressing towards digitalization and coordinated Lean implementation.

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## **Acronyms**

**TPS** – Toyota Production System

**JIT** – Just in Time

**WIP** – Work in Progress

**PDCA** – Plan Do Check Act

**ROV** – Remotely Operated Vehicle

**BIM** – Building Information Modeling

**TMC** – Toyota Motor Company

**LCI** – Lean Construction Institute

**RA** – Risk Analysis

**SØA** – Samfunnsøkonomisk Analyse

**UA** – Usikkerhetsanalyse

**CPM** – Critical Path Method

**NTP** – Nasjonal Transport Plan (National Transportation Plan)

**IP** – Involverende Planlegging (Involving Planning)

**SaaS** – Software-as-a-Service

**VSM** – Value Stream Mapping

**NCA** – Norwegian Coastal Administration

**VR** – Virtual Reality

# Chapter 1: Introduction

To write an assignment while working full-time can be a challenge, especially if the task requires a lot of time and research. Some of the potential challenges that may arise include:

1. **Time pressure:** Balancing your full-time job with writing an assignment can lead to time pressure and stress. It can be difficult to find time to complete research and writing while still managing your work tasks without getting mentally drained.
2. **Motivation:** Maintaining the motivation and energy to write an assignment after a long day at work can be a challenge. It may be tempting to postpone writing until the weekend or other free time, but this can lead to the work not being completed on time.
3. **Limited resources:** Conducting thorough research can be a challenge when you do not have access to resources that were previously available at the university library.

When it comes to writing about Lean and digitalization in public administration, some specific challenges may include:

1. **Complex topics:** Lean and digitalization in public administration are complex topics that may require a lot of research and analysis to fully understand. It can be difficult to find time and resources to do the necessary research as the resources are scarce.
2. **Limited access to data:** Some of the data you need to complete your assignment may be limited due to sensitivity and confidentiality, and it can be challenging to access all the information you need.
3. **Changes in technology and administration:** Digitalization and Lean principles are constantly evolving and changing, so it can be challenging to keep up with the latest information and understand how this affects public administration.

To address these challenges, it may be helpful to plan well, maintain a strict schedule, and find a balance between work and leisure time. It can also be useful to involve colleagues and supervisors at work in research and writing, and to use resources such as libraries and online databases to obtain relevant information.

## 1.1 Digitalization of the construction industry

The construction industry is constantly evolving in response to changes in consumer needs. One of the most critical changes taking place in the construction industry today is the implementation of lean techniques and digitalization. These lean techniques and digitalization

strategies help streamline processes and increase efficiency, reduce costs, and improve customer satisfaction. I will discuss the current implementation of lean techniques and digitalization in the construction industry, the benefits they provide, and the ways they can help businesses remain competitive in the future.

Lean implementation and digitalization in construction are becoming increasingly popular due to their numerous benefits. As stated in (Sawhney, Riley, & Irizarry, 2020), digitalization in construction can help to improve communication and collaboration within the industry. It can also provide better project visibility, enabling more efficient project management and increased productivity. Additionally, digitalization can be used to gain better insight into project costs and identify potential risks (Sawhney, Riley, & Irizarry, 2020). This can be beneficial in helping to reduce project delays and improve cost efficiency. Furthermore, digitalization can help to ensure better compliance with regulations, eliminating the need for manual paperwork and data entry. This can lead to greater accuracy and fewer errors. Finally, digitalization can help to reduce paper waste and improve the overall sustainability of the industry. In conclusion, the benefits of lean implementation and digitalization in construction today are clear. Through improved communication, collaboration, project visibility, cost efficiency, and sustainability, digitalization can help to drive the industry forward.

Today, the construction industry is facing immense pressure to increase efficiency and reduce costs in order to be competitive in the market. In this context, Lean implementation and digitalization have become increasingly important. According to (Sawhney, Riley, & Irizarry, 2020), Lean implementation can help reduce waste and improve quality control, while digitalization can help increase project visibility and improve performance. Lean implementation utilizes principles such as value stream mapping (VSM) and the elimination of wasteful activities to help streamline processes. Additionally, Lean can help reduce costs and improve communication between different stakeholders. Meanwhile, digitalization can provide key benefits such as improved collaboration, real-time data analysis, and better asset utilization. Digitalization can also help construction professionals to better manage their project lifecycles and keep track of costs. In sum, Lean implementation and digitalization can be hugely beneficial for construction projects today and can help improve project outcomes in terms of cost, quality, and efficiency (Sawhney, Riley, & Irizarry, 2020).



In the present day, construction companies are increasingly turning to lean implementation and digitalization to improve efficiency and productivity. According to (Sawhney, Riley, & Irizarry, 2020), these two strategies are being used to reduce waste and to make the building process more efficient. Lean implementation involves the elimination of wasteful activities while digitalization involves the use of digital tools and technologies to automate processes. For example, the use of Building Information Modelling (BIM) allows for the efficient planning and collaboration of complex projects. With digitalization, there is also an increase in the use of drones to monitor and survey sites, as well as the use of sensors to measure and collect data for real-time analysis. These techniques help to reduce risks and save time and money during the building process. Additionally, digitalization enables companies to use analytics to find patterns and trends in their operations, allowing for more informed decision-making. Ultimately, the use of lean implementation and digitalization in construction can enable companies to maximize their resources and increase their efficiency.

It is evident that the construction industry is undergoing significant changes due to the implementation of Lean principles and digitalization. Lean principles allow for more efficient, organized and cost-effective operations and are slowly replacing traditional methods. Meanwhile, digitalization is allowing for more efficient information management, enhanced collaboration and reduced paperwork - all of which provide immense benefit to construction projects. While these changes may be difficult at first, they supply an invaluable foundation for improving construction operations in the long run.

## **1.2 Purpose and Research Questions**

The purpose of the thesis is to use literature studies and qualitative method to evaluate challenges and experiences by implementing Lean into the public administration (The Norwegian Coastal Administration), and possibilities for digitalizing Lean. This theme is important for me because of my personal interest in streamlining activities in order to get the best result possible and finding new ways of solving a problem. In view of my association with the Norwegian Coastal Administration as my employer, my thesis statement is therefore defined as:

***How can Lean implementation and digitization be optimized in a public administration context? An exploration of challenges and experiences at The Norwegian Coastal Administration Development Department.***

### 1.3 Research Questions

<b>RQ1</b>	<i>What are the challenges faced by public administrations such as NCA in implementing Lean methodologies, and how can digitalization be leveraged to optimize Lean implementation in such contexts?</i>
<b>RQ2</b>	<i>What are the experiences of employees and management at The Norwegian Coastal Administration Development Department in implementing Lean methodologies, and how can digitalization be used to address challenges and improve efficiency?</i>

Table 1 - Research Questions

### 1.4 Challenges

Introducing Lean and digitalization in public administration can be challenging due to several factors, including resistance to change, lack of awareness of Lean principles, and the complex nature of public organizations. In the context of the Norwegian Coastal Administration, there are additional challenges to consider, such as the need for early involvement of knowledgeable actors, the importance of leadership encouragement, and the difficulty of implementing change in a governmental organization. Another significant challenge is the lack of digital infrastructure and technical expertise, which can limit the successful implementation of digital tools.

Moreover, the Norwegian Coastal Administration is a public organization, which means that there are bureaucratic procedures that need to be followed, which can slow down the implementation of Lean and digitalization initiatives. Additionally, there may be resistance from employees who fear that the introduction of innovative technologies could lead to job loss or a shift in their roles. This resistance can be compounded by the limited understanding of Lean and digitalization among some employees, which can lead to a lack of buy-in and motivation to change. Therefore, it is essential to provide adequate training and education to ensure that employees understand the benefits of Lean and digitalization and feel comfortable using new tools and processes.

### 1.5 Standardizing - Frees up creativity and is more economically profitable.

Construction is a rapidly developing industry and, as a result, there is a strong emphasis on implementing advanced processes for organizing and managing worksites. One of these processes is that of standardization; this refers to the establishment of uniform, predefined guidelines and practices for all aspects of the construction process.

The use of standardized systems and processes in the construction industry can be beneficial in several ways. According to the study by RRA Issa, I Flood and G Caglasin (Issa, 2003), Standardization in construction can improve the efficiency of the construction process and improve consistency in the quality of work. Standardization of construction processes also enables construction companies to focus on their core competencies, as they are no longer required to waste time and resources on reinventing the wheel every time when they start a new project. Furthermore, standardization makes it easier for construction companies to introduce modern technology, as they can make use of existing templates and processes to quickly integrate modern technology into their workflow.

In addition, standardization can reduce the risk of errors in construction projects, as the use of standard processes and templates ensures that the same procedures are followed in all projects. This can be highly beneficial, as errors in the construction process can result in significant financial losses for the company. In conclusion, the use of standardized systems and processes in the construction industry can be highly beneficial, as it can improve efficiency, reduce errors and enable companies to focus on their core competencies. Standardized construction practices can provide several benefits to construction projects. According to IC Wu et al., in their study of the "Influence of standardization on construction projects", standardized construction practices can help to reduce project duration, costs, and errors (Wu, Borrmann, & König, 2010).

Standardization helps to reduce the amount of time spent on planning and coordination of the project and can make it easier for construction teams to collaborate efficiently. Furthermore, the use of standardized construction practices can help to reduce the risk of costly mistakes, since all the necessary materials and processes have already been specified. In addition, standardized construction practices can help to ensure that the construction project meets all relevant safety regulations, which can help to protect workers from potentially dangerous situations. Finally, the use of standardized construction practices can also help to improve the overall quality of the construction project, since all the necessary materials are known in advance and can be properly monitored. Overall, it is clear that the use of standardized construction practices can provide numerous benefits to any construction project.

The use of Information Technology (IT) in the construction industry has become increasingly popular in recent years, as it offers a range of potential benefits. According to RRA Issa, I Flood, and G Caglasin in their 2003 study of Information Technology in Construction (R, I, & G, 2003), the most significant of these benefits is the potential for standardization. Standardization allows for an efficient, standardized approach to construction projects, resulting in improved communication, a reduced need for repetitive work, and a reduction in the risk of errors. Furthermore, the use of IT in construction can allow for improved collaboration between different stakeholders, enabling a more efficient and effective construction process. It also allows for greater integration between different software and hardware systems, resulting in improved access to data and a more streamlined construction process. Additionally, the use of IT in construction can also enable more effective cost management and control, as well as improved accuracy in project estimates. Overall, the use of IT in construction is a cost-effective way to improve the efficiency and effectiveness of the construction process, providing numerous potential benefits to the industry.

Standardization in the construction world is essential for success, as it ensures quality work and increases the safety of the construction worker and the building. Through the implementation of standard materials and construction processes, mistakes can be easily avoided, and budgets can be better managed. In addition, standardization can help to ensure that buildings are safe and comply with local building codes for sustainability and energy efficiency. It is clear that construction standardization is beneficial for all parties involved, from the building owner and construction workers to the local community at large.

**1.6 The Assignment`s design**

<b>Chapter</b>	<b>Chapters context</b>
<b>Introduction</b>	This chapter gives an introduction for the background, theme for the thesis, as well as its limitations, and at the end, a declaration.
<b>Method</b>	In this chapter, an account will be given of common research methods. Furthermore, it will be described which methods used in this assignment and assessments which are the basis for the final choice of methods.

<b>Lean</b>	In this chapter it will be presented how the construction industry has adapted to the principles of the production system by Toyota Production System and converted them to the philosophy of Lean Construction. In addition, the 7 basic principles and two different Lean methodologies will be presented.
<b>Toyota</b>	In this chapter, I will present the history behind Toyota Production System and their mindset that later gets implemented into Lean Construction.
<b>Last planner system and Involving Planning</b>	In this chapter the two methodologies in Lean Construction will be defined. Here I will present the two methodologies in debt, and finish with how these two stands out from each other.
<b>Projects</b>	In this chapter a case study will be presented and defined.
<b>Synergies</b>	In this chapter we will look at the interaction between Lean and digitization of Lean is being understood, and how these two combined can have a profound effect.
<b>Results</b>	In this chapter I will present the result from the literature study, the case study and interview objects.
<b>Discussions</b>	In this chapter the research questions will be discussed with background from the literature in the theory chapters and the findings made.
<b>Conclusion</b>	In this chapter, the conclusion from the thesis will be presented. The conclusion summarizes the thesis and answers the

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	research questions. In addition, there will be included a proposal for further work.
<b>Bibliography</b>	In this section an overview over all literature in the thesis will be presented.
<b>Appendix</b>	All the appendixes used in this thesis will be presented in this section.

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*Table 2 - The Thesis Layout*

### **1.7 Declaration and limitations of the assignment**

The literature review findings presented in this paper are based on the author's interpretation. As a result, the statements made in the findings and conclusions section rely on this interpretation, which may result in potential misinterpretations of the empirical data gathered through literature reviews and interviews. Therefore, the individuals who participated in the study cannot be held liable for the content of the thesis.

In order to maintain a manageable scope, the study imposes limits on the allocation of resources, particularly in terms of time. The case studies selected for this research are those that are still under discussion and have not yet entered the development stage. Moreover, ongoing projects or internal resources of entrepreneurs may not provide a comprehensive understanding of the situation if they present a negative portrayal of the company or project. Due to the considerable distances involved in ongoing projects, it is not feasible to conduct physical inspections of ongoing construction projects in northern Norway.

## **Chapter 2: Method**

### **2.1 Method**

This chapter reviews the methods used in this master thesis to highlight the main purpose of promoting the research methods used to obtain information to answer the research questions. The reader will then be able to go through the description to assess the basis on which the results are designed. Descriptions will also be made of other methods that have not been used, along with assessments regarding them.

Definition of Aubert, reproduced in Hellevik:

*“A Method is an approach, a means for solving problems and acquire new knowledge. Any means that will serve this purpose, belongs in the arsenal of methods.” (Hellevik, 2002)*

#### **2.1.1 Qualitative and quantitative method**

Quantitative and qualitative methods are the two primary forms of data collection used in research and present different approaches for collecting and analyzing data. By examining the differences between quantitative and qualitative methods, readers will gain a better understanding of both approaches and their impact on the results of research.

Methods used can be either qualitative or quantitative. Qualitative methods are used when the purpose is to study or go in-depth into an idea, a case, or a theory (Holme & Solvang, 1997). By using a quantitative method, the main purpose is to gain a good and broad overall understanding. This can be achieved by examining and analyzing data from interviews, observations, document analyses, and case studies.

Qualitative methods are research methods used for collecting and analyzing qualitative data, which usually comes in the form of text, unlike quantitative data, which is expressed in numbers and other measuring terms. The purpose of quantitative studies is to gain in-depth knowledge and a holistic understanding of a specific context, or to develop concepts, categories, and typologies. Such studies can also aim to formulate hypotheses and theories or make theoretical generalizations (Grønmo, 2023).

Quantitative research is based on substantial amounts of data that is often presented in tables, figures, and statistics. If there are larger amounts of research data, secondary data, or empirical data that you collect yourself, this method can be used (Kaiser, 2015). Quantitative methods often depend on good interpretations, as the data is only presented through data analysis consisting of numbers and statistics. As constructions are never the same, it can be difficult to carry out quantitative studies on construction projects.

Therefore, quantitative research methods will not be used in this thesis because there is not enough available data within the topic to adequately answer the thesis.

### **2.1.2 Approach (inductive and deductive)**

The scientific method is a continuous process, and the way one chooses to answer the hypothesis depends on how well the collected data correlates with the predictions. Because of this, a distinction is often made between induction and deduction. These different terms tell us how decisions are made based on a logical analysis. In any deductive method, one starts from a theory and approaches it to evaluate the strength of the set theory.

The inductive procedure involves collecting knowledge by going from empirical data, such as research, to develop a theory. This thesis will deal with an inductive approach, as conclusions will be drawn based on a limited data base.

## **2.2 Methods used in this Thesis**

In this thesis, I have chosen to use the qualitative research method to answer the main issue of the thesis as well as the research questions. With the qualitative method, a literature study will be carried out first, wherein knowledge of the topics from several points of view is acquired. Then, interviews will be conducted to supplement the information in the literature. This will be done by asking the interviewees about what I am particularly wondering about. Finally, it will be possible to discuss the problem by combining the theory in the literature and experiences from various actors in the Norwegian construction industry.



### 2.2.1 Literature studies

The purpose of conducting a literature study is to provide a comprehensive understanding of the research question, to identify relevant theoretical and empirical frameworks, and to guide the development of the research methodology. By conducting a literature study, the researcher can build upon and extend the existing knowledge and theories in the field and provide evidence-based recommendations for future research and practice.

The information used to form the theoretical basis for the thesis was obtained through a literature study. As there are diverse ways to find relevant literature, it all started by planning which search engines would be used. The selection naturally fell on Oria and Google Scholar. Oria is the University Library's search engine and has access to most articles, books, and theses. Meanwhile, Google Scholar supplements Oria well by possessing large amounts of international academic literature. The summary of selected keywords is presented in Table 3.

<b>Search word</b>	<b>Oria (UiS)</b>	<b>Google Scholar</b>
<b>Lean</b>	112 624	3 610 000
<b>Lean Construction</b>	3227	1 560 000
<b>Last Planner System</b>	1519	1 160 000
<b>Involverende Planlegging</b>	34	16 600
<b>Toyota Way</b>	1539	563 000
<b>Toyota Production System</b>	1728	434 000
<b>Toyota Kata</b>	31	20 800
<b>Improvement Kata</b>	914	107 000
<b>Digitalisering</b>	3152	44 400
<b>Lean Digitalisert</b>	4	3820
<b>Digitalisering bygg</b>	1212	15 800
<b>DigiLean</b>	0	13

*Table 3 - Overview of the literature searches conducted in Oria and Google Scholar*

The numbers represented in Table 3 show that there are a lot of works within the major main themes in this thesis. By specifying the diverse topics more, we can see that a large number of searches lapses. Separately, we can see that Lean and digitization have many articles but combined there are very few. Therefore, it was chosen to look at these theses and large publications by the main topics and then check their references. By doing it this way, it was

possible for me to control and ensure the quality of the literature. Figure 1 shows a clear procedure for the literature search.

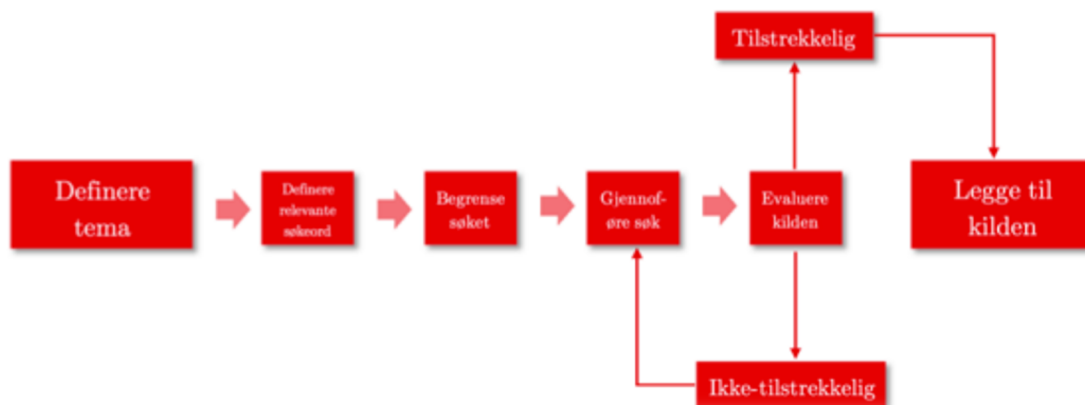


Figure 1 - Strategy for literature search

### 2.2.2 Qualitative interviews

It was decided to hold interviews to get a direct opinion from people in the construction industry about their thoughts and opinions regarding the implementation of Lean and the digitization of Lean. It was chosen to go for a semi-structured approach, although there are several ways to conduct quantitative interviews.

In interviews based on a semi-structured approach, the questions are pre-decided, and the same questions will be asked to all interviewees. Follow-up questions and more detailed questions are asked based on what the candidate tells, giving the interviewee the opportunity to elaborate on what has already been said for an in-depth understanding. The disadvantage of using a semi-structured interview format is that the answers vary depending on the candidate.

The most usual format for interviews is called a semi-structured interview (the term "semi-structured" means "half structured, partly structured"). This type of interview can best be described as a conversation between the researcher and interviewee, with the flow of the conversation determined by the researcher. Beforehand, the researcher has created an interview guide, an overview of the topics they wish to discuss, based on the main research problem in the thesis (Andersen, 2020)

In a semi-structured interview guide, the topics covered are essentially predetermined in advance. The order can be adjusted as the interview progresses. This means that interviews can follow the interviewee's narrative while still obtaining information about the

predetermined topics. The flexibility this type of structure offers allows the questions to be linked to those of the interview prerequisites and allows room for topics that have not been planned in advance (Wikipedia, 2022).

An interview guide was prepared to conduct the semi-structured interviews, based on the problem I had chosen to dive into. The interview guide was sent to the interviewees in advance, giving them the opportunity to get a brief overview of the content of the master thesis and an idea of the questions to be answered. This allowed the candidates to prepare earlier for the interview, ensuring that the interviews were conducted in the most efficient way.

**2.2.3 Interview objects**

The interviewees were chosen based on their backgrounds and positions in the organization. The company was chosen because of my personal connection to it, as I am employed here as a Chief Engineer. The interviews will be conducted in person, as some of the candidates are in-house. The reason for the involvement of these candidates is due to their various positions in the company and how they are using Lean and digitization to tackle different tasks. For me, this was a way to get a holistic picture of how different departments of The Norwegian Coastal Administrations Development Department use the Lean methodology and digitization in order to complete a project.

<b>Name</b>	<b>Firm</b>	<b>Experience</b>	<b>Role</b>	<b>Project</b>
<b>Interview 1</b>	<i>The Norwegian Coastal Administration</i>	8 years	Quality Manager Facilitator of Improvement Projects	Business Department
<b>Interview 2</b>	<i>The Norwegian Coastal Administration</i>	12 years	Senior Engineer/Team leader	Investigation
<b>Interview 3</b>	<i>The Norwegian Coastal Administration</i>	7,5 years	Senior Engineer/Team leader	Implementation Department

To be able to analyze and consider the content of the interviews that were conducted, the interviews were recorded, then later deleted after transcription. The interview candidates were informed of this beforehand in the interview guide, so they were able to give their consent.

Afterwards, the interviews were transcribed and analyzed so that the information could be used in the thesis.

## **2.3 Method Quality**

As the methods chosen in the assignment lay the foundation for quality, it is important to ensure the credibility of the information obtained. Therefore, the reliability and validity of the information must be assessed. It is this information that should be used to draw conclusions, so it is important to be critical of it.

### **2.3.1 Reliability**

Credibility and reliability give an indication of the credibility of what is to be investigated. The reliability ascertains whether the results achieved provide a sufficient basis for answering the problem. When a source has low reliability, it will not be able to answer the problem. With high reliability, multiple people can use the same source and get the same results.

In this thesis, an attempt has been made to achieve high reliability of the sources used. In the literature research, the sources were assessed based on their publication date, publication channel, and credibility to the author. Sources used in multiple theses are a good example of sources with high reliability. However, when using qualitative interviews, the reliability can be challenging. The interviewees may be influenced by subjective and subjective experiences. This is something to be aware of when deciding who to interview, how to ask the questions, and how to interpret the answers. If several of the interviews indicate the same information, the reliability will increase.

### **2.3.2 Validity**

Validity gives an indication of how relevant and applicable the information obtained for the problem is. If a study has external validity, the results of a limited scope can be generalized. In the case of good internal validity or definitional validity, one has control over possible biases. The internal validity assesses whether a chosen indicator measures what is intended to be measured.

To ensure the validity of the sources used in the thesis, the introduction has been reviewed, as well as the summary and conclusion of the sources. It is easier to ensure the validity of the

qualitative ones, such as the interviews, as the flexibility is higher. During an interview, you can change questions or ask follow-up questions, thus ensuring that you get the information you want. The interview subjects have been selected because they have positions or roles that deal with the use of Lean in diverse ways, providing a wide range of knowledge within the respective topics and thus ensuring higher validity. The interview guide that was sent out to the interviewees also helped to ensure high validity, as they were given the opportunity to prepare themselves.

### **2.3.3 Advantages and disadvantages of the methods**

To conduct a literature study has the advantage of providing a vast array of literature on the main themes of Lean and digitization in the construction industry, enabling the comparison of literature against each other. Selections of literature with multiple citations were made, providing a better basis for discussion of empirical data due to the use of renowned researchers.

However, a weakness of literature studies is that some selected sources may rely on each other, resulting in a one-sided approach to the topics. Additionally, since most of the sources were international, there may be some cultural differences in the construction industry between different countries that could affect manufacturing. Nonetheless, it is important to note that Lean is an international concept implemented in Norway from abroad, and thus there should be no significant differences.

Qualitative interviews have a great strength in that the interview guide's design allows interviewees to come prepared, avoiding misunderstandings. A semi-structured interview also offers the opportunity to clarify claims and steer interviewees back to the topic if they stray off. However, a weakness of qualitative interviews is the lack of experience in conducting them. The inability to generate appropriate follow-up questions at the right time can lead to a lack of depth in responses. To address this issue, interviewers need to practice conducting interviews and prepare a list of follow-up questions.

## **Chapter 3: Lean**

In this chapter, a variety of themes related to Lean and digitalization will be presented, with some subtopics not intended for further discussion, but chosen to provide insight into the different types of measures in the Lean topic in order to understand the practicality. The theoretical section will cover the background, principles, challenges, and other aspects associated with Lean, illustrating the vast range of possibilities that are encompassed in the Lean approach, but the suitability of all these aspects for public administration will be analyzed later.

### **3.1 Background**

The term Lean originates from the production philosophy of the Japanese car manufacturer Toyota Motor Company (TMC) called the Toyota Production System (TPS) which originated in the 1950s in Japan. In the post-war period, Japan was a country with a lack of resources such as capital, qualified labor and natural land. To be able to compete with other world elites within the car industry, Toyota had to develop new and innovative techniques to drive car production. To gain a better understanding of how this was done elsewhere, a young Japanese engineer named Eiji Toyoda embarked on a 3-month pilgrimage to the United States to draw inspiration from the well-established Ford Motor Company. Ford Motor Company was already renowned for its manufacturing efficiency, and Eiji Toyoda returned to Japan with innovative ideas and techniques that he implemented in TPS. This allowed Toyota to produce cars with high quality and efficiency, and the Lean philosophy was born. This Lean philosophy has since been adopted by many other industries and has become a cornerstone of modern production and manufacturing (Womack, Jones, & Roos, 2007).

Simply put, Lean deals with the reduction of waste on all available resources, thus dictating time and cost and looking at the customer's complete experience of the product's value rather than the cost elements. The principles encourage creating a better flow in work processes and developing a continuous improvement culture. ("The Five Principles of Lean") A business can remain competitive by practicing these principles and, at the same time, increasing the value delivered to customers and reducing costs, which, in turn, will increase the profitability of the company (Do, 2017).

Lean can often be seen as a set of tools used to identify and continuously eliminate factors that contribute to waste. As these are effectively eliminated, work is being done to improve

quality and, in addition, reduce costs and production time. Kanban and Value-stream mapping are examples of tools that are used in Toyota's factories, but we will get more into this later in the thesis.

### 3.2 Main principles within Lean

In the book *The Machine That Changed the World*, Womack and Jones came up with a definition for the five principles of Lean production. These principles are considered a recipe for improving efficiency in the workplace, encouraging the creation of a better flow in work processes and developing a continuous improvement culture.



*Figure 2 - The 5 main Principles of Lean*

#### 3.2.1 Define Value

Before defining the customer's value, it is important to define what a value is. Finding value is essentially about discovering the customer's actual needs and what they are willing to pay for. When the customer has a need for new products or technologies, they may not know what they need. A customer is awaiting the result of your work. Then, it is essential to use qualitative or quantitative methods to uncover the exact need (Do, 2017).

#### 3.2.2 Mapping the value stream

In this principle, you must be able to use the needs of the customer to identify the activities that contribute to meeting those needs. Activities that do not contribute to value should be removed if possible. These activities can be divided into two subgroups: non-valuable activities that are necessary and non-valuable activities that are not necessary. The former should be reduced as much as possible, while the latter should be eliminated. This helps

ensure that the customer's needs are covered, while at the same time reducing costs (Do, 2017).

### **3.2.3 Make Flow**

As the value-creating activities have now been identified, one must ensure the flow of these without disruptions or delays. To make this happen, segmentation of production and reconfiguration of the production steps come into play, so that they equalize the workload. It would also be an advantage to create cross-functional departments where the employees are adaptable with broad expertise (Do, 2017).

The term "flow" comes from psychology, where it refers to a state of being so motivated and engaged that one forgets time and place while engaged in a given activity. In industrial production, flow refers to the product being moved to the next process one at a time, without interruptions, and each step in the process is completed just before the next process takes over. The goal is to eliminate queues and waiting time between each process and to streamline the core processes to save time and increase quality. Achieving flow in projects has a more direct interpretation and application than what psychology refers to. In construction projects, flow is fundamentally different from industrial production because construction projects move processes, not products. Good flow is achieved when one plans well and follows up on production accordingly, and good planning requires common plans. To achieve flow, one must also manage slack and handle variations that go beyond a defined maximum limit, which requires implementing and training on methods and tools for handling deviations.

### **3.2.4 Establish Pull**

Inventory is considered one of the biggest sources of waste in any production system. The goal of a pull-based system is to limit inventory and work in process (WIP) - articles, while ensuring the necessary material and information for a smooth workflow. ("The Five Principles of Lean") In other words, a Just-in-time delivery (allows goods to arrive as close as possible to the start of activity) and production where products are produced at the time there is a need and precisely in the quantities needed. Pull-based systems are always created based on the customers' end needs. By following the value stream and working backwards through the production system, you can ensure that the manufactured products will be able to satisfy the customers' needs (Do, 2017).



### 3.2.5 Perfection – Quality Control

The last principle is perhaps the most essential. When the preceding four principles are followed, one must ensure that these are practiced with the goal of improvement. One must ensure that the Lean principles become part of everyday life and the organizational culture. This requires that the employees strive for perfection and deliver products based on the customers' needs (Do, 2017).

### 3.3 “The Seven Wastes”

From the five main principles of Lean mentioned above, we can see that the focus is on cutting activities that do not add value but rather create waste. Waste is any activity or action that does not add value for the customer. The seven sources of waste (originally muda in Japanese) were developed by Taiichi Ohno, chief engineer at Toyota, as part of the Toyota Production System (TPS). More recently, an eighth source of waste has emerged. The various sources are illustrated in Figure 3 and described further below the figure.



Figure 3 - The Seven Wastes + 1 (Skhmot, 2017)

### **3.3.1 Defects**

Defects usually occur when a product is not suitable for use, which often leads to processing or discarding the product. Both cases result in an additional cost without any value. To avoid such defects, it is important to identify the errors that occur most frequently and focus on them. One should perhaps implement a process that detects deviations and does not allow them to reach the production process. For example, broken or defective parts that need to be returned and fixed. A solution to this could be to adopt standardized processes that ensure a smooth and error-free production process (Skhmot, 2017).

### **3.3.2 Overproduction**

When a product or sub-product is produced before it is needed or in demand, we call it overproduction. This can often happen when there is spare production capacity. This leads to higher storage costs and prevents a smooth flow of work. This requires high capital expenditure to finance production. Here, one should rather make use of the Just-in-time philosophy, where products are only produced when there is demand. An example of this may be producing too many goods, just in case (Skhmot, 2017).

### **3.3.3 Waiting**

Wasting time due to waiting includes, among other things, people waiting for materials or equipment, and equipment that is not being used. Waiting time usually occurs when there are irregularities in production situations, which can often lead to overproduction. Examples of waiting could include waiting for the computer to load a program or waiting for a delivery (Skhmot, 2017).

### **3.3.4 Transportation**

Waste transportation includes the transport of people, tools, fixtures, equipment, or products that are no longer needed. Excessive movement of materials can often result in deficiencies, and excessive movement of people can lead to unnecessary work, exhaustion, and costs related to transport and work. For example, moving objects and materials from one place to another (Skhmot, 2017).

### **3.3.5 Inventory**

Excess inventory is considered waste; in other industries, such as finance, for example, inventory is seen as an asset and is viewed positively. Suppliers also offer discounts for bulk purchases, as this saves them storage space and allows for a smoother flow in production without waiting. If there is excess stock, however, defects may go unnoticed for a long time, as production-related problems take time to be discovered. A common result of this is the need to initiate more work to correct the errors, such as parts and materials that have not been delivered. A solution to this could be to create a queue system to prevent overproduction (Skhmot, 2017).

### **3.3.6 Motion**

Unnecessary movement is defined as any unnecessary movement of people, equipment, or machines. Tasks that require excessive movement should be restructured to achieve an increased level of health, safety, and environment (HSE) for the workers. Production of movement can be a repetitive movement which does not add value for the customer. An example of this could be the distance that must be traveled to collect the necessary equipment. Another example of unnecessary movement could be the movement of workers or machinery. One solution to this could be to ensure that the workplace is well organized with nearby equipment and ergonomic placement of materials (Skhmot, 2017).

### **3.3.7 Extra Processing**

This category involves doing more work by having more steps or adding more components of a product or service than what the customer requires. For example, this can be products of far too high a quality with capacity beyond what is required, implementation of more analysis than necessary, or having more functionality in a product than necessary. To avoid this, you must have a good understanding of the customer's needs. One should be able to produce what the customer needs for the required quantities (Skhmot, 2017).

### **3.3.8 Unused Talent**

The eighth waste was not originally part of the TPS but remains a source that has been recognized. The eighth source is about the waste of human potential, which occurs when one does not make use of human talent and ingenuity. This often happens in organizations that have a hierarchy between the management and the employees, where it is the manager's responsibility to plan, organize, and bring about innovation of the production process. The

worker's responsibility is simply to follow orders and carry out the planned work. It is often those who do the work who are most capable of identifying problems and coming up with solutions. This problem is often visible in places where employees are poorly trained and do not know how to use the equipment effectively, or when employees are not challenged to think innovatively and improve their work (Skhmot, 2017).

### **3.4 Lean Construction**

Lean construction is an effective, efficient, and innovative method of project management that serves to enhance construction operations. Its application is beneficial to any organization due to its ability to increase productivity and reduce costs. The main goal of Lean Construction is to create a faster and more streamline workflow

The concept of Lean Construction has become increasingly popular in recent years to reduce waste and improve production efficiency. As outlined by EN Shaqour in the Ain Shams Engineering Journal (Shaqour E. , 2022), the main benefit of adopting Lean Construction practices is that it helps to reduce cost and time consumption. This is achieved by streamlining processes and eliminating unnecessary steps and activities, which helps to simplify and optimize the workflow. Additionally, it encourages collaboration between stakeholders to ensure the project is completed on time and within budget. Furthermore, it promotes better communication between the different teams involved in the project, helping to ensure that everyone is on the same page and the project is delivered on time. This can also help to reduce conflicts and disputes, as well as improve the overall quality of the project. Overall, Lean Construction practices have the potential to bring a variety of benefits to any construction project and should be seriously considered by all stakeholders.

The implementation of lean construction practices in the construction industry has been proven to result in several positive outcomes. According to Sarhan and Fox (Sarhan & Fox, 2013), the use of these practices has been associated with improved quality, increased productivity, and reduced costs. Moreover, there is evidence to suggest that the use of lean construction practices has improved the overall safety and health of workers. This is due to the reduction in waste and improved communication between all stakeholders. Furthermore, the use of lean construction practices has resulted in shortened lead times and improved customer satisfaction. The use of these practices has also led to improved collaboration among all stakeholders, resulting in better relationships that can be beneficial in the long term.

In conclusion, the use of lean construction practices has been associated with a number of positive outcomes in the construction industry and can be beneficial to all stakeholders when implemented properly.

In a 2008 study by LF Alarcón, S Diethelm, O Rojo, and R Calderón (Alarcón, Diethelm, Rojo, & Calderon, 2005), it was shown that implementing Lean Construction Practices can bring many advantages to the construction process. Lean Construction Practices focus on improving the efficiency of the construction process by eliminating waste and streamlining production. As a result, the construction process is more cost-effective, and the time required to complete a project is reduced. Additionally, Lean Construction Practices result in better use of resources, improved quality of the final product, and lower costs in terms of materials, labor, and energy. The study also found that Lean Construction Practices lead to increased customer satisfaction, as projects are completed faster and with fewer defects. Overall, the evidence indicates that there are numerous benefits to be gained from implementing Lean Construction Practices, which can lead to improved efficiency and cost savings in the construction process.

Lean construction is a powerful and widely adopted tool for managing and completing construction projects. It can be used to create a lean culture and framework that maximizes efficiency at all steps of the process from planning through to completion. Additionally, it can be used to optimize workflow and logistics, reduce costs, minimize waste and enhance quality control. Lean construction is a smart way to ensure that projects are completed to the highest standards with maximum efficiency.

### **3.5 Use of Lean by practice**

Lean is specifically used both during the planning phase and afterwards on the construction site. The client meets with the contractor, where a weekly schedule is drawn up, often planned two to three weeks in advance. This helps to increase the contractor's ownership of the activity they must carry out, contributing to them taking a more active role when planning something. This can lead to fewer delays due to the increased ownership and gives a large scope for their own input.

Whiteboard meetings are also used, with input and plans on post-it notes for better visibility. Board meetings are often held 3-4 times a week, and it is common to bring along the

contractors so that they can make comments and provide their own input on their activities. When these contractors are not involved, it is quite normal to walk around the construction site to observe and get updates. In the Lean philosophy, this is what is being strived for, rather than relying on reports and commands; one must go out to observe.

### **3.6 Challenges related to the use of Lean**

Lean can be an effective tool which helps companies to optimize productivity and efficiency. Meanwhile, there are a lot of challenges related to introduction and implementation of Lean methods.

Lean-based production systems have become increasingly popular in recent years as companies strive for greater efficiency and cost savings. In order to take full advantage of these systems, however, businesses must pay attention to the potential challenges they may face. One of the biggest issues is that these systems are often quite complex, requiring a significant amount of time to plan and implement. Additionally, there are potential risks associated with the implementation of a lean system, such as disruption of existing processes, a lack of communication between departments, and a lack of understanding of the system by those who are responsible for its implementation (Arntsen, 2016). Moreover, a successful lean system requires a change in the corporate culture and an acceptance of the new processes and tools that are being used. This can be difficult to achieve, especially in large companies, where there can be a resistance to change (Womack, Jones, & Roos, 2007).

At the board meetings, it is often discussed the various activities and how far one has arrived from the fixed end date. It is often the case that activities depend on each other, so it is important that deadlines are met. When one activity is completed, other activities must be carried out in the same area. In case of a breach of a deadline, it quickly creates ripple effects for other activities that depend on each other, which in turn creates delays for the entire project. Delays can occur for various reasons such as insufficient equipment, delayed deliveries, or machines needing maintenance.

When planning an activity, it is important to have a fixed end date due to activities that must be started immediately afterward. Having contractors help set realistic deadlines will contribute to making it more difficult to postpone the deadlines, as they have helped to determine these at meetings or on the construction site.

Apart from maintaining end dates and deadlines on activities, it's not a big challenge when using Lean. It is largely the same thinking and methodology that has been used for a long time, but it is only relatively recently that the term Lean has been used. That's pretty much it; other digitization has more challenges, such as 3D/4D modeling instead of floor plans or the implementation of other tools from the digital world.

Implementation of Lean methods has been an essential element in corporate strategies worldwide for several years (Arntsen, 2016). There are many challenges associated with implementing Lean in project environments, but fortunately, there are some strategies that can be helpful in overcoming these obstacles. First, companies should focus on the cultural changes necessary to make Lean methods work effectively. This includes understanding the needs of employees and management and ensuring they receive the necessary training and support needed to succeed. In addition, it is important to focus on integrating Lean methods into the company's existing structure and processes. This can be done by identifying problems and coming up with new solutions that can improve manufacturers' efficiency and productivity. It is also important to ensure that Lean methods are incorporated into the company's daily operations through regular audits and follow-up. By implementing these strategies, companies can facilitate a successful implementation of Lean methods and overcome the challenges that often arise in production environments (Arntsen, 2016).

Lean methodology has become a very popular tool for organizations to improve their productivity and efficiency. Lean brings many benefits to organizations, but it also has financial and cultural side effects. Managers must consider the challenges that come with Lean implementation and must encourage employees to adopt the Lean philosophy and methodology. To take advantage of the many benefits of Lean, managers need to hire a Lean expert who can help them navigate the challenges and successfully implement the Lean methodology. With this expertise, organizations are well-prepared to take advantage of Lean to achieve their productivity and efficiency goals.

### **3.7 Kaizen**

Kaizen is a Japanese word that means continuous improvement. Within the lean methodology, Kaizen is used as a tool to systematically identify and eliminate waste and inefficiency in work processes. Kaizen focuses on small and gradual improvements that can be made continuously over time and involves all employees in the organization in this process.

In public administration, Kaizen can be an effective way to increase productivity and efficiency in work processes. It can help the organization to identify and eliminate waste and inefficient steps in the processes while providing a way to systematically improve and optimize the work processes. Kaizen can also help engage and motivate employees by giving them an active role in the improvement process, providing them with a sense of ownership and control over their own work.

In this way, Kaizen can be a useful tool for creating a culture of continuous improvement and learning in public administration. In summary, Kaizen can be a valuable tool for improving work processes and increasing productivity in public administration. By involving all employees in the improvement process, an organization can create a culture of continuous improvement and learning that can have positive ripple effects on the organization as a whole. Kaizen can help the organization become more efficient and resource-saving, while at the same time giving employees a sense of commitment and ownership of their work.

### **3.8 Value Stream Mapping**

Value Stream Mapping (VSM) is a method within the lean methodology used to analyze and map work processes to identify and eliminate waste and inefficiency. VSM shows the entire value stream for a product or service, from supplier to customer, and identifies all steps in the value stream and the amount of time and resources used at each step.

In public administration, VSM can be an effective way to analyze and improve work processes. By mapping the entire value stream for a service or product, one can identify where there is waste and inefficiency in the process and develop measures to eliminate it. Using VSM can also provide a better understanding of how work processes are interconnected and how changes in one part of the process can affect the rest of the value stream.

By using VSM in public administration, a mutual understanding and engagement around work processes can also be created. By involving all employees in the mapping and analysis of the value stream, a collective understanding of work processes can be created, and employees' input and ideas on how to improve them can be obtained. This can help create a culture of continuous improvement and learning in the organization, increasing employee engagement and ownership of their work.



In summary, Value Stream Mapping can be a useful tool for analyzing and improving work processes in public administration. By identifying and eliminating waste and inefficiency, productivity and efficiency in the organization can be increased while creating a culture of continuous improvement and learning. VSM can also help create a common understanding and engagement around work processes, giving employees a sense of ownership and control over their own work.

### **3.9 Lean in the Norwegian Coastal Administration (NCA)**

The Norwegian Coastal Administration (NCA) is a government agency responsible for maritime safety and preparedness, as well as management of coastal and marine resources in Norway. As part of its efforts to improve efficiency and effectiveness, the NCA has implemented Lean principles in its operations.

The implementation of Lean in the NCA has led to a focus on continuous improvement, waste reduction, and increased customer satisfaction. By eliminating non-value-added activities, streamlining processes, and empowering employees to identify and solve problems, the NCA has been able to improve its services while reducing costs.

One of the key challenges in implementing Lean in the NCA has been the cultural shift required. As a government agency, the NCA has traditionally been a hierarchical organization with a top-down approach to decision making. Lean requires a more collaborative and bottom-up approach, which has required significant change management efforts.

Another challenge has been the integration of digitalization with Lean principles. While Lean focuses on process improvement, digitalization offers opportunities for automation and innovation. The NCA has recognized the importance of incorporating digitalization in its Lean initiatives to optimize its operations.

Overall, the implementation of Lean in the NCA has been a positive step towards improving its services and increasing efficiency. By addressing cultural barriers and integrating digitalization, the NCA is well-positioned to continue its Lean journey and drive further improvements.

## **Chapter 4: Toyota Motor Company (TMC)**

In the pursuit of operational excellence, many organizations strive to improve their processes continuously. One approach to achieve this is by adopting the Toyota Kata philosophy, which is a management system based on the idea of looking at complex problems as an opportunity for improvement. Kata is a Japanese word that means "detailed movement patterns performed singly or in multiples," and Toyota Kata applies the concept to business operations to drive continuous improvement. In this article, we will explore Toyota Kata, the Improvement Kata, and how to implement them to achieve significant improvements in business processes. We will also examine the challenges associated with implementing the Toyota Kata philosophy in an organization.

### **4.1 Toyota Kata**

Kata is a Japanese word that describes detailed movement patterns performed singly or in multiples. Toyota Kata is a philosophy for continuous improvement in business operations, based on the idea of looking at complex problems as an opportunity for improvement rather than an obstacle (Rother, *Toyota Kata: Managing People for Improvement, Adaptiveness and Superior Results*, 2009).

The car manufacturer Toyota and their car factories have laid the foundation for the concept of Lean. Toyota has for quite some time been considered the leader in manufacturing and production. Through continuous improvement and a free-spirited leadership style, they have from the outset risen to be one of the largest car manufacturers in the world.

Although the organizational structure of Toyota is no different from that of other car manufacturers, are there other factors that make it stand out. They constantly put a large emphasis on improvements through what they call improvement Kata, which is a form of repetitive routine used to both improve, develop, and adapt production. This has been very helpful in the way people work together and, more specifically, how to manage one organization in the most efficient way possible (Rother & Aulingen, *Toyota Kata Culture: Building Organizational Capability and Mindset through Kata Coaching*, 2017).

The main principle of the kata is to set a target condition, which is to say, a description of a process that is done in such a way as is necessary to achieve the desired outcome. It is important not to misunderstand this as a target, as this is an outcome, result, or goal. In factories, they do not start to improve or move forward until the target condition has been set. It is also essential to understand that the improvement kata only deals with behavioral

routines, i.e., routines about thinking and doing that take away our ability to improve ourselves and solve problems.

## **4.2 Improvement Kata**

"The Improvement Kata", or the Improvement Kata in good Norwegian, is a routine to move from the current situation into a new situation in a creative, purposeful, and meaningful way.

This is based on a four-part model:

1. The idea of a new vision or direction
2. Grasp the current situation.
3. Define the next goal.
4. Move incrementally toward the new process, uncovering obstacles that need to be worked on along the way.

Improvement Kata operates with a long-term vision, representing an ideal situation that may not be achievable. This is seen more as a form of guidance. When the guidance is clear, Kata is often used at the process level to start with. Then, you start to develop an understanding of the current state of the process. When this understanding is underway, first-hand observation and analysis of the situation is often required. By having a good grasp of the current state and the general direction or goal to be attained, the next target condition for the process can be described. How do we want this process to go?

Once this process is defined, a series of PDCA cycles (Plan-Do-Check-Act) are often initiated towards the target condition. The PDCA cycles reveal anticipated obstacles that we need to process in order to reach the target state we have set. Based on the feedback from the PDCA cycles, learning and adaptation take place. These three levels build on each other, and the more understanding one has of the current situation, the more precise the target condition will be. If the target condition is more precise, it will be easier and faster to recognize obstacle (Rother, *Toyota Kata: Managing People for Improvement, Adaptiveness and Superior Results*, 2009).

When the short-term target condition is reached, the PDCA cycle will repeat itself, as only the short-term goals are achieved, not the long-term. To get the best possible result out of the long-term goal, it is important to reflect on findings and solutions from previous improvement projects before moving forward.

Toyota Kata consists of two key components: the Improvement Kata and the Coaching Kata. The Improvement Kata is a series of steps that help to identify and break down a process into smaller, achievable goals. The Coaching Kata then works to develop a mindset of continuous improvement and provide feedback and support to individuals as they work to reach their goals. This combination of components helps to create an environment of continuous learning and improvement, which can ultimately lead to significant improvements in business processes. It can be used to address complex issues with relatively low risk and cost, as well as to help teams become more engaged and productive (Rother & Aulingen, Toyota Kata Culture: Building Organizational Capability and Mindset through Kata Coaching, 2017).

### **4.3 Implementing Kata**

Toyota Motor Company has had remarkable success with the implementation of kata in their company, but this is not as easy to implement in other organizations. This has been attempted on several occasions, and it rarely ends in success. Unfortunately, it's not just about implementing a method; to make this work, you also must change the way of thinking and the routines that are currently in place in an organization. There are several differences in the procedures and the activities of the managers at Toyota Motor Company (TMC) compared to those of other organizations. As everyone works with goals and outcome metrics, this is only the beginning. The Toyota managers/mentors, who are also responsible for teaching, must be aware of these differences.

The demands placed on training creates a bond between superiors and subordinates, wherein they depend on, learn from, and coordinate with each other. This arrangement is not just for a few employees; it is a principle that applies to all employees. All employees must then have their own mentor, such as in Toyota. However, in recent times, this has presented problems, as the organization has expanded to a great extent, making it difficult for them to maintain the way of being able to teach improvement kata to their employees. Due to the expansion of the company, the mentor/mentee approach has encountered problems, as this requires more experienced mentors, which are a limited resource and time.

### **4.4 Advantages and Disadvantages by implementing “improvement kata”**

For an organization that continuously wants to improve and develop, Toyota's Improvement Kata is an effective way of thinking. At Toyota, they have developed this into a universal and practical method of development along unpredictable paths towards general defined long-term

plans. This way of thinking promotes teamwork while strengthening the adaptability of the employees. This also steers towards greater flexibility in an environment with obstacles and challenges. Improvement Kata makes employees think about the process every now and then in the quest for perfection. Instead of blaming individuals for something not going right, one looks at the process as a whole and how it can be effectively improved. By using the Improvement Kata, one goes in with the mentality that any employee could tackle this job and deliver the same result as the previous one. This way of thinking will, in practice, lead to the process being developed and improved.

The disadvantages of improvement kata are that this is not just a method, technique, or something similar that can be implemented or added and expect everything to go smoothly. The goal is to develop a consistent pattern of behavior across the entire organization, which is a time-consuming process. There is also no definitive conclusion on how to achieve this, as it is a varying factor from organization to organization, and even among Toyota's suppliers, who have long tried to create this way of thinking without much success. The biggest disadvantage is that there is no definitive conclusion on how this should be implemented, as there are several different procedures depending on each individual organization.

## **Chapter 5: LPS and Involving Planning**

Last Planner System (LPS), a registered trademark owned by Lean Construction Institute (LCI), is seen as a production system developed by Glenn Ballard and Greg Howell in 1992 to improve workflow, reliable planning, and predictability in work. By using LPS, the engineering group can reduce waste in the design and thus increase the value for the customer. LPS is a central part of Lean Construction (Ballard & Howell, *The Last Planner System of Production Control*, 1994).

Last Planner System (LPS) is thus a system used to plan or control the flow in project-based production, referring to the craftsmen being involved in the planning of their own everyday life at the workplace. LPS has no official version or certification; rather, it is referred to as a mindset and principles that are constantly being developed.

The Last Planner System (LPS) is an innovative approach to construction project management that has the potential to significantly improve project efficiency and effectiveness. As stated by AlSehaimi, PT Fazenda, and L Koskela in their 2014 publication in *Emerald* (AlSehaimi, Fazenda, & Koskela, 2014), the LPS is a “pull planning system” that encourages collaboration between project stakeholders and “empowers them to take responsibility for the planning, scheduling, and execution of construction works.” The main benefit of using the LPS is that it encourages individuals and teams to plan and act collaboratively, allowing them to work in a more organized and efficient manner. Furthermore, the system enables project teams to identify and address potential challenges early on, reducing the risk of costly delays and errors. This also helps to minimize the risk of costly changes to the project design, as project stakeholders can ensure that all requirements are correctly identified and accounted for. In addition, the system allows teams to keep track of their progress and provides them with the ability to quickly identify areas for improvement. By using the Last Planner System for construction projects, teams can improve their overall efficiency, reduce project costs, and ensure that projects are completed on time and within budget.

In the 90s, Glenn Ballard prepared a manual for CPM (Critical Path Method), wherein it was measured that the traditional project management and governance was not able to deliver a predictably workflow. It was reported that only 54% of all planned activities in the work plan were completed in suitable time (Howell & Ballard, 1998).

As this has easily generated uncertainty and variations for all those who will perform tasks further down the production chain, this provided the basis for including PPU (Percent Planned Done) in the Last Planner.

### **5.1 Koskela Theory**

The development of the Last Planner System was based on Toyota Motor Company's production system and Koskela's TFV theory. Koskela's TFV theory is very central to understanding the focus on production in the Lean Construction environment, where T stands for transformation, F stands for flow, and V stands for value (Koskela, 1992).

**T – Transformation:** This includes the transformation of materials, as well as the composition of parts and components.

**F – Flow:** In addition to the transformation work, this also includes rigging and picking up goods, as well as storage and different types of indirect work.

**V – Value:** It is about producing value for the customer, satisfying both the builders' and the users' needs and requirements.

It is important to look at the Last Planner System (LPS) as values and a way of thinking, rather than as a set of tools. The mindset is what is important when companies are constructing their own versions, not necessarily the essentials such as a main plan, phase plan, and similar.

A method is needed that can contribute to a quick response in the face of all unpredictable situations which are not predetermined, but which will surely occur.

## 5.2 Levels in the Last Planner System (LPS)

Based on the Should-Can-Will-Did principle, five elements have been created in the Last Planner System (LPS). As the LPS is a holistic system, it means that all five elements must be performed to obtain Lean project planning.

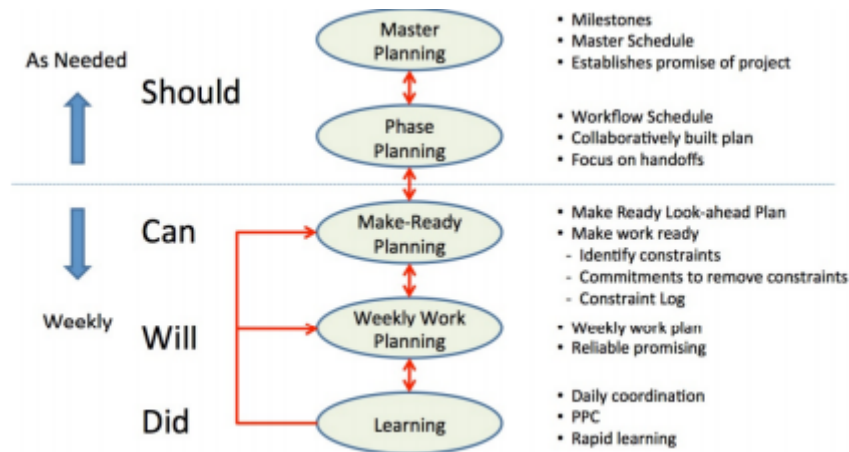


Figure 4 - Elements in Last Planner System

### 5.2.1 Description of the 5 different elements in LPS, based on (Richert, 2017).

#### 5.2.1.1 Master Planning (Master Schedule)

This part is formed at the beginning of a project, during which it is important to identify the important milestones and deadlines that will help determine the pace of the project (Ballard, Lean Project Delivery System', Lean Construction Institute, 2000). In this phase, uncertainty is often high, and the level of detail is low, mostly to create the best possible reliable plan. It is usually created at the beginning of the project and serves as a guide for the rest of the planning process.

#### 5.2.1.2 Phase Planning

This process takes place by dividing the master schedule into phases of the project, which are meant to be reasonable to consider as a unit. The division will often depend on the size and complexity of the work. The phase planning also creates an agreement between the last planners on how the work between two phases is to be completed. The phase plans make use of Pull Planning techniques that help to ensure that the planning takes place in sufficient time before the design.



### ***5.2.1.3 – Make-Ready Planning (Look-Ahead Plan)***

This form of plan again divides the phase plan into new intervals, usually six-week plans. The outlook plan also uses the pull planning technique, which is updated every week so that new activities can be added. According to (Forbes & Ahmed, 2020) there must be three fulfilled criteria for them to be set up in the prospecting plan:

1. The activities must have a manageable size (sufficiently detailed)
2. The activities must be easily measurable (duration)
3. The activities must be healthy (Subchapter 5.5)

### ***5.2.1.4 Weekly Work Planning***

This plan focuses on work that any last planner must complete to complete the activities that were planned in the phase plan. Under this plan, everyone involved must identify the activities that the various work teams must work on daily in the following week. To develop these plans, reliability is extremely important (Richert, 2017). The weekly schedule is more detailed than the Make-Ready plan and includes models and design documents used in the production. Here, the activities that can be conducted must be transformed into activities that will be carried out in the coming week. The weekly plan is also used as a basis for the PPU.

### ***5.2.1.5 Learning (Daily Huddle)***

The last element includes learning from the work that has been done. By adopting daily meetings at the end of the day, planners can use the PPU to record how much work has been completed. The purpose of this analysis is to find reasons why activities are not completed by a specified time. The goal of the daily huddle is to ensure that everyone is on the same page and that the project stays on track.

### 5.3 Pull Planning

This is a technique that is used in work that has been done in LPS. The project group uses backward planning to determine a completion date, based on the customer's needs. The pull-planning technique then plans regarding which resources are available. The purpose of this is to improve the understanding of various addictions and the importance of following a plan.

The preparation depends on three steps:

1. *Create an overview of the milestones.*
2. *Add activities to be carried out.*
3. *Assess the limitations of the activities.*

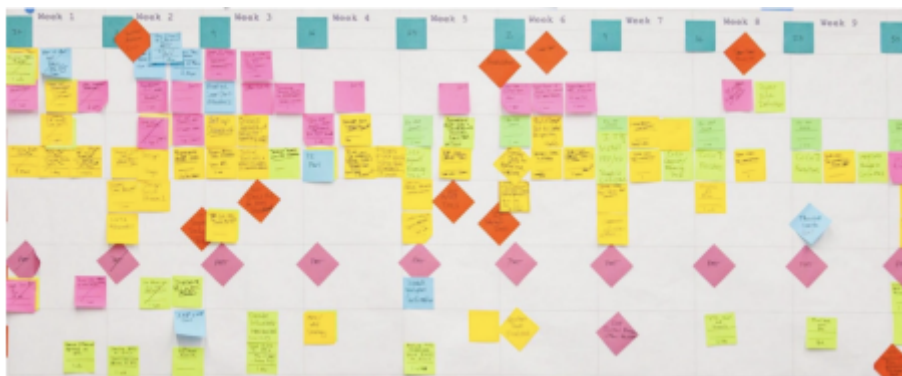


Figure 5 - Pull Planning with the usage of post-it notes (Medium, 2017).

#### 5.3.1 Make Milestones

Milestones are displayed as diamonds in pull planning, as shown in Figure 5 above.

Milestones are set up as part of the preparation of the master plan. A milestone is a date in the project when an activity or task must be completed. These must be prioritized depending on the scope of the activity and delivery times.

#### 5.3.2 Add activities

A milestone consists of several activities that must be completed, planned from the milestone and backwards. In the planning, all subjects are represented, and the different work teams work together to shape the weekly plans by using post-it notes, where each subject gets its own specific color, making it easier to get an overview of who does what. This has been adopted in Figure 5.

### **5.3.3 Consider limitations**

At the same time as milestones and activities are set up, the limitations are assessed as they are necessary. These restrictions are symbolized using an asterisk (\*) and include all problems that prevent planned activities from being carried out. By using pull planning, you have an overview of the dependencies in the project. Therefore, it is very important to have reliability throughout the project, so that all activities can be carried out.

### **5.4 Percent Planned Executed (PPE)**

Construction planning and management have always been a complex and intricate process that requires careful and thoughtful planning. This is especially true when it comes to coordinating multiple teams and keeping them accountable during the process. Percent Planned Executed construction is an effective tool that helps to streamline the process by providing a measurable metric to be tracked to ensure that the project is completed on time and on budget. By understanding more about the concept and its benefits, it is possible to make more well-informed decisions that lead to better results. This essay will discuss how Percent Planned Executed construction can reduce the risks associated with complex construction projects.

An effective 80/20% planned-executed construction model has a number of distinct benefits over the traditional linear approach. This approach can often reduce the total duration of a project and decrease costs, since design and construction activities can overlap instead of occurring sequentially (Hempel et al., 2019). The 80/20 model also allows for a higher level of certainty, since a greater portion of the work is planned upfront, and it can be easier to manage changes in scope (Hempel et al., 2019). Additionally, this model can reduce the need for downstream coordination, since many of the decisions are made early on, and there is less of a need for corrections later in the project (Hempel et al., 2019). Finally, this approach can improve communication between key stakeholders, as early involvement leads to a better understanding of project goals and objectives (Hempel et al., 2019). All these benefits make the 80/20% planned-executed construction model an attractive option for any construction project.

Last Planner focuses strongly on the root causes of deviations from the plan. Examples often show that it is beyond the craftsmen's control should complications arise in production.

Therefore, it is important to include craftsmen in the planning, so that they can contribute with their input and learn about any challenges they may encounter within the various subjects.

In addition to completing started activities, it is essential to carry out work without errors; otherwise, it will be both a waste of time and disruptive to workflows, which in turn will lead to a demotivating environment and irritation around projects.

Construction projects require careful planning and execution for them to be completed successfully. Therefore, it is important for all stakeholders to be involved in the planning and execution of construction. This process involves close collaboration between project planners, architects, and engineers to create a plan that effectively uses resources, meets budget requirements, and meets all safety and quality standards. In the end, the planning and execution of construction is an important part of any construction project and should be considered by all stakeholders in order to ensure its successful completion.

## **5.5 Healthy Activities**

It is the task of the Make-Ready plan to turn activities into healthy activities to be able to prepare realistic and predictable work plans. Lean Construction focuses on ensuring that activities that are started can be completed and prevents activities from being started when they are not healthy, so that they cannot be completed. Starting an unhealthy activity will result in improvisation, rigging up and down, and often a bit of chaos and mess, which can quickly contribute to a lot of waste of resources, time, and costs. Seven prerequisites must be met for an activity to be considered healthy; these are listed and described below.

### 5.5.1 Description of the seven prerequisites that redefine a healthy activity

**Labor/Crew** – It is required that the crew/employees have the right skills and the capacity to perform the required work.

**Equipment** – The equipment must satisfy the need for safety, load, and efficiency.

**Materials** – The right quantity and quality of materials must be available.

**Adequate space** – The workplace must be prepared and cleared before work can begin.

**Project basis** – Drawings and descriptions must contain the correct information before work can begin.

**External conditions** – External conditions such as weather or public permits must be in place before the work may occur.

**Previous activities** – Previous activities must be completed with the correct quality before the next one gets started.

Even though an activity may be healthy at one point in the project, it may not be so at a later point. Therefore, it is important to find people responsible for activities who will stay up to date on the situation, as it is constantly changing and must be continuously worked on.

The purpose of converting activities into healthy activities before production is construction and the construction industry's translation of the mechanics Toyota uses when they mass-produce cars. A vehicle under construction will never advance to the next workstation until all work associated with the station it is on is done with a standardized quality. By implementing the same mechanics in the building and construction industry, if not all the seven prerequisites (mentioned in 5.5.1) are present to carry out work in a healthy way, work shall not be initially started. It is very demanding to achieve the ideal healthy activity, and due to cost reasons, activities are often started even if they are not necessarily 100% healthy. One can almost imagine that it is a kind of dream situation to have all activities healthy when they are started.

### 5.6 Last Planner System in the future

Simply put, the Last Planner system is a mindset and set of principles, and solutions and techniques are still under development. It is a system, and the challenge lies in getting good social change processes in projects. This point of change is what we find most challenging to

achieve, as this must be carried out throughout the project and, in addition, adapted to the scope of the project.

Developing alternative reporting formats based on LPS could be an idea for development. At the same time, automating LPS can lead to disadvantages, as some of its decisive characteristics about involvement can lose some of their potential.

However, there are still some areas of improvement that can be made to better meet the needs of construction project managers. For example, the system could be better integrated with other software, such as scheduling and budgeting tools, to make it easier to manage resources and tasks. Additionally, it could be improved to provide better visibility into the progress of the project, allowing project managers to monitor the progress of the project more closely.

Finally, the system could be developed to provide more detailed reporting capabilities, such as custom reports for specific tasks and resources. These improvements would help improve the efficiency of project management and reduce the risk of project delays. With these improvements, the Last Planner System could become an even more powerful tool for construction project managers.

## **5.7 Involving Planning – Veidekke – (IP)**

Involving Planning (IP) - Lean Construction is Veidekke's methodology for operating progress planning in project-based production, in accordance with principles for good improvement work. By progress planning, we mean planning the use of time for the production activities in the project (Kalsaas, 2017). The main objective of Involving Planning (IP) is to reduce lost time and create flow in production. The approach to this stems from involvement, where everyone participates in planning their own everyday life (Veidekke ASA, u.d.).

Veidekke, a leading Norwegian construction company, has achieved success through involving planning. According to (Fundli, 2014), they have integrated technology and communication technology to achieve a comprehensive planning process. This process includes the involvement of the customer, employer, employees, and other involved parties in the planning phase, which provides a good basis for achieving the goals. Veidekke has also developed a flexible planning system that is adapted to different projects, and this has helped the company achieve its goals. Furthermore, Veidekke has focused on involving the employees in the planning process, which has strengthened commitment and increased

motivation among them. This has resulted in increased productivity and efficiency. All in all, involving planning has helped Veidekke to achieve success by optimizing the process and increasing the commitment and motivation among the employees. (Fundli, 2014) claims that this has helped Veidekke to achieve its goals.

Veidekke's projects can benefit from involving planning to improve results. This is because involving planning is a good way to ensure that all stakeholders in the project are aware of each other and their roles. As (Hetlelid, 2017) explains, involving planning helps to ensure that all stakeholders are aware of the expectations placed on them, and that they can work together effectively to achieve the desired results.

Furthermore, this suggests a higher degree of responsibility, which in return gives higher motivation and greater awareness of how important it is to follow the projects plans and time frames. Involving planning is also useful for identifying potential challenges and opportunities that may arise along the way, which can help Veidekke or any other company using this technique to maximize their project success. All in all, participatory planning has great potential to improve Veidekke's projects by ensuring that all parties involved are aware of each other's roles and work together effectively.

To maximize efficiency through effective planning, it is important that all employees and managers have knowledge of what is to be achieved and how it can be achieved. It is also essential that all employees can provide input and ask questions about the planning process. By allowing all employees to have a say, a culture can be cultivated that encourages collaboration and boosts productivity. Additionally, it is important to communicate the goals in a clear and unambiguous manner, so that all employees comprehend what is expected of them. This can help to motivate employees to work towards the shared goal.

Involving planning by Veidekke is an effective system for organizing the jobs carried out by its employees. It ensures the involvement of two central parties, Veidekke suppliers and project suppliers, making it easier for the company to prioritize and concentrate work on the most profitable jobs. By involving the two parties, changes and problem-solving can be made more efficient, reducing the potential problems and difficulties in the project.

### 5.7.1 What is it primarily about based on Veidekke Entrepreneur AS

- Plans are made jointly by those who will carry out the work.
- That everyone involved has knowledge of and influence over their own work tasks.
- Make plans through mutual promises.
- By rolling out the plan and increasing the detail of the plan, the amount of time needed to carry out the work can be reduced (**Plan system**).
- Remove obstacles and dangers systematically so that only healthy and safe activities can be executed (**Obstacle planning**).
- If planned activities are not completed, find the reason for the deviation and eliminate the obstacles, learning from them. (**Risk Management**)
- Different plan levels have different owners (**Meeting structure**)

Here are some principles that The Norwegian Coastal Administration's Development Department can adopt to enhance project efficiency and mitigate potential problems and difficulties. While some of these points may already be integrated into the department's operations, continuous improvement is crucial to achieving the best possible outcome. It is a learning process that requires ongoing efforts to refine project management practices.

### 5.7.2 Main elements in Involving Planning

- **Division of Work in Time:** Different levels of management plan different time horizons.
- **Obstacle Analysis:** Systematic analysis and removal of obstacles using the seven prerequisites.
- **The Planning System:** Strategic plans are created once. Rolling operational plans start from the strategic plans and become more detailed the shorter the time frame in which the work must be carried out. Different plan levels have different owners.
- **The Meeting Structure:** The meeting structure is adapted to and processes the various plans. Different meetings have different owners.
- **Risk Management:** Systematic analysis of risk and removal of hazards.

### 5.7.3 Rolling Time planning

A consequence of the variation in time use within project-based productions, comes rolling scheduling. The lack of predictability means that one does not have the possibility to plan in



detail and make decisions in a longer time perspective than that one can continuously adapt to the actual use of time. When planning, any activity is timed based on assumed staffing and expected man-hour consumption. The man-hour consumption is based on an average of previous experience. When we first start to produce, two events can occur: Firstly, the staffing is often different than expected, for example due to sickness absence. Secondly, we don't use the exact number of hours we have used as a basis for planning; you can either spend more or less time than planned. This does not mean that one is any worse at planning or producing; this type of uncertainty is completely natural in project-based production. Estimated time for activities will always deviate from the average to a greater or lesser extent (Veidekke ASA, 2015).

As the phase plan contains the necessary activities to complete the phase, plans are made for rolling within these to be able to make decisions at the right time, not necessarily as early as possible.

That something should be done according to an overarching plan does not mean that an activity is ready to be carried out. For an activity to be ready to be carried out, it is important to implement a process that uncovers and eliminates any obstacles, so that the activity not only should be performed, but can also be performed. This process takes place through the operational plans.

#### **5.7.4 LPS vs. IP**

Although Involved Planning (IP) is built on the Last Planner System (LPS), it also stands out on some important points:

- The various management levels plan with the focus on different time aspects; the higher you are in the project hierarchy, the greater the time perspective of the planning horizon. This is referred to as the time division of labor.
- Greater emphasis should be placed on describing the connection between the plan and the meeting structure, i.e., in which meetings the various plans are to be discussed.
- In LPS, it is often the chairman who is the last planner, while in Involving Planning (IP), it is the base and, ultimately, the individual craftsman who makes plans.
- A fifth plan level has been added to LPS's four; the team plan.
- PPE is not as central in Involving Planning (IP) as it is in the Last Planner System (LPS). In LPS, there is no fixed structure on how an obstacle analysis should be carried out, whereas in Involvement Planning, the seven assumptions are used.

- The individual craftsman has a greater role in IP than in LPS.
- As the Last Planner System is only about progress planning, has Involving Planning integrated both logistics and rig planning in addition to risk management.

### **5.8 Initial implementing of Involving Planning (IP)**

Involving planning was first assessed in the introductory phase, while the preceding phases were planned in the traditional way. This led to experiences that indicated that IP was difficult to obtain in practice as activities overlapped, in addition to the fact that the thinking and planning routines had to be changed along the way. Being able to calculate the time perspective needed for activities requires several years of experience with construction site production, as it is not only the direct work that needs to be timed, but also the indirect work which includes arrangement, transport, rigging and similar.

Most of the subcontractors were not used to breaking down activities in the same way that IP wanted it to be done. The difficulty in determining time with the degree of detailing also increases. There was often an expectation from the subcontractors that Veidekke Entreprenør AS would manage their work schedule, and the case handlers from the subcontractors were also not particularly skilled at following up on the operational side of the planning.

It was not just with the subcontractors that problems arose; there were also challenges experienced by Veidekke's more engineers involved in Planning (IP). For example, it was very time-consuming to update and detail a rolling weekly schedule. Experiences from earlier often gave the impression that weekly plans had little or no value.

What stood out most from the IP was that the previous weekly plans were only an extract from one overall plan that should reflect what could and should occur in the future weeks. While in IP, there are weekly plans that focus on reflecting actual events as much as possible.

### **5.9 Projects (Pilot)**

Pilot projects that operated with IPs' planning structure and the associated meeting structure, not only in the initial phase, had a recurring problem in that subcontractors and sometimes Veidekke Entreprenør AS did not show up well-prepared. There were also cases where subcontractors sent representatives with little or no authority to make decisive decisions, which drastically reduced meeting efficiency, which is very central to IP. In addition, it could also happen that activities that were said to be finished were not in reality.

Accurate guidelines and clear expectations from management were requested in several projects, which led to less understanding why IP was used, as well as what it could do. Reasons for this may be attributed to poor training, as the training was mainly aimed at the project manager level, and to a limited extent at the rest of the organization.

Table 4 - Experiences

<b>Theme</b>	<b>Challenge</b>	<b>Learning</b>
<b>Plan system</b>	- Set time for activities	- The plans must reflect what should occur, as well as any indirect work.
	- Detailed activities at a strategical level	- Work more on detailing operational plans, especially the make-ready plans.
<b>Meeting structure</b>	- Ineffective meetings	- Create a tighter agenda, with better meeting preparation and ensure the right people are in the right meeting.
<b>Obstacle analysis</b>	- Handover between subject groups	- Focus on that which is finished, must be completely conducted.
<b>Anchoring</b>	- Lack of guidelines and expectations for projects from superior managers	- Explain why planning is important and provide thorough training.

**5.10 Further Development of Involving Planning (IP)**

A major advantage of Involved Planning (IP) is that it is a simple methodology with straightforward principles. The method does not require software or advanced computer tools, although these can provide useful support such as Microsoft Teams in order to streamline the meeting structure and eliminate both distance and time being used for travelling. IP is easy to use and has few limitations. The key point of Involved Planning (IP) is the methodology, and this improves with experience. The disadvantage of IP is that it is not only necessary to know how to use it, but also why it should be used.

A broader and more uniform understanding of the principles that form the basis for the methodology of planning, as well as how they are connected, can make it easier to promote better use. To emphasize the benefits, it may be wise to facilitate good visibility of the gains.

By involving the subcontractors from the start, it will be possible to realize the full potential of participatory planning and get an overview over the possible time-spectrum or obstacles that may or may not occur. Experience also indicates that project types such as large-scale projects, which make use of repetition, yield good results when participatory planning is combined with location-based planning.

For public administrations, it is important to involve the people who grant money in the state budget and those who decide which measures are to be implemented. These individuals are usually in higher positions in other departments. During user meetings that the Norwegian Coastal Administration conduct in person, we listen to stakeholders' opinions and solutions. We also gather a lot of information about their operations and future plans. This highlights the importance for those of us who plan and collect information. Therefore, if the people who approve these the funds for the measures in the National Transport Plan (NTP) also participate in such user meetings, they will see the importance of each measure. This will later contribute to the correct priorities being carried out and an understanding of the importance of these kinds of meetings being conducted.

## **Chapter 6: Case Study – An interactive Mapping System with relevant Information for the Planning group at The Norwegian Coastal Administration’s Development Department.**

In order to dive into the Case Study, it is important to get an overview of the way planners are working at The Norwegian Coastal Administration today. A project done by The Norwegian Coastal Administration starts with an investigation, where a harbor, port or fairway is presented with different difficulties. The next step is to survey the stakeholders in order to get their personal experience with the current measure. These meetings including mayors, municipal leaders, stakeholders in the area, residents and so on.

Thereafter, it is the investigation teams that forms the project, before handing it over to the planning team. From here, it is for the members to map previously performed analysis, and information based on meeting being done from the past, to get a broad understanding of the area and what has been done. If there are no activities being performed previously, it is important to order analysis such as geotechnical data, sediment surveys, depth data, ROV data footage and further on. There are many places previous analysis and data can be stored. The Norwegian Coastal Administration is a company that operates along the coastal line of Norway, so the data that previously has been collected through several years are all stores under the same names as the current measure and can date back several years.

For now, many of the documents and letters are stored in an electronical archive and can be assessed through access or look through the archive disc in the shared folder distributed through the company. This leads to many problems, and many hours spent looking for specific documents. During my time here at The Norwegian Coastal Administration, I have spent multiple hours trying to coordinate different projects, and this case study will present a solution in order to cut the timeframe being used, and present data in a much more efficient way, in order for the planning process is more efficient and precise.

So, the main issue for this Case study is:

**“How do we streamline information gathering at the Norwegian Coastal Administration’s Planning Department?”**

## Today's situation:

Case Number	Title	Status	Administrativ enhet	Saksbehandler	Opprettet
2022/1822	Ger 10 Bnr 38 - Ballstad Slip - Vestvågøy kommune - Nordland fylke - Utfylling	Under behandling	Transport, hamn og farle	Vigdis Iye	09.11.2023
2022/768	Utbedring - Ballstad - Vestvågøy kommune - Nordland fylke - Detaljregulering	Under behandling	Avdelings for ham- og kystforvaltning	Anniken Nyland Aagard	07.02.2023
2022/3608	Ballstad havn - Vestvågøy kommune - Nordland fylke - Områdesakerlegging	Under behandling	Avdelings for ham- og kystforvaltning	Anniken Nyland Aagard	06.07.2022
2022/1152	Allmenneleggen Ballstad - Vestvågøy kommune - Nordland fylke - Detaljreguleringsplan	Under behandling	Transport, hamn og farle - Auhending	Anniken Nyland Aagard	12.06.2021
2021/2865	Ballstad Servicehavn - Vestvågøy kommune - Nordland fylke - Detaljregulering	Under behandling	Transport, hamn og farle - Auhending	Anniken Nyland Aagard	14.02.2021
2022/1878	Ballstad - Vestvågøy kommune - Nordland fylke - Opprydding/fjerning av vannlednings	Under behandling	Transport, hamn og farle - Auhending	Vigdis Iye	07.04.2022
2021/1637	Ger 11 bnr 173 - Ballstad - Vestvågøy kommune - Nordland fylke - Flytebrygge	Under behandling	Avdelings for ham- og kystforvaltning	Tor Vidar Olsen	25.01.2021
2022/1428	Gjennsestørrelsesoppsett på Ballstad - Vestvågøy kommune - Nordland fylke - Etablering av sjøledning	Under behandling	Avdelings for ham- og kystforvaltning	Chris-Thomas Jørgensen	30.06.2022
2022/052	Ger 10 bnr 46 - Ballstad havn - Vestvågøy kommune - Nordland fylke - Sjøvannlednings	Under behandling	Avdelings for ham- og kystforvaltning	Ingrid Thomassen	08.02.2022
2022/2011	Ger 9 bnr 20 - Ballstad - Vestvågøy kommune - Nordland fylke - Endring av brygge	Under behandling	Avdelings for ham- og kystforvaltning	Chris-Thomas Jørgensen	12.04.2022
2022/3716	Ger 9 bnr 13 - Krossmoen/Reisen 33 - Ballstad - Vestvågøy kommune - Nordland fylke - Rubevassent - fasedokument	Under behandling	Transport, hamn og farle - Auhending	Vigdis Iye	14.07.2022
2022/4064	Ger 9 bnr 20 - Ballstadlandet 202 - Ballstad - Vestvågøy kommune - Nordland fylke - Malings ved kai	Under behandling	Avdelings for ham- og kystforvaltning		18.08.2022

Figure 6 - Digital Archive System showing multiple measures and cases for one measure, in this case Ballstad Habor

From here the main goal is to collect previous tests such as environmental survey, geotechnical assessment and geotechnical investigations, socio-economic analysis, cost estimations, risk analysis, letters for landfill and sea landfill, preliminary project and more.

These files are hidden in different case numbers as shown in Figure 6. This makes the work so much more ineffective and time consuming.

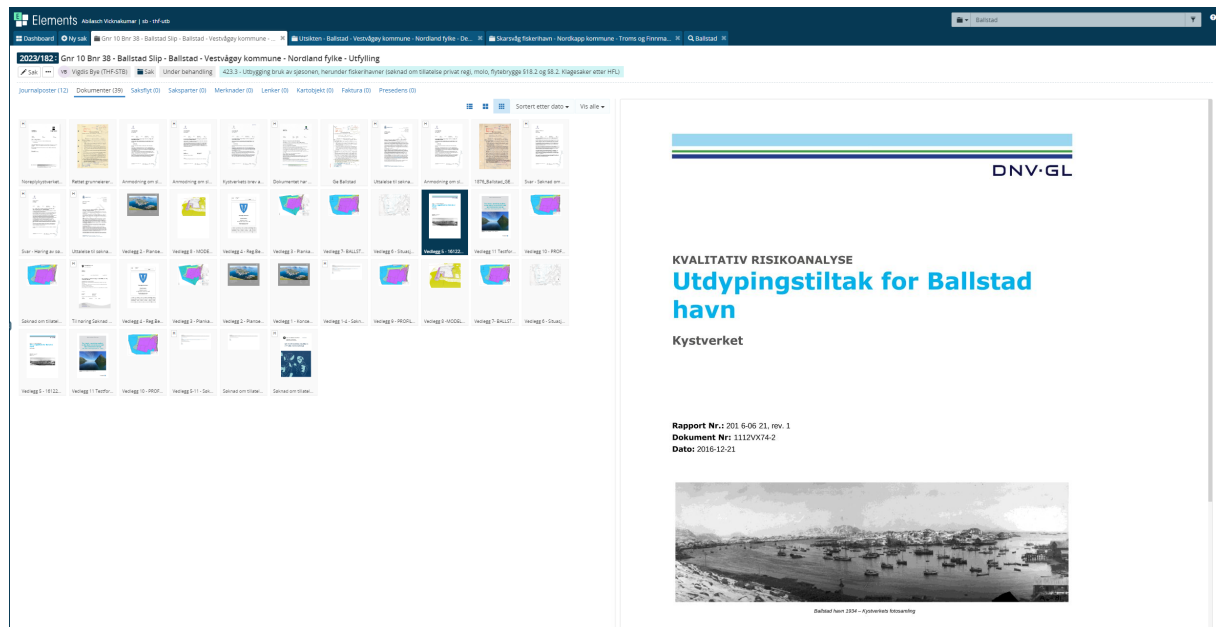


Figure 7 - Choosing a case in order to collect information and documents.

The next step is clicking through all the relevant case numbers and collecting as much data in order to get orientated on what was done the last time this measure was brought up, and which

tests are being done, and match them to the newest updated version of the measure and find out if some of the test should be done again, or to plan a more comprehensive test. This includes environmental survey, drone pictures, depth base data, geotechnical investigations and quantity calculations on the mass being planned to deepen. The mentioned analysis and investigations will contribute to making a new cost estimation on the measure, that later will be used in prioritizing the different measures being prioritized in the National Transport Plan (NTP).

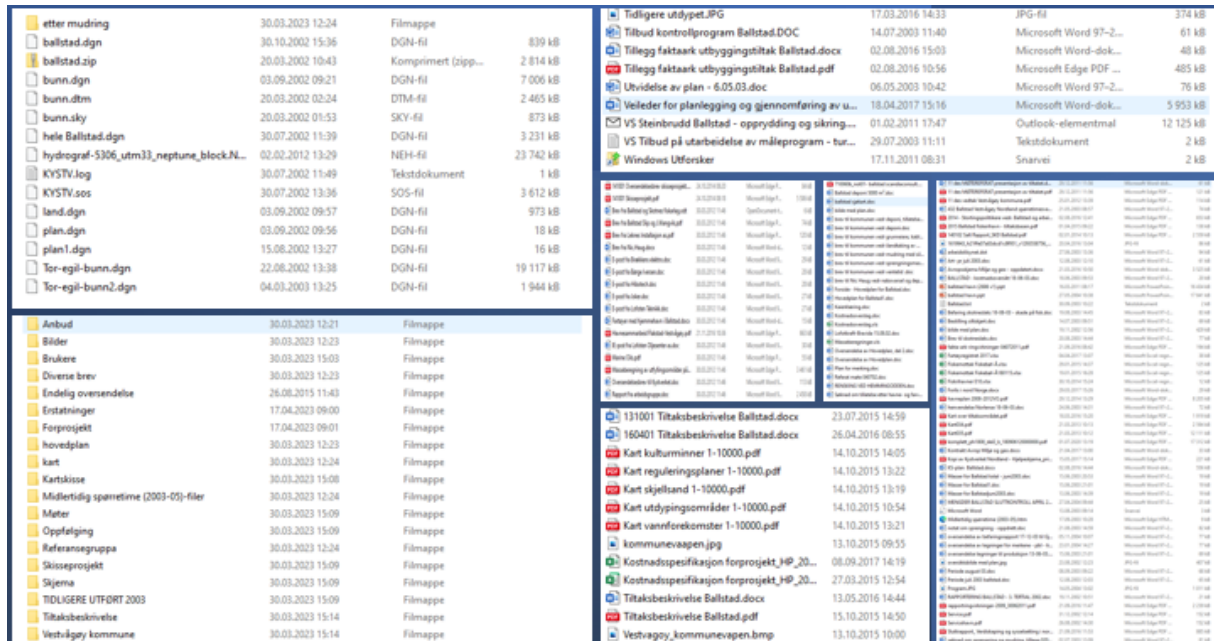


Figure 8 – Example of information investigation for a measure, in this case Ballstad (total of 2756 files)

In Figure 8 you can see the number of documents that I as a planner must go through in order to correctly coordinate the project named Ballstad harbor which is in its initial phase after The Norwegian Coastal Administration received the responsibility for measures in fishing ports. This is just approximately 40% of all documents I must go through in order to find information on what has been done earlier and other information from the stakeholders. As you can clearly see, this takes weeks and even months to coordinate in order to present this to the team leader for taking it further up the chain.

The solution is simple, but comprehensive to perform. An interactive mapping system would be the most efficient way of solving the amount of time being spent on searching to several map-structures and archives in order to collect relevant data for the current area. This includes plotting in:

- Drill point done in geotechnical investigations.
  - o *Current Depths and margins*
  - o *Accurate points*
- Grab point from the sedimental investigations.
  - o *Accurate position for the investigation*
  - o *Their corresponding condition class (contamination)*
- Correct depth data in the area
- Previously designed breakwater designs on measures containing a new breakwater.
- AIS data as a filter, to see the amount of traffic and the most common route
- Nature conversation areas nearby
- Stakeholders in the area
- Property boundaries
- Other relevant information such as:
  - o **RA** – *Risk analysis*
  - o **SØA** – *Socio-Economic analysis (Samfunns Økonomisk Analyse)*
  - o **UA** – *Uncertainty Analysis (Usikkerhetsanalyse)*
  - o **Merkeplan** - *Plan for navigation installations*
  - o **Strømmåling** - *Wave and current measurements*

The most important part of the points and coordinates are the reports being linked to them, when clicking on the different point. When searching for the actual place on the map, the reports such as RA, SØA, UA, plan for navigation installations, Wave and current measurement, can be accessed through the interactive map as they are linked to the actual measure.

For this to be implemented it is important to have a map basis where the subcontractors used for the different examinations, have the technical ability to plot in their data and report results in an interactive system between The Norwegian Coastal Administration and the subcontractors. This includes thorough data collecting when implementing the examination at the different harbors, fairways or the sailing ins so they correspond to the map being used.



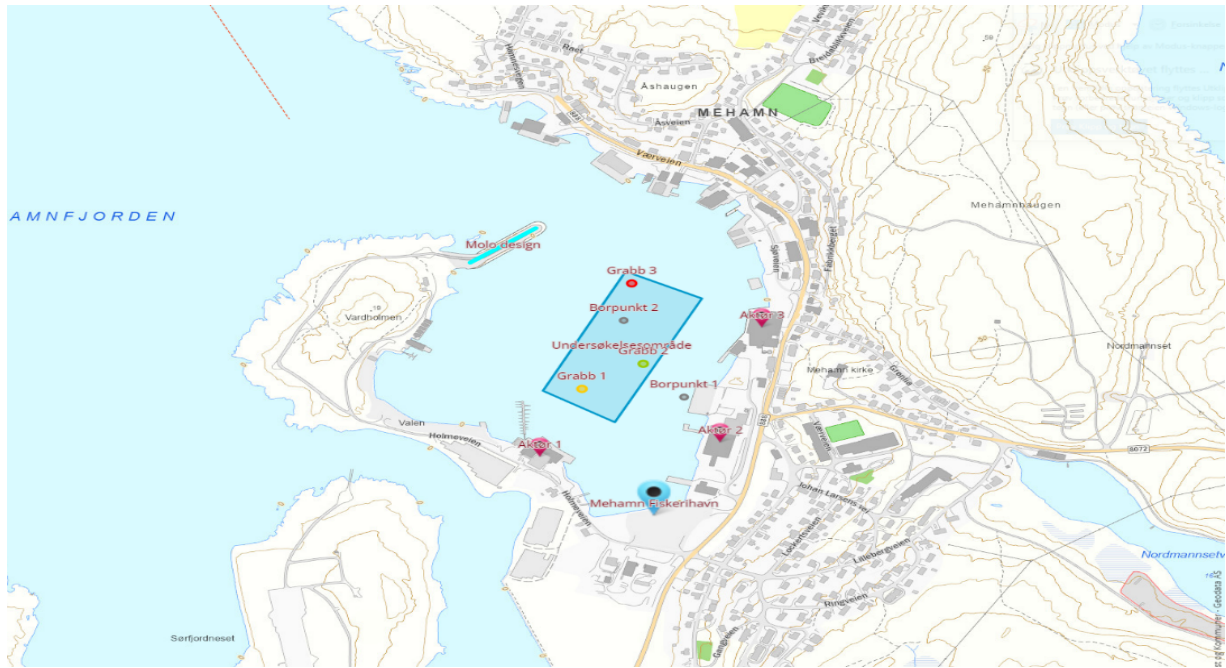


Figure 9 - Example of an interactive map with information from subcontractors in this example Mehamn Fishing port is being used.



Figure 10 - Example of an interactive map with high quality pictures

The solution presented above is a vague representation of a possible solution to the main problem presented in the case study. The points represent different results from analysis done by sub-contractors for a project being planned in Mehamn Fishing harbor, Troms and Finnmark, Norway. This allows planners at The Norwegian Coastal Administration to see

previous result from examinations done, with the report linked by clicking on the relevant point in order to get more information to collect.

This solution will minimize the amount spent looking through mapping structures and archives in order to acquire the same relevant information provided in an interactive map. This also provides a better communication between the contractors and sub-contractors. In order to acquire a well-functioning and precise map-structure, it is quite essential that data are revised before officially posting it. This includes, correct positioning of the points, correct data linked to the points, fully revised and approved reports and the name of company and contact person. This provides direct and efficient communication and structure in order to receive a good cooperation.

The interactive mapping system and information source will contribute to a substantial decrease in the time spent looking for relevant data and information. This allows the planners to efficiently record the reports of interest, and to check if they need to renew the reports due to their age in order to get updated data if a measure is being revised for a new NTP (Nasjonal Transport Plan) for the next period.

In my opinion, the time and effort required to coordinate previous projects can be reduced to days instead of months or weeks. This statement is based on my experience as a planner, having spent several weeks finding data related to various projects in both personal and external archive systems, where it consists of multiple case numbers etc. As the next step is to calculate cost and their social-economic analysis (SØA), it is important to have recent and correct data gathered in order for this to be initialized.

This solution will streamline the time used to plan a measure. This means that we can send in an increase of projects to be considered by the government in the next NTP (Nasjonal Transport Plan) and streamline our work being done in order to consider all the measures that has to be done in order to ensure safe and efficient traffic along the coast and into ports and being responsible for the national emergency preparedness against acute pollution.

This solution reduces the time required to plan countermeasures. This means that more projects can be submitted for consideration by the government in the next NTP (Nasjonal Transport Plan), providing all the necessary resources to ensure safe and efficient transport along the coast and ports. Streamlined work to include measures and responsible for national emergency preparedness for acute contamination.

## **Chapter 7: Synergies between Lean and digitalization**

In the modern technological landscape, lean and digitalization have become increasingly intertwined and offer powerful opportunities for businesses to improve efficiencies, reduce costs, and drive innovation. Now we will explore the concept of synergy between lean and digitalization and discuss the myriad of advantages for companies that can effectively combine these two powerful strategies.

In recent years, there has been an ever-growing interest in the combination of lean manufacturing and digitalization. This is because this combination can provide multiple benefits for businesses, as outlined in the study by SV Buer, M Semini, JO Strandhagen, and others, published in the 2021 edition of the *International Journal of Production Economics* (Buer, Semini, Strandhagen, & Sgarbossa, 2020). For instance, when using digitalization in combination with lean manufacturing, businesses can gain a better understanding of the production process, allowing them to identify areas that can be improved. This can result in increased efficiency, as digitalization enables businesses to track and analyze production data in real-time, allowing them to quickly identify and address inefficiencies. Additionally, digitalization can also help to reduce costs, as it allows businesses to automate certain processes, eliminating the need for manual labor, and reducing the need for physical resources.

Furthermore, digitalization can also provide businesses with access to more data, enabling them to gain a more detailed understanding of their production process, and allowing them to better anticipate and address any potential issues. This can also help to improve the quality of the product, as businesses can identify and address any potential quality issues quickly and efficiently.

Recent research has demonstrated the potential for tremendous benefits associated with the implementation of lean principles in a digitalized environment (Fathi & Ghobakhloo, 2019). These benefits include improved efficiency and productivity, reduced waste and costs, improved customer satisfaction, and increased competitiveness. In a digitalized environment, lean principles are used to identify and eliminate waste and non-value-added activities. This process can include streamlining processes, simplifying systems, and automating tasks. By relying on data-driven decisions, organizations can create a culture of continuous improvement and become more agile in responding to customer needs.

The implementation of lean principles in a digitalized environment can also lead to enhanced employee engagement. By providing employees with access to the latest digital tools and technologies, organizations can empower employees to better engage in their work. This can result in improved job satisfaction, increased motivation, improved morale, and better collaboration between teams. Additionally, lean principles can increase employee skills and knowledge, which can result in improved performance and increased productivity.

## **7.1 Visualizing**

Digital tools such as BIM (Building Information Modeling) have contributed to better visualization. A BIM model opens the possibility of collaboration across disciplines. Within Lean, BIM will help to create flow in the work. Visualization avoids variation, and the use of BIM opens the possibilities of conducting collision checks that prevent conflicts and production errors that may occur during production. By digitizing Lean in the form of BIM, one could also identify several design alternatives early on, before moving on to the production process. This helps to increase the value for the customer.

Another example for visualizing is the usage of high-resolution depth measurements presented in txt files and visually presented in a pdf file that The Norwegian Mapping Authority will send us here at The Norwegian Coastal Administration for our projects in the Norwegian waters. These files will then later be processed in a program, where the txt file will be transformed into an 3D model of the seabed for the measure in question. This allows the software to calculate the amount of mass ( $m^3$ ) needed to dig through and for us engineers to be able to see if the seabed consists of mountains (rock mass), loose mass or a combination of this, to approximately calculate the cost estimates associated with the project and to coordinate where to extract either environmental grab tests or geotechnical foundation boreholes in order to get the best result for the reports.

The coordination of positioning where to get the grab teste and boreholes from together with the subcontractors, results in a more successful understanding of the seabed in which the Norwegian Coastal Administrations Development Department is going to implement a measure. This thorough understanding will also result in a more complete report (pdf) that will be delivered from the subcontractors.

## **7.2 Flexibility**

The Lean methodology/philosophy is based on creating great flexibility in production. It implies that if there is a need for restructuring in production, this must happen quickly and cost-effectively. This is something that BIM contributes to. If the customer is dissatisfied with the design or if the building, for example, does not meet the requirements, this can be changed quickly in the BIM model. After the changes have been made, they will be available to all participants immediately. This requires the use of the IFC format, which gives all parties the opportunity to open and modify the model. This allows for multi-competence in the working groups, which significantly contributes to greater flexibility in the solutions that are made.

A recent invention being used by The Norwegian Coastal Administration is the usage of VR-simulations (Virtual Reality simulations) in order for stakeholders and users of the harbor to test out the effects after implementing a measure, before even implementing it. A recent meeting in Tromsø involved a measure in Vardø harbor, where the project manager had designed a breakwater prototype and implemented it into the VR-simulation. This was according to the project manager, met with skepticism before even starting the simulations. Then after trying to maneuver the harbor using their ship in the VR-simulation, they came into conclusion that the maneuver was possible if the breakwater was 100m shorter. This would allow the user to not cancel any arrivals that brings the municipality quite a lot of income and for the socio-economic analysis to not lose a factor in order for this project to turn into a positive outcome for Vardø.

## **7.3 Cooperation**

Last Planner System (LPS) can be used to conduct weekly or daily meetings with project managers from different disciplines. Lean methodology raises the bar for transparency in communication between the participants. Digital tools that contribute to visualization make it easier to visualize the project during the meetings. Solutions and experiences taken under these meetings can further be designed in the BIM model, which will improve cooperation throughout the project. Together with LPS, progress in the project can thus be measured using PPU.

A project hotel is a web-based tool where all project information is stored. This entails a reduction in wastage during the search for information, as well as traceability in the project history for the individual elements produced in the project. Interaxo Project is a cloud-based

collaboration platform that enables builders and subcontractors to work together seamlessly on construction projects. Some of the benefits of using Interaxo Project for collaboration include:

1. **Improved communication:** Interaxo Project provides a centralized location where builders and subcontractors can easily share project information, such as plans, schedules, and progress updates. This can help to reduce misunderstandings and errors that can occur when information is scattered across multiple locations.
2. **Increased transparency:** Interaxo Project enables all stakeholders to have access to the same project information, which can help to promote greater transparency and accountability. This can help to build trust between builders and subcontractors and can help to minimize disputes.
3. **More efficient workflows:** Interaxo Project provides tools for managing tasks, deadlines, and workflows. By using these tools, builders and subcontractors can work together more efficiently, which can help to reduce delays and costs.
4. **Enhanced project control:** Interaxo Project provides real-time updates on project progress, which can help builders and subcontractors to identify and address issues more quickly. This can help to minimize the risk of cost overruns and delays and can help to ensure that projects are completed on time and within budget.
5. **Better project outcomes:** By using Interaxo Project to collaborate, builders and subcontractors can work more effectively together, which can help to improve the quality of the final project outcome. This can lead to greater customer satisfaction and can help to build a positive reputation for all parties involved in the project.

#### **7.4 Involvement of actors**

Early involvement of actors with knowledge of costs and materials should be utilized early in the design and project phase to reduce errors and changes. With early involvement, the design will be more reliable as you have the opportunity to design and modify information in the BIM model much earlier. Early involvement of key actors is also a fundamental principle in the Lean methodology. Through early involvement, the project team will gain a better and deeper understanding of the objectives of the project. In the Lean philosophy, the involvement of actors will therefore be employed early on to maximize the knowledge as best as possible. While digitization will involve the actors early on to achieve the most optimal utilization of the project.

Involvement of external Lean actors can provide training and education to the NCA staff on Lean principles and methodologies, which can help to build internal Lean capabilities and foster a culture of continuous improvement. This can later lead to a more effective problem-solving and decision-making, as well as increased efficiency and productivity.

Another argument is that external Lean actors can provide accountability and benchmarking for the NCA's Lean initiatives. By tracking and measuring performance against industry standards and best practices, external Lean actors can help the NCA to identify areas for improvement and ensure that Lean initiatives are achieving their intended results.

## **7.5 Reduction of inventory**

The principle of the reduction of inventory is a key component of Lean management, and it involves minimizing the amount of inventory or materials that a company holds to reduce waste and improve efficiency. This principle is particularly relevant to the Norwegian Coastal Administration, which is responsible for managing a wide range of materials, equipment, and supplies across its operations.

By reducing inventory, the Norwegian Coastal Administration can improve the efficiency of its operations, minimize waste, and reduce costs associated with storage and handling. This can be achieved through a variety of Lean practices, such as implementing a Just-In-Time (JIT) inventory system, which involves ordering materials and supplies only when they are needed and in the required amounts. Other strategies may include optimizing inventory levels based on demand forecasts, standardizing processes to minimize variations in materials usage, and implementing visual management systems to improve visibility and control over inventory levels.

In addition to improving efficiency and reducing waste, the reduction of inventory can also help the Norwegian Coastal Administration to better manage its resources and improve customer service. With a more streamlined and efficient inventory management system, the organization can more easily respond to changes in demand, reduce lead times, and ensure that materials and supplies are always available when needed.

Overall, the principle of the reduction of inventory is a crucial element of Lean management for the Norwegian Coastal Administration, and it can help the organization to achieve greater efficiency, reduce waste, and improve customer service across its operations.

## **Chapter 8: Results**

In this chapter, the findings given by the interviewees will be presented. The results included in this chapter are based on the answers provided by the interviewees who were represented by different group leaders in the developing department. The questions asked are presented in Appendix A. The interviewees themselves are presented in Chapter 2.2.3. It will not be disclosed who is responsible for the various results/statements. Instead, an attempt will be made to compare the results given by different group leaders.

### **8.1 Knowledge and attitudes towards Lean**

After asking the question “How do you envision the actual development using Lean Construction?” from the interview guide (Appendix 1), the answers were very similar. A culture of improvement is being implemented, which of course leads to further development of the methodology in the form of imposition and digitization.

One of the main arguments given by the interviewees was that the future is awaiting digitization, and more processes are being digitized and used on a larger scale. Today, we are seeing a decrease in travel for meetings because of Microsoft Teams, which experienced an incredible upswing after the COVID-19 pandemic hit the world in 2019. This method of digitization has been used to streamline meeting structures and give companies the opportunity to hold these meetings weekly without having to travel long distances to gather subcontractors and other corporations that The Norwegian Coastal Administration is collaborating with.

Another form of digitization that has found its place in the construction industry is the visualization of projects we are working on. BIM, 3D models, VR simulations, project hotels and developed information seekers based on mapping systems are digital tools that are being used in order to map and plan projects we have in our portfolio. By using common formats (.shp, .kml, .IFC) we are able to share and distribute different types of data throughout the organization, so that employees and subcontractors can access the data needed in order to do their activities. This contributes to a better interaction and cooperation, in addition to adjustments and changes. If you combine the common understanding of a project and its process with weekly meetings and early involvement, everyone gets to say something and present their solutions, which again contributes to efficiency and finding the best possible solution.



### **8.1.1 The development of Lean in the future**

The interviewees are all agreeing upon the fact that it is important to use the principles in Lean for conducting their work. But the implementation must come from the leaders in the organization, as The Norwegian Coastal Administration is a public administration.

Lean Construction is a methodology focused on maximizing value and minimizing waste in the construction process. This philosophy has gained popularity in recent years as the construction industry seeks to improve its efficiency and productivity. The future evolution of Lean in Construction may be driven by many factors. One of the main drivers is the need to reduce costs and improve profitability. As construction projects become more complex and budgets tighter, the need for lean technology that helps streamline processes and eliminate waste increases. Another important driver of lean in construction is the increasing use of technology.

As digital tools become more sophisticated and pervasive, there are more opportunities to automate processes, improve communication, and improve collaboration. This reduces errors, shortens project delivery times, and improves overall quality. Finally, the future development of Lean in Construction will be shaped by an increasing focus on sustainability. Lean technology is becoming increasingly important as the construction industry strives to reduce its environmental impact and promote sustainable practices. By minimizing waste and maximizing value, Lean helps reduce resource consumption and promote more sustainable building practices. Overall, future developments in lean-in construction are likely to be driven by a combination of cost pressures, technological advances, and sustainability concerns. By adopting lean principles and practices, the construction industry can become more efficient, productive and sustainable, resulting in better outcomes for customers and end users.

### **8.1.2 Success factors and barriers to the successful implementation of Lean**

When it comes to anchoring in management, this is something that most sources highlight as essential at the start of the implementation of lean for it to be effective. This applies to managers at all levels in the organization. They must function as door openers, instigators, and engage with the employees. It is also crucial that management helps to release the resources required to start such an implementation, and that management has the competence needed to drive such an implementation going forward. Furthermore, it is important to set clear goals for what you want to achieve from the lean process, which implies a focus on customer satisfaction. Additionally, employee involvement is crucial in any change process.

This requires that employees see the benefits of the changes that are to take place and feel that they have real influence. Then, it is important that the person or persons who will facilitate the lean implementation are familiar with the culture in the organization, whether it is external or internal.

When it comes to significant differences in the implementation of lean in the private and public sectors, it appears that some of the terminology associated with lean can be difficult for employees in the public sector to grasp. Words such as efficiency can have negative associations in service professions and can make employees hesitant. Sources indicate that incentives such as greater rewards, salary flexibility, and fear of job loss can promote a willingness to change among employees in the private sector, making lean implementation more effective. The fact that the private sector is more exposed to competition can also contribute to employees feeling that they have more to gain from readjusting and becoming more efficient, as well as meeting customer needs.

When it comes to managers in the public sector, it is pointed out that they do not have the necessary competence to carry out the type of change that lean requires. They are not as accustomed to rapid change as those in the private sector. It is also emphasized that there is greater variation in competence and experience in the public sector, which makes it difficult to address the real problems, and the implementation may become more superficial.

By using lean principles in the public sector, barriers can be broken down to create better value in the service delivery process. The financing of public sector services differs from that of the private sector. If you don't want a product from a private company, the company must change or go bankrupt. This is not the case for the public sector.

It is therefore extra important that lean be prioritized so that value is continuously delivered to the user. Wasteful sub-processes should be reduced so that quality and value for the end-user are the focus.

The first step is to shift from thinking top-down to bottom-up when creating a service. Then, you should document all processes to become less dependent on individuals to deliver the service. The third point is to map what actually adds value for the user. Finally, one evaluates how the actual flow of service delivery works, not only in theory but also in physical, everyday life.

### **8.1.3 Synergies between Lean and Digitalization of Lean**

In today's competitive business environment, companies are constantly looking for ways to improve processes and increase efficiency. His two popular methods of achieving this are lean principles and digitization. Lean principles focus on eliminating waste and adding value, while digitization involves integrating technology into business operations. Combining these two methods creates a synergistic effect that yields even greater improvements. This article introduces lean principles and digitalization, explores the benefits of combining the two, and explains how companies can successfully implement this approach in their operations.

Applying the Lean Principle is a widely used approach in various industries to improve operational efficiency, reduce waste and increase productivity. However, the advent of digitization has opened new opportunities for lean implementation, making it more effective and efficient. This integration of lean principles and digitization has led to the development of what is called 'lean digitization'. This is what he combines the advantages of these two approaches to achieve excellent results. A lean approach to digitization provides companies with the tools and technologies they need to streamline operations, optimize processes, and reduce costs while ensuring high-quality products and services. By leveraging digital technologies such as artificial intelligence, machine learning and the Internet of Things, organizations can achieve higher levels of productivity, efficiency and quality. The integration of lean principles and digitalization is therefore a powerful combination that helps companies achieve better results and gain a competitive advantage in their respective industries.

The combination of lean principles and digitization offers organizations many benefits. Lean principles focus on minimizing waste and maximizing value, while digitization involves using technology to improve efficiency and productivity. A study conducted by Liao and Wang in 2021 (Liao & Wang, 2021), found that combining these two approaches of his leads to shorter lead times, better quality, higher productivity, and lower costs. Digital tools such as automation, artificial intelligence, and big data analytics can enhance lean principles by providing real-time data and insights to identify areas for improvement. For example, automation can streamline processes and reduce human error. Big data analytics also help identify patterns and trends to optimize operations. In addition, digitization facilitates communication and collaboration among team members, helping them work more effectively toward common goals. By integrating digital technologies into lean principles, companies can become more competitive and sustainable in the long run.

Overall, the combination of lean and digital offers significant benefits for companies looking to improve their operations in the modern business environment. An implementation of lean principles in a digitized environment can provide a significant array of benefits. By streamlining processes, simplifying systems, and automating tasks, organizations can improve their efficiency, reduce cost estimations, and become more competitive. In addition, the use of digital tools and other technologies can lead to improved employee engagement and increased productivity. So, to finish this paragraph, leveraging lean principles in a digitalized environment can be a powerful and effective strategy for organizations.

In conclusion, the implementation of Lean and digitalization can provide businesses with a competitive edge in today's rapidly changing business environment, and it is essential for companies to adopt these strategies to remain relevant and sustainable in the long term. This allows the company to achieve their goals as well as providing efficient result with minimal waste and cost-reductions. By learning from their steps, they will always be a possibility to improve in order to achieve better result, and cost reductions.

The Norwegian Coastal Administration's Development Department is putting in significant efforts to adhere to the government's cost restrictions and to increase its portfolio in the ongoing and upcoming NTP. NCA recognizes that it is essential to reduce costs and develop a comprehensive plan for implementing measures along the Norwegian Coastal Line to ensure the smooth execution of projects. With this approach, NCA can inspire confidence among end-users and offer them the option to reduce costs in accordance with the ever-evolving cost caps. To achieve this objective, NCA is committed to promoting a culture of continuous improvement, which will be facilitated by the usage of software and digital tools. The use of such tools is expected to minimize human error and improve the quality of outcomes, thereby enhancing NCA's credibility in the eyes of stakeholders.

## Chapter 9: Discussion

In this discussion, we will explore the findings from a qualitative research study that was conducted to investigate the challenges faced by the Norwegian Coastal Administration (NCA) in project management, specifically in the development department. The study was conducted using various sources of data, including literature review, feedback from Kystverket, and interviews with project managers and other stakeholders within the NCA.

The primary objective of this study was to answer the following research questions: What are the current challenges faced by the NCA in project management? How can these challenges be addressed to improve project efficiency and effectiveness?

In the following sections, we will discuss the key findings from this research and examine the implications of these findings for the NCA. We will also provide recommendations for how the NCA can improve its project management practices overcoming these challenges and achieve better project outcomes.

### **9.1 RQ1: What are the challenges faced by public administrations such as NCA in implementing Lean methodologies, and how can digitalization be leveraged to optimize Lean implementation in such contexts?**

The literature does not say a lot about what needs to be facilitated correctly in order to implement Lean and digitize it in public administration. However, it can certainly be said that digitizing Lean is a paradigm shift for the construction industry. An implementation could be considered demanding due to the many aspects that need to be changed. It is mostly those in the industry who best get to experience the prerequisites for the implementation in their own projects and companies. The answers given below are therefore based upon the experiences of the interviewees and the undersigned's interpretation of these.

It should not be hidden that attitude towards the use of Lean and digitized tools, which contribute to increased Lean effect, are good. However, there is a difference in terms of experience between the different roles in the construction project. Project managers often see the overall advantages of using both the methodology and various digital tools, and thus they are the most positive about its use. To ensure that all levels in the project will want to use both Lean and digitized tools, one must gain good experience and knowledge. A solution that is often mentioned by the interviewees is early involvement of actors with knowledge of the methodology and trying to get everyone involved to understand it and the involvement and encouragement from the leaders in the company (IP). By doing this, there will be an

opportunity to form a movement that moves between all employees in the form of commitment, motivation, and will, which will later be significant in the degree of success of the implementation.

The interviewees all states that the encouragement must come from the leaders in the company, as it is their representation and methods that sets a path in the way the workers do their activities. If the activities are going to be changed in a more effective way, this involves training, and the understanding of the workers on how this will benefit their way of working. As The Norwegian Coastal Administration is a governmental organization, this requires a suggestion from way up in the hierarchy as there are loads of steps to be implied for a change to be implemented in the developing department at The Norwegian Coastal Administration.

As we are continuing in a more technologically powered industry, the construction industry is always looking for new ways to improve and streamline their work and activities. At The Norwegian Coastal Administration today, we use **Interaxo, Kystinfo, BarentsWatch, Anslag 5.2.1.1, Tiltaksbase** and other developed software in order to streamline our field of activities in order to implement our project along the Norwegian Coastal Line.

Table 5 - Overview over some of the digital tools being used at the Development Department of The Norwegian Coastal Administration

DIGITAL TOOL	WHAT DOES IT DO?
<b>INTERAXO</b>	<i>Project Hotel – interacting space for builders and contractors</i>
<b>KYSTINFO</b>	<i>Map, with depths along the coastal lines and different filters, for people to get an overview and data. In addition, there are a lot of filters with relevant information.</i>
<b>BARENTSWATCH</b>	<i>BarentsWatch will collect, develop and share information about Norwegian coastal and marine areas.</i>
<b>ANSLAG 5.2.1.1</b>	<i>Software for cost estimates for project in the planning phase to determine a cost around the project.</i>
<b>TILTAKSBASE</b>	<i>The purpose of the database is to collect key information for all ongoing measures in one place. This ensures that planners, coordinators, orders, and decision-makers have equal access to key information about the individual measures.</i>
<b>MICROSOFT TEAMS</b>	<i>The main purpose is to connect the people that are going to successfully complete a measure. Teams provide great communication and collaboration.</i>
<b>AUTOMATED MAPPING OF FISHING PORTS</b>	<i>Python script developed by Menon Economics in order to receive relevant information such as traffic and landings, sorted by vessel size, type, type of fish and quantity.</i>

## Graphical Examples:

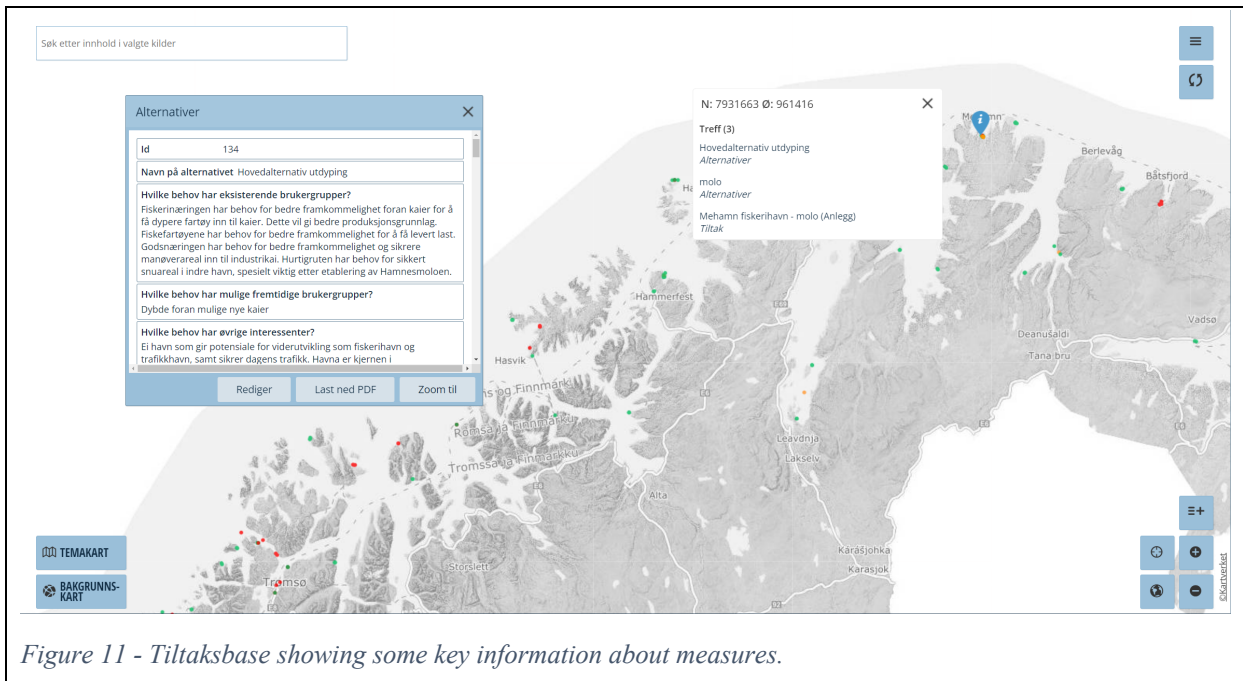


Figure 11 - Tiltaksbase showing some key information about measures.

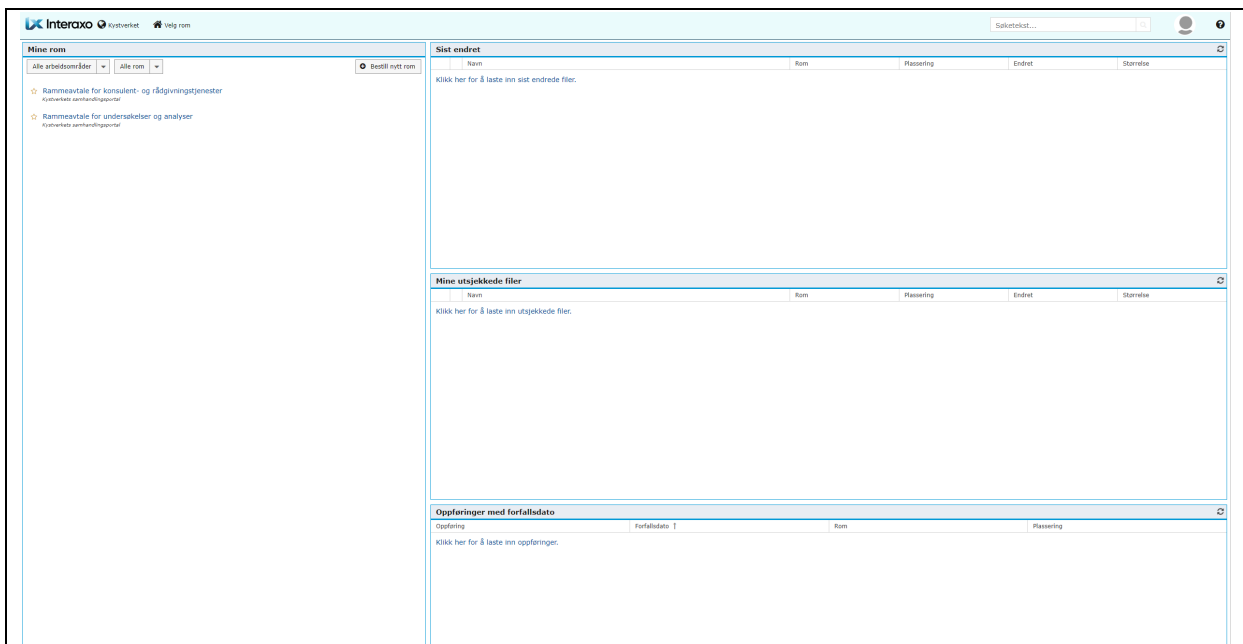


Figure 12 - Interaxo, Project Hotel - interacting space for builders and contractors

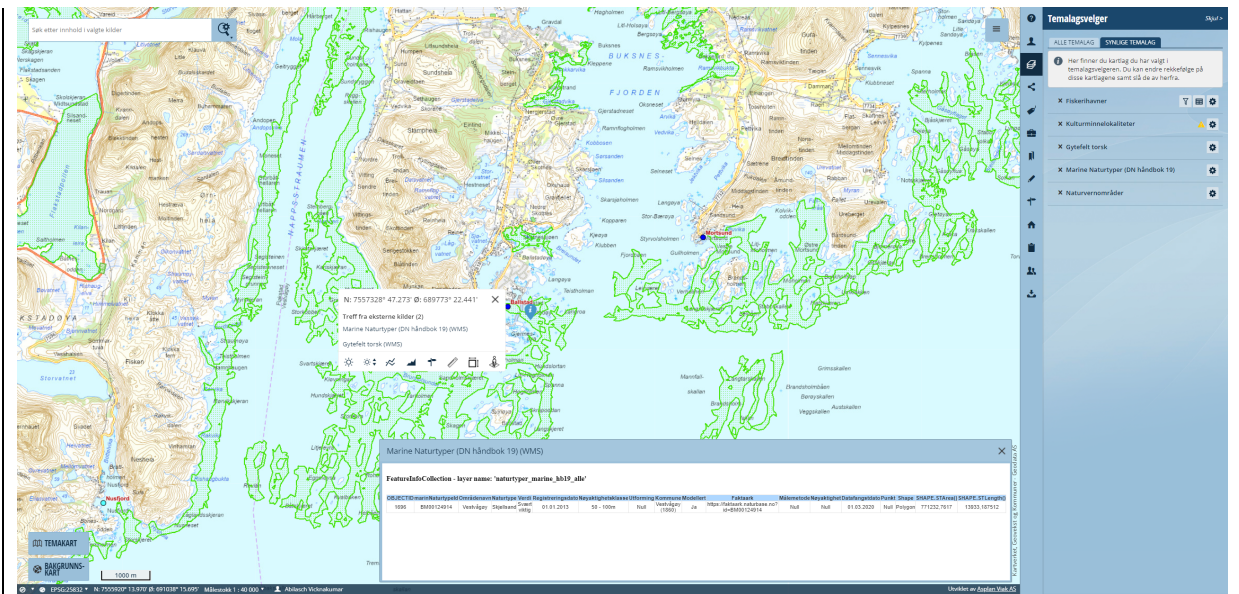


Figure 13 - Kystinfo, with different filters activated, and a full description of finds.

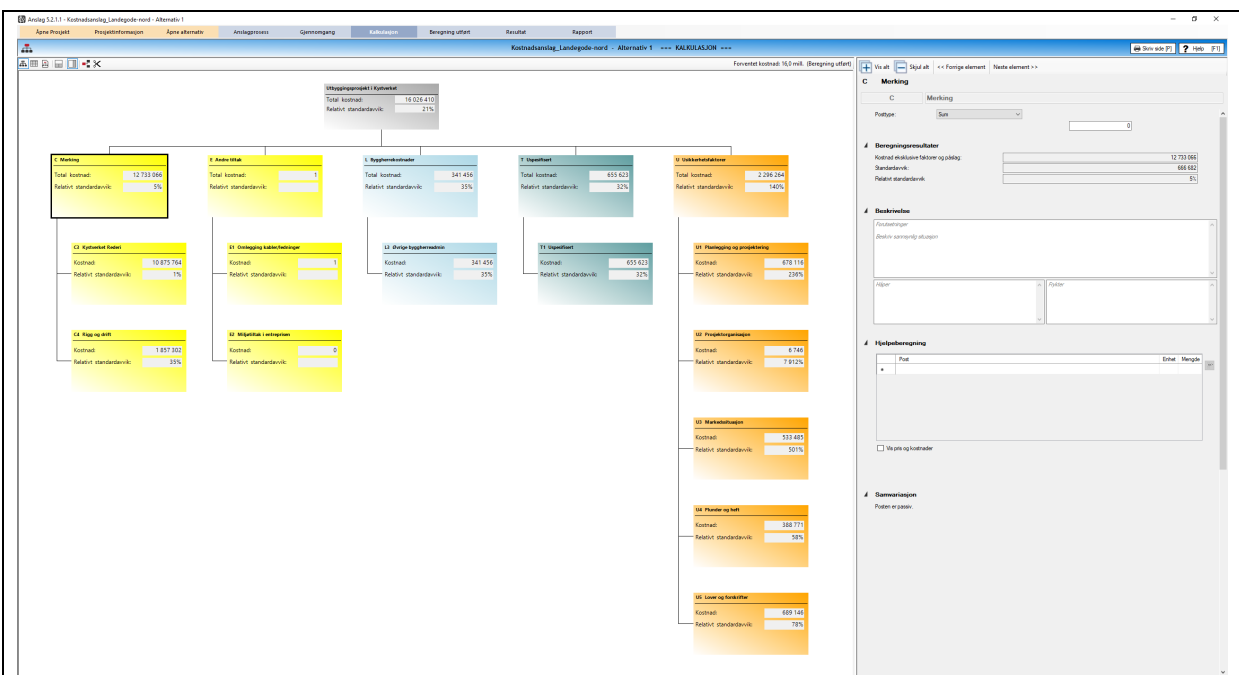


Figure 14 - Anslag 5.2.1, showing a calculus tree The Norwegian Coastal Administration use for cost estimating a project and its biggest uncertainty factors.



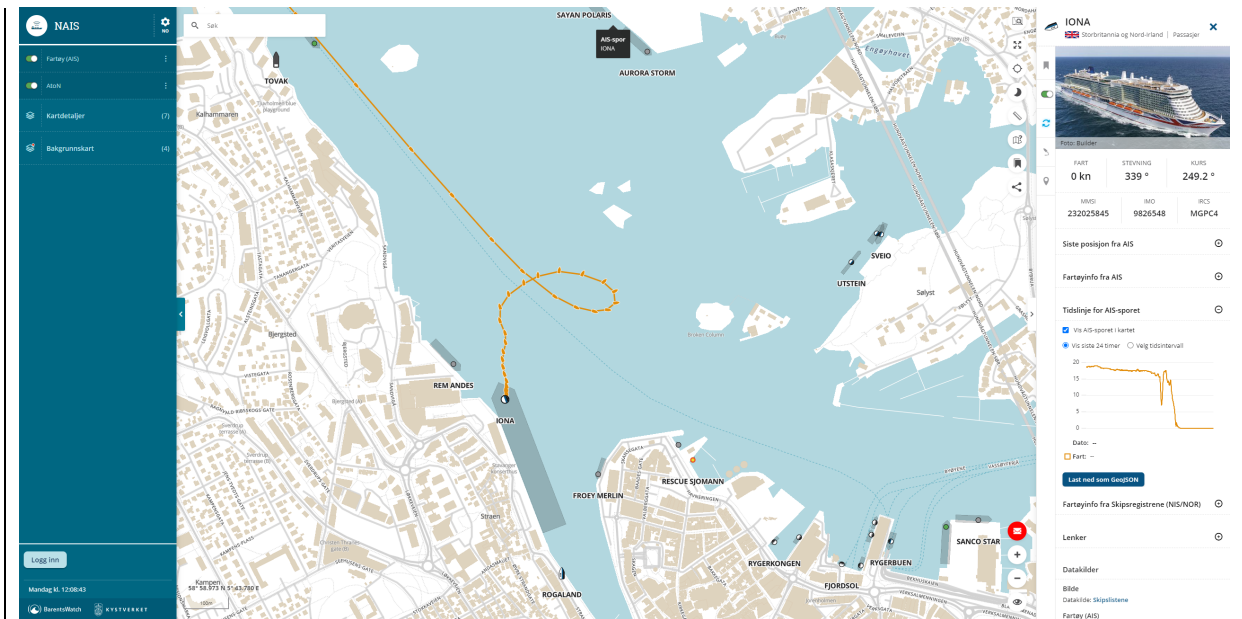


Figure 15 - NAIS obtains data from the Norwegian Coastal Administration's land- and satellite-based AIS network and from offshore installations.

```

if (len(trafikk) > 0) & (len(trafikk) != 100_000): # Hvis den er 100_000 lang, så har Kystdatahuset croppet outputen, og vi må forkorte den per år.
    self.har_funnet_trafikk = 1

else:
    print("Kan ikke hente trafikk for hele perioden, prøver å hente ett år av gangen")
    trafikk = gpd.GeoDataFrame()
    delkjøringsår = sluttår
    while delkjøringsår >= startår:
        print(f"Prøver hente for {delkjøringsår}")
        trafikk_del = hent_ais_fra_polygon(polygon = bufret_område.at[0, 'geometry'],
            starttime = f'{delkjøringsår}-01-01',
            endtime = f'{delkjøringsår + 1}-01-01') # +1 siden vi vil ha med hele året
        delkjøringsår = delkjøringsår - 1

        if len(trafikk_del) > 0:
            trafikk = trafikk.append(trafikk_del)
        else:
            print(f"Klarte ikke hente for {delkjøringsår}")
            delkjøringsår = 0 # Bryter while-loopen, klarer ikke hente for ett år av gangen
            trafikk = pd.DataFrame() # Sletter trafikk, siden den ikke klarte hente for ett år. Vi må ha full dataserie.

if len(trafikk) == 0:
    print("Kan ikke hente trafikk ett år av gangen, prøver en måned av gangen. Dette kan ta lang tid.")
    sluttår_datetide = datetime.datetime.fromisoformat(f'{sluttår + 1}-01-01')
    deltid = sluttår_datetide
    trafikk = gpd.GeoDataFrame()
    while deltid.year >= startår:
        print(f"Henter ut for de 30 dagene før {deltid}")
        start_delstreng = str(deltid - datetime.datetime.timedelta(days=30)).split(' ')[0]
        slutt_delstreng = str(deltid).split(' ')[0]
        trafikk_del = hent_ais_fra_polygon(polygon = bufret_område.at[0, 'geometry'],
            starttime = start_delstreng,
            endtime = slutt_delstreng)
        deltid = deltid - datetime.datetime.timedelta(days=30)
        trafikk = trafikk.append(trafikk_del)
        if len(trafikk_del) == 0:
            print("Klarte ikke hente ut for denne månedene")

```

Figure 16 - Python Script made by Menon in order to collect information from harbors.

Table 6 - Factors to be facilitated in order to get a successful implementation of Lean and digitalization at The Norwegian Coastal Administration (NCA).

<b>Factor</b>	<b>Description</b>
<b>Leadership commitment and support</b>	Senior leaders at NCA must be committed to the implementation of Lean and digitalization and provide the necessary resources and support to ensure its success.
<b>Employee involvement and engagement</b>	Employees must be involved in the implementation process and engaged in the continuous improvement of operations. This includes providing training and development opportunities for employees to build the necessary skills and knowledge for Lean and digitalization.
<b>Clear communication and change management</b>	Clear communication about the purpose and benefits of Lean and digitalization must be provided to all employees to gain their buy-in and support. Effective change management processes must be implemented to ensure a smooth transition to the new ways of working.
<b>Continuous improvement culture</b>	A continuous improvement culture must be fostered at NCA to encourage employees to identify and address areas for improvement using Lean and digitalization tools and methodologies.
<b>Integrated technology and data management systems</b>	Lean and digitalization require integrated technology and data management systems to enable the collection, analysis, and dissemination of data. NCA must invest in the necessary technology infrastructure to support Lean and digitalization initiatives.

## **9.2 RQ2: What are the experiences of employees and management at The Norwegian Coastal Administration Development Department in implementing Lean methodologies, and how can digitalization be used to address challenges and improve efficiency?**

It has been made clear that Lean is a methodology, while digitization of Lean implies the use of digital tools to make work more efficient. Through the literature study, it was highlighted that there are synergies between these. In this sub-chapter, it will be discussed how these synergies come about, as revealed in both the literature and the interviews.

Lean and digitalization are often used interchangeably as both aim to improve efficiency, reduce waste, and increase value for customers. Lean focuses on the elimination of waste, the standardization of processes, and the continuous improvement of operations, while digitalization involves the use of technology to automate processes, collect data, and provide real-time information.

Pre COVID-19 it was a valid attempt in implementing Lean through coursing and implementation. There were table meetings in the mornings and discussion before going to their own offices. These table meeting was according to the interviewees done in a common room with space for a lot of people. After Covid-19 struck, and people were forced into their homes, the meetings died out and the board collected dust. After two years of remote working, the pressure loosened from the leaders in the department. By bringing in digital tools in addition to an improvement methodology, you can get a visualization that helps you avoid variation in work. Participants in the meeting can also gain a better understanding of the design and thus find the most optimal solutions.

At the Norwegian Coastal Administration Development Department, Lean and digitalization have been combined to improve the efficiency and effectiveness of operations. One example is the implementation of a digital platform for the management of navigational aids along the Norwegian coast. This platform provides real-time data on the status of navigational aids, enabling more efficient maintenance and repair processes. The platform also allows for remote monitoring and control of navigational aids, reducing the need for on-site visits and improving safety for employees.

The Norwegian Coastal Administration is constantly looking for ways to digitize processes, as they know from experience that it is better to tackle processes rather than the solution itself.

Here, interviewees believe that the focus should be more holistic, where they prepare their processes to have the best possible solution.

It has been said by everyone that we still have a long way to go when it comes to implementing the Lean methodology in all employees and building a good knowledge base for both management and employees. On the other hand, we are making progress in our digital lives every day. The tools we have enable us to make better decisions, which helps us choose the best solutions. However, as the Norwegian Coastal Administration is a public administration, implementing Lean is more challenging than it is for private actors. To achieve successful implementation and coordination with digitalization, it is important for employees to understand Lean and its principles and how they can positively influence work processes.

Another example is the implementation of a Lean digitalization program to improve the management of coastal data. This program aimed to streamline the collection, processing, and dissemination of coastal data, improving the accuracy and timeliness of information for stakeholders. The program involved the redesign of processes, the implementation of digital tools, and the use of Lean principles to continuously improve operations.

So, in order to answer the research question, it is important to establish a culture of improvement from management down to all employees. This focus will contribute to employees and management wanting to address the solution in the best possible way, rather than getting lost in processes. Successful implementation of a fixed improvement culture can lead to improved communication and opportunities to identify defects in processes and improve them. However, the Norwegian Coastal Agency may be a little behind on the Lean side, but they are actively seeking opportunities to digitize processes. In any case, I would like to emphasize the importance of good communication and involving planning. This means that users of software and processing are actively involved in addressing defects and problems to arrive at an effective solution.

### **9.3 Challenges with Lean**

The literature study uncovered that the implementation of Lean and Involving Planning (IP) encounters challenges, especially in the initial phase. Difficulties arise in understanding why it pays off to use Lean rather than other strategies, as the gains are hardly visible, and things often take more time than usual. This applies especially at the planning level.

One of the bigger challenges when implementing Lean, or improvement kata like that which is talked about in Toyota's way of thinking, is that the construction industry is process-based, making it difficult to transfer to a project-based industry. Much of this has to do with the fact that the kata often focuses on improving repetitive processes, which can be hard to find in the construction industry. An example of this is that they look at processes that run in the same way repeatedly to recognize different areas of development or potential for improvement, without it going beyond costs, resources, time, etc. When trying to implement this in project-based processes, and looking for repetitive processes that can be improved, there are fewer repetitive things to pick up, making it more difficult to implement.

One can again try to transfer the thinking to project-driven business, but it is again difficult to find processes that can be streamlined or developed in an unpredictable environment. That said, it is important to know that we are not talking about a simple technique that is used over and over in a short period with which to work, but a way of thinking and a way of being that must define how to think about processes in a way that will enable ways to improve them.

Wanting to become a Lean company in relation to a company that actively uses Lean goes down on an individual level. To be able to implement Lean, the entire company must be receptive to changes in the way they both think and react. It is particularly important that the governing body in the organization has a well-integrated understanding of Lean and good prior knowledge of this methodology. It is not easily achieved, as it requires involvement from the entire structure. This is one of several themes that are addressed in the books *The Machine That Changed the World* and *Toyota Kata*, which are among the first two books to mention the term Lean.

Other challenges linked to Lean are the maturity of the employees; the employees must be ready to accept a new way of thinking, which can often encounter difficulties, as not everyone is ready for this. Digitization linked to Lean will also encounter what DigiLean AS refers to as digital maturity; their advice is, as mentioned earlier, for managers and decision-makers to work on this so-called digital maturity within the industry.

#### **9.4 Experiences with Lean**

After discussing the topics that include Lean and digitization with team leaders and other employees at the Norwegian Coastal Administration, we can see that it is largely a difficult method to implement in a public administration, especially in an administration that has an extensive customer register. By this, we mean that the Norwegian Coastal Administration

delivers its services as a state agency to counties, municipalities, users of the action area, right down to the individual fishers. It is not just one customer that must be satisfied, but an entire society with different needs. The biggest challenge the Coastal Administration faces when implementing Lean is understanding which principles within Lean can be used in public administration, as we have a broad societal mission that makes it difficult to measure the quality of what we do.

Attempts have been made to hold Lean meetings and provide employees with courses, but this was before a reorganization and a pandemic. This has not been followed up after COVID-19, and thus has been lost from everyday working life. This is a sign that the introduction of Lean and its follow-up must come from management. According to all interviewees, it is essential that a successful implementation of Lean at the Norwegian Coastal Administration must come from management commitment. This is because the employees want to acquire as much knowledge as possible about the area, the various processes, and the results these can offer the company. A commitment from management in a public administration such as the Norwegian Coastal Administration will set the standard for the degree of use and follow-up of the Lean methodology at the company.

The Norwegian Coastal Agency is constantly looking to streamline its work and digitize work processes to make them easier for employees to carry out. This is also evidenced by Einar Vik Aarset taking over the position as Coastal Director, where he quickly established a digitization staff to meet the challenges we face today and explore opportunities for digitization.

At the Coastal Administration's Development Department, we can see that some employees have received training in this, but there is still a long way to go before this can be implemented as an everyday working method in our project. Employees need to see what benefits and positive changes can take place with a new and improved process that will quickly change the way they work. It is also important for the management, who want such commitment, to be able to show the various principles and what effects these selected principles have for the company. As the Norwegian Coastal Administration is a public administration, the situation is also different. As it is often difficult to determine who the customer is, and the use of contractors is also a contributor to the entire process from planning to handover being Lean-based, complications can always arise. As they also work along the entire coast and must deal with other legal arrangements such as nature conservation and other similar protections, it is also limited when they can work on various projects and whom

they can use for the various projects, as the Norwegian Coastal Agency is a public administration and there are other rules for whom they can use as subcontractors to carry out our work along the coast.

## **9.5 Digitalization of Lean**

The background for this subchapter is based on DigiLean AS, the company behind the software platform called DigiLean. DigiLean AS offers its services as a Software-as-a-Service (SaaS), and its customers were primarily those with more or less established Lean cultures and practices. The platform is not industry-specific, but flexible enough to be implemented in construction, banking and finance, manufacturing, and more.

There are several Lean tools available today, and as mentioned, whiteboard meetings are often used. Post-It notes are one of the most common, while close follow-up of activities is another. By digitizing these tools, it will be possible to take advantage of them everywhere on the construction site. The information will be available not only in the rooms where the boards are located, but also where the people are. In the technological world we now find ourselves in, usually only a smartphone/tablet and an internet connection are needed. This contributes to better interaction among users.

Traditionally, analogue whiteboards or Excel are usually used, which simply do not work well enough to collaborate in, or which are not easily accessible or visible outside the workplace. Digital Lean tools help make it easier to set up boards, manage one's own tasks and activities, in addition to registering deviations in the same platform. This information will then be available to everyone on digital devices such as mobile phones, tablets, or computers.

By using digital tools that help digitize Lean, the managers get a better insight into projects through status visualization, progress, and risk factors. Employees get a better visual presentation of their activities and the team's focus areas, which can also contribute to reducing unnecessary activities that do not add value to the customer. Deviations and improvements can be handled in the same platform and linked to boards and plans, ensuring follow-up and implementation, and taking integrated Lean tools into use in the platform.

Feedback from employees at The Norwegian Coastal Administration suggests that many companies describe themselves as lean, but they don't necessarily do so directly. This suggests that the lean methodology itself requires more effort than originally thought. Lean techniques themselves are not actively employed but are often implemented indirectly through

digital tools. This indicates that digital tools are often the preferred route and often seen as a natural place to start.

In addition to all this, there are also scenarios where digital maturity is a factor. Although many companies have a need to digitize, or have benefited greatly from it, digital is often the last tool in the series of prerequisites for an efficient company. The alpha and omega are culture and processes that must be present, and if the employees are not motivated or mature enough to use any kind of digital tools, then this will not work for them. According to the DigiLean AS, their advice for managers and decision-makers is to work with this so-called digital maturity. This means that a company may already be Lean, but not want to digitize. In other cases, Lean is already well established in the company's management, and from there the road is short to establishing digital Lean tools. It often happens that companies have their own IT systems which must be retained, so it is therefore important that any digital Lean solutions could be integrated into existing systems.



## Chapter 10: Conclusion

Using a literature study and tree interviews, an attempt has been made to map the challenges and experiences that arise from implementing Lean in the construction industry, as well as digitizing Lean within the Norwegian Coastal Administration. Since the assignment is very open-ended, the concluding chapter will summarize the discussion of the main issue. The answers provided are naturally based on the results of the literature study and interviews, as well as the case study mentioned in the thesis. Finally, a conclusion on the issue will be specified.

It has been demonstrated that the Lean methodology, which is used for planning, can be effective over a long period of time, but only if one has sufficient knowledge of how to use it. The precise mechanisms and strategies of Lean are still unclear, as it represents a philosophical and cultural shift away from traditional planning and project management approaches. As such, it is crucial to establish a clear definition of Lean that is tailored to the specific needs of a company before attempting to implement it. It is also important to recognize that Lean is a process that requires ongoing effort, as the benefits of its implementation may not be immediately apparent. However, numerous studies have demonstrated that the implementation of Lean can lead to significant improvements in time, cost, efficiency, and waste reduction.

The digitization of Lean is a relatively new way of using the Lean methodology. Today, physical presence is usually the norm during meetings and planning. However, due to an improvement culture that has been implemented in various companies, they are becoming digital instruments used to a large extent. As there has been a pandemic that has contributed to a larger increase in digital tools in the form of planning, engineering, modeling, and digitization of the meeting structure. An example of this is BIM (Building Information Modeling), which helps to streamline visualization and collaboration and Microsoft Teams that makes the distance between relevant people smaller and a quite developed software for the business meetings. But the lack in presence in user meeting in different harbors leads to down prioritizing measures to be planned. This is because the people who decides the importance (government) does not attend the meetings that the Norwegian Coastal Administration does, and that is one key factor for several of measures being down prioritized.

Lean is a relatively new concept in the construction industry, but the way of thinking has been around for quite some time. Today, more and more companies envision becoming as Lean as possible. Therefore, one can conclude that Lean is a philosophy and methodology that is here to stay. In production-based companies, especially manufacturers, more people realize that the methodology used by the car manufacturer Toyota in its factories is superb. They put more and more time and resources into copying or improving their method.

Although Lean is a novel idea in the construction sector, the underlying principles have existed for some time. Nowadays, a growing number of firms aspire to become as Lean as they can be. This indicates that Lean is a philosophy and technique that is expected to remain relevant. In production-focused organizations, particularly manufacturers, the approach employed by Toyota in its factories is seen as exceptional. Hence, more and more resources and effort are being devoted to replicating or enhancing this technique.

It requires a lot of time, expertise, and resources to get to grips with Lean, and then to be able to conclude that you are a Lean company. However, with the increase in companies that want to adopt Lean, the number of people who can continue learning it further is also increasing with time.

With the steadily increasing number of companies making it a legal requirement to conduct their building plans according to lean principles, the impression arises that it is very important to adapt to this. It is also common to digitize the entire process as much as possible. This improves the planning structure and helps eliminate errors and challenges early. Early detection and planning of issues can help reduce the so-called "7 Wastes". Moving some lean tools to digital also seems very important in order to streamline the processes and reduce the costs in planning and implementing av measure.

This is the information in rough outline that has been appropriated to answer the problem: "What are the challenges and experiences in trying to implement Lean in The Norwegian Coastal Administration Development Department, and what are the opportunities for lean digitization?" It is understood that there are several challenges involved in the implementation of Lean and the digitization of Lean. These challenges emerge as premises in the discussion chapter. It is also felt that the biggest challenge is a lack of experience and knowledge of the methods and that such a revolution must come from higher up in the hierarchy of a public administration. The literature indicates that there are more opportunities in the implementation than challenges, but these principles must be demonstrated in a project-based

workplace where there are several processes without a specific customer to satisfy. Lean and digitization of Lean will be tools and philosophies in future construction projects but will generally take longer to implement in a public administration as there is a much greater hierarchy, and the pressure around a public administration is less than with a private actor.

### **10.1 Recommendation for further work**

Lean is a tool and methodology that will continue to evolve and grow. There is a strong desire to go lean among various companies, and in addition to pointing out previous projects where lean was used with tangible results, it contributes to increasing competition among them.

These days, there is also an opportunity to improve today's technical tools used in the construction industry. Digital tools are used to simplify project work, and with continued optimization of these tools, I believe digital tools will become mainstream in a few years. As of today, using and deploying digital tools in projects presents some complications. However, with proper follow-up, proper routines, and proper training, these can contribute to an optimized final product for interested companies.

Additionally, it is imperative to address both the general and digital maturity of the company's workforce. As more and more companies strive to be the best in the market, employees must follow this trend. It is important that the organization's employees are mature enough to embrace change and practice a culture of continuous improvement. This applies not only to smaller positions, but also to management positions responsible for facilitating and following up on this. This will lead to increased follow-up and broader implementation of a culture of improvement.

Another key point in order to implement Lean in a public administration is to involve the leaders in the department and getting them involved in Lean and Lean management. This will allow the benefits shown in courses and result shown in the principles to be relayed further down the chain, all the way to the employees. With good communication, continuously improving working strategies, acquiring more knowledge around Lean and documenting the effects and results, the opportunity is there for Lean to be implemented in the public administration, but this will take some time and prioritization from the management at the Norwegian Coastal Administration.

After establishing a culture of improvement high up in the management, the next step is to extend it to the development department of the Coastal Agency. The development department consists of several teams that work closely together to achieve the best possible results when

implementing a project, right from the moment the need arises until the measure has been completed. An implementation of Lean is probably only successful if the implementation process is initiated simultaneously in the various working groups that belong to the development department of the Coastal Administration. For the three groups (investigation, planning, and implementation), it is particularly important that they are implemented at the same time, as these groups continuously work closely together to carry out a measure - a completed technical project. These three working groups can be considered as three integrated parts of a work process towards completing a measure. The groups must make arrangements for the group that will take over the project after their work on a measure has been completed. This is to avoid mistakes in the work and delays.

At the departmental level, it is recommended to establish a group of Lean ambassadors, where the implementation process starts simultaneously in all workgroups. This Lean group will consist of certified Lean navigators, who will work practically with the implementation of Lean, in addition to specializing in their work group at the Norwegian Coastal Administration. In their tasks, they must focus on important principles such as flow in work processes, collaboration across groups and departments, subjects and areas of responsibility, and successful communication between employees.

Implementation of Lean and digitalization in public administration can be a complex process, and there are several recommendations that can contribute to a successful implementation. Here are some further recommendations for implementing Lean and digitalization in public administration:

1. **Start with a thorough analysis of the work processes:** A thorough analysis of the work processes can help to uncover inefficiencies and waste that can be eliminated through Lean and digitalization. Such an analysis can also provide a better understanding of how digitalization can contribute to improving work processes.
2. **Involve employees:** Employees who work with the work processes daily can provide valuable input and ideas for improvement. Involving employees can also help to create a culture of continuous improvement and learning.
3. **Start with simple projects:** It may be wise to start with simple projects that can provide quick wins and contribute to building trust and engagement among employees and leaders.

4. **Build a culture of change:** Implementation of Lean and digitalization requires a change process, and it is important to build a culture of change where all employees are involved and engaged in the process.
5. **Have a clear strategy and objective:** A clear strategy and objective can help to ensure that the implementation of Lean and digitalization is in line with the organization's overall goals and vision.
6. **Ensure competence development:** Implementation of Lean and digitalization requires competence development among employees and leaders. It is important to offer training and education so that everyone can actively participate in the improvement process.
7. **Continuously evaluate and adjust:** Evaluation and adjustment of the implementation are important to ensure that desired results are achieved and that adjustments can be made if necessary.

Overall, it is important to have a holistic approach to the implementation of Lean and digitalization in public administration. It requires a change process that involves all employees and leaders and considers the organization's goals and values. By following the recommendations above, one can contribute to creating a culture of continuous improvement and learning that can increase efficiency and productivity in the organization.

## **10.2 How to adapt the Lean Methodology to the Norwegian collaboration model?**

Adapting the Lean methodology to the Norwegian collaboration model requires a careful consideration of the unique characteristics of the model. The Norwegian collaboration model is built on a culture of trust and cooperation, where stakeholders work together towards a common goal. This contrasts with the traditional adversarial approach to construction, where each stakeholder works towards their own interests.

To adapt Lean to the Norwegian collaboration model, it is important to focus on communication and collaboration between stakeholders. This includes involving all stakeholders in the planning and design phases of the project and encouraging open and honest communication throughout the project lifecycle.

Another important aspect is to focus on continuous improvement and the elimination of waste. This can be achieved by encouraging stakeholders to identify areas of improvement and to implement changes that increase efficiency and reduce waste.

Adapting the lean methodology to the Norwegian collaboration model can be done in several ways. An important adaptation is to include participation and collaboration between employers and employees in the improvement process. This can be achieved by actively involving employees in the improvement process and giving them responsibility for identifying and eliminating waste and inefficiency in work processes.

Finally, it is important to emphasize the importance of data and metrics in the Lean methodology. By tracking performance metrics such as cycle time and defect rates, stakeholders can identify areas for improvement and measure the effectiveness of changes made.

In summary, adapting the Lean methodology to the Norwegian collaboration model requires a focus on communication, collaboration, continuous improvement, and the use of data and metrics to drive decision-making. Adapting the lean methodology to the Norwegian collaboration model is about including participation and collaboration, focusing on values and culture, and considering Norwegian legislation and agreements. This can help create a culture of continuous improvement and learning that is in line with the Norwegian collaboration model and that can contribute to increased productivity and efficiency in the organization.

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# Appendix

## Appendix 1

### Interview guide

#### Background and Purpose

My name is Abilasch Vicknakumar, and I am currently studying in the last semester of the master's program in Industrial Economics at UiS (University of Stavanger), specializing in Project Management and Risk Management. The purpose of my master's thesis is to map the challenges and experiences in the Coastal Administration and parts of the construction industry in general by implementing Lean and digitization to increase the efficiency of work related to various processes within a project. As this task is a natural collaboration with the Norwegian Coastal Administration, I have selected interviewees in various phases of the project to hear different versions of how Lean can influence a project and simplify current work tasks.

#### The breakdown of the interview guide

The interview guide has been divided into three parts:

1. Information about the interview and its implementation.
2. General questions for the interview subject and the subject's personal relationship to Lean and digitalization.
3. In-depth questions related to Lean and digitization of Lean.

#### Conducting the Interview:

The interview guide, along with associated questions, will be sent out to relevant interviewees in advance so that they will have an opportunity to review the questions and prepare for the interview.

It would be desirable to conduct the interviews via Microsoft Teams or in person if the location is suitable, but other suggestions are also welcome. It is intended to make audio recordings of the interviews. If you suspect that someone does not want this, please inform them.

The answers given during the interview will be used, along with appropriate documents and literature, to find out about current challenges and experiences with Lean and digitization in construction projects that the Norwegian Coastal Administration investigates, plans, and executes along the Norwegian coast. The interviewees' reactions, utterances, and statements will be kept anonymous unless otherwise agreed upon.

If any of the content is unclear during the interviews, I encourage you to ask for clarification.

### **Questions Background:**

1. How many years of experience do you have in the construction industry?
2. Have you previously worked with the Lean philosophy/construction? If so, for how long?
3. What is your role in the project you are currently working on?
4. How are your attitudes related to the use of Lean at the Coastal Administration and the subcontractors they use?
  - a. *Will it actually be used?*
  - b. *Is the level of knowledge about Lean high enough among most people?*
5. How do you envision the actual development using Lean Construction?
6. Which digital tools do you use today?
  - a. *Does it make work more efficient? If so, in what way? And if not, how do you think you can achieve the best possible outcome with the tool?*
7. How would you describe the meeting structure in your team? Is it daily, weekly, or monthly?
8. What are your opinions about the imposed implementation strategy that stipulates that the contractor must make use of Lean Construction?

## Lean

*“Lean construction is a project delivery process that uses Lean methods of maximizing stakeholder value while reducing waste by emphasizing collaboration between teams on a project. The goal of Lean construction is to increase productivity, profits, and innovation in the industry.” (“Lean Construction | Lean Construction Institute”)*

1. Based on previous or ongoing projects in which you have been involved, do you feel that the Lean philosophy is being utilized?
2. Are methods within the Lean framework being used in the project you are currently working on? a. What advantages/challenges has this led to? b. Has this method made the project more efficient? If so, in what way?
3. Have you received any form of training or taken courses in Lean through your employer?
4. Since there are external Lean consultants who specialize in efficiency improvement methods and the like, would you recommend that companies bring them in during planning and engineering? If so, why?
5. What arguments would you like to present as the success factors for a successful implementation of the Lean philosophy in a company?
6. What do you think are the biggest barriers to overcome for a successful implementation of Lean Construction in a company?
7. What advantages do you think Lean Construction offers the construction industry?
8. The word waste is a key element linked to the Lean methodology, but what does it mean to you? a. What is your understanding of waste in the construction industry?
  - i. *Time*
  - ii. *Inventory*
  - iii. *Defects*
  - iv. *Overproduction*
  - v. *Waste of talent*
  - vi. *Transportation*
  - vii. *Motion*

## Synergies:

1. What impact do you think management commitment will have on the practical use of Lean and digitalization?
2. How are Lean methods used in conjunction with digitalization?
3. Is Lean used as a tool without digitization?
  - a. *Are digitization principles used without Lean?*
4. How do you see the possibility of streamlining planning with the implementation of Lean and digitalization?
  - a. *Are final decisions made more quickly?*
  - b. *Are decisions easier to make?*
  - c. *What are other advantages/disadvantages?*
5. In previous or ongoing projects, have you experienced improvements/advantages under the keywords resulting from the use of Lean methodology and digitalization?

These include:

  - a. *Visualization*
  - b. *Cooperation*
  - c. *Early involvement of actors (involvement of actors with knowledge of costs and materials should be done early in the design phase to limit errors and changes)*
  - d. *Reduction of inventory (materials).*

## Appendix 2

Result from Python Script for Andenes get implemented into an Excel file, down under are examples of statistic that can be collected through the script.

Lengdegruppe	Fiskefartøy	Andre servicefartøy	Passasjerbåt/Roro	Passasjerbåt	Stykkods-/Roro-skip	Øvrige
0-30	2806	756	0	169	0	992
30-70	714	51	0	5	91	19
70-100	0	0	621	0	2	14
Missing	3203	10	0	0	0	130

Figure 17 - Berth based on size

Lengdegruppe	Fiskefartøy	Andre servicefartøy	Passasjerbåt/Roro	Passasjerbåt	Stykkods-/Roro-skip	Øvrige
0-30	174	14	0	2	0	24
30-70	12	5	0	1	9	4
70-100	0	0	1	0	1	3
Missing	11	1	0	0	0	6

Figure 18 - Calls based on unique ships

year	Fiskefartøy	Andre servicefartøy	Passasjerbåt/Roro	Passasjerbåt	Stykkods-/Roro-skip	Øvrige	Ukjent
2016	7150	659	400	113	59	961	436
2017	7539	339	397	191	77	1003	450
2018	7402	393	390	55	56	1001	855
2019	7993	443	402	228	57	964	1860
2020	9567	406	265	121	79	562	1911
2021	24003	761	649	10	121	1323	22453
2022	33723	797	621	308	93	1155	12362

Figure 19 - Arrivals based on Year

month	Fiskefartøy	Andre servicefartøy	Passasjerbåt/Roro	Passasjerbåt	Stykkods-/Roro-skip	Øvrige	Ukjent
Januar	1827	46,14285714	0	5,285714286	5,857142857	133,4285714	509,5714286
Februar	2270	41,57142857	0	13,85714286	10,57142857	145,4285714	721,4285714
Mars	1928	43	0	3,571428571	14,71428571	102,4285714	556
April	1166,714286	47,71428571	0	4,571428571	6,428571429	50,85714286	189
Mai	1069,857143	70,28571429	43,42857143	4,571428571	4,714285714	76	381,5714286
Juni	633,5714286	44,57142857	116,2857143	12,28571429	6,285714286	100,4285714	619,5714286
Juli	201,8571429	39,14285714	145,1428571	39,14285714	2,857142857	178,2857143	508,1428571
August	798,4285714	55,14285714	129,5714286	31,85714286	6,571428571	110	443,4285714
September	825,2857143	50,14285714	11,85714286	11,71428571	4,857142857	56,28571429	426,2857143
Oktober	1015	43,57142857	0	16	5,428571429	25,71428571	642,1428571
November	970	29,28571429	0	1,428571429	4,714285714	10,57142857	410,4285714
Desember	1205,285714	32	0	2,285714286	4,428571429	6,142857143	353,4285714

Figure 20 - Arrivals based on month

year	1-10	10-15	15-30	30-50	50-70	70+
2016	0,171779141	0,425108484	0,387550501	0,010474338	0,001197067	0,003890468
2017	0,192764353	0,489872887	0,299064115	0,0142478	0,001815896	0,002234949
2018	0,212584081	0,512471973	0,267516816	0,00588565	0,00154148	0
2019	0,202869113	0,423384537	0,359527739	0,012568237	0,001650375	0
2020	0,056947368	0,618526316	0,316210526	0,007473684	0,000842105	0
2021	0,05105973	0,563918908	0,37882215	0,005152048	0,001047164	0
2022	0,150167254	0,524455293	0,321248832	0,003736853	0,000391767	0

Figure 21 - Fishing vessel length groups

