

Syed Hamza Tariq Bukhari

# Effect of early contractor involvement in statens vegvesen projects

A study of Early Contractor Involvement in Norwegian Public Roads Projects

Master's thesis in Master of Science in Engineering in Project Management

Supervisor: Ole Jonny Klakegg

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Norwegian University of Science and Technology

Faculty of Engineering

Department of Civil and Environmental Engineering



Norwegian University of  
Science and Technology





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**Statens vegvesen**  
Norwegian Public Roads  
Administration

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## Preface

This masters thesis is written as the final part of the degree Masters of Science in Engineering in Project Management. The masters programme is a part of department of Industrial Economics and Technology Management and Department of Civil and Environmental Engineering.

The thesis constitutes 30 credit hours and this report accounts for 100% of them. The thesis was started in January of 2021 and was supposed to be finished around June-July 2021. Due to the conditions regarding the Covid-19 pandemic it was not possible to carry out a proper study. Hence the thesis was extended for another semester from August 2021 to February 2022.

The thesis would not have been possible without the support, advice and motivation from my supervisor Ole Jonny Klakegg. I am extremely grateful that you have supported me throughout this journey filled with uncertainties and giving me another chance to write this report. I would also like to especially thank my co-supervisor, Paulos Wondimu Abebe from the Norwegian Public Roads Administration. Your friendly nature and useful advice was a great source of help for me and without you it would have been impossible to carry out the interviews.

I will give a special thanks to my employer, Aker Solutions for giving me the opportunity to work on my thesis while being an employee and giving me the necessary support when needed. A special thanks also goes to all of my friends who gave me useful advice.

Last but not the least I would like to thank my family especially my mother and my sister. Your constant support and help made me what I am today and you have stood beside me like a rock in demanding times. Without you none of this would have been possible.

*This paper is carried out as a part of the education at the Norwegian University of Science and Technology and is therefore approved as a part of this education. However, this does not imply that the University answers for the methods that are used or the conclusions that are drawn.*

Trondheim, February 2022

Syed Hamza Tariq Bukhari

## Abstract

Public infrastructure projects are of peak importance to the society. They serve as the basic building blocks of a society and should be carried out with utmost care. Public projects go through a certain process which is aimed towards transparency and efficient use of resources.

Early Contractor Involvement is a new method that is aimed towards incorporating contractor's knowledge earlier in the project to make a better design. This attempt is made to find out a better use of resources. The world is becoming increasingly environmentally conscious and governments are taking measures to bring down the emissions and reduce waste. One of the most intensive use of human and other physical resources are the construction projects which serve the public. Early contractor involvement has been popular in the recent decade. It has also been extensively researched these days owing to its claimed benefits, lower costs and better relationships to name a few. This thesis attempts to find the effect of this new method in public projects set up in the Norwegian road sector.

The effects found out as a result of this study are:

- *Lower costs:* Both of the projects have exhibited significantly lower costs. Nydalsbrua project was made possible by ECI because the initial estimate was over approved budget.
- *Better risk management:* More time to work with project and negotiation rounds lead to increased assessment of risk.
- *Better relationships:* As the parties had the opportunity to work before execution they had better understanding of each other.
- *Increased trust among the stakeholders:* More time spent working in the design phase lead to increased trust among the stakeholders.
- *Better management of construction activities:* The contractor had more time to work on and review the work hence there was an improvement in the construction plan.
- *Reduction in conflicts:* ECI helped with enhancing trust and mutual understanding among the stakeholders which lead to a reduction in potential conflicts.
- *Improved quality:* The quality of design has been improved (more efficient and cheaper than expected). The effect on quality of work is not known as it is too early to judge the quality of work.

# Contents

<b>List of Figures</b>	<b>vii</b>
<b>List of Tables</b>	<b>vii</b>
<b>1 Introduction</b>	<b>1</b>
1.1 The cost of development . . . . .	1
1.2 Transportation industry and emissions . . . . .	1
1.3 Need for sustainable and efficient transport . . . . .	4
1.3.1 A brief history of Transportation Systems . . . . .	4
1.3.2 Rise in Population and transportation . . . . .	4
1.3.3 Rationale for Sustainable Transportation Systems . . . . .	6
1.3.4 Why study Early Contractor Involvement? . . . . .	7
1.3.5 Optimaltid and delimiting . . . . .	7
1.3.6 Research Question and purpose of this master's thesis . . . . .	8
1.3.7 Problem statement and research questions . . . . .	8
1.3.8 Information about the projects . . . . .	9
<b>2 Methodology</b>	<b>12</b>
2.1 Research Question . . . . .	12
2.2 Literature Review . . . . .	14
2.3 Selection of Literature Review method . . . . .	15
2.3.1 Systematic Literature Review . . . . .	15
2.3.2 Scoping Literature Review . . . . .	15
2.3.3 Selecting the method . . . . .	15
2.4 Collection of Data . . . . .	16
2.4.1 Preparing the interview guide . . . . .	16
2.4.2 Projects selected for the study . . . . .	17
2.4.3 Analyzing the interviews . . . . .	17
2.5 Challenges . . . . .	18
2.5.1 Challenges with collection of Data . . . . .	18



<b>3</b>	<b>Theory</b>	<b>20</b>
3.1	Keywords used and description of results obtained from Google scholar . . . . .	20
3.2	Constructability . . . . .	21
3.3	Early Contractor Involvement . . . . .	28
3.3.1	Drawbacks of the Traditional Method . . . . .	28
3.3.2	What is Early Contractor Involvement? . . . . .	30
3.4	Success and effects of Early Contractor Involvement . . . . .	37
3.4.1	Cost Savings . . . . .	38
3.4.2	Time Savings . . . . .	39
3.4.3	Better relationships . . . . .	41
3.4.4	Risk management . . . . .	41
3.4.5	Innovation . . . . .	42
3.4.6	Project control . . . . .	42
3.4.7	Change management . . . . .	43
3.5	Technical terms used in the interviews . . . . .	43
<b>4</b>	<b>Discussion</b>	<b>45</b>
4.1	Summarized interpretation of results . . . . .	45
4.2	Detailed interpretation of results . . . . .	46
4.2.1	Previous experiences with ECI . . . . .	46
4.2.2	Type of ECI in the projects . . . . .	46
4.2.3	ECI and Cost . . . . .	48
4.2.4	ECI and Risk Management . . . . .	49
4.2.5	ECI and Trust and Relationships among stakeholders . . . . .	50
4.2.6	ECI and time . . . . .	50
4.2.7	ECI and conflicts among stakeholders . . . . .	51
4.2.8	ECI and constructability . . . . .	51
4.2.9	ECI and quality of work . . . . .	52
4.2.10	ECI and Pre-qualification of contractors . . . . .	52
4.2.11	ECI and planning . . . . .	53
<b>5</b>	<b>Conclusion</b>	<b>54</b>
5.1	Overall experience with ECI . . . . .	54

5.2	Recommendations for future practitioners . . . . .	56
5.3	Limitations . . . . .	57
5.4	Suggestions for further research . . . . .	57
	<b>References</b>	<b>58</b>
<b>6</b>	<b>Appendix A</b>	<b>62</b>
6.1	Interview Guide for the client (Norwegian Public Roads Administration) . . . . .	62
6.2	Interview Guide for the contractor . . . . .	65
<b>7</b>	<b>Appendix B</b>	<b>69</b>
7.1	Interview 1 . . . . .	69
7.2	Interview 2 . . . . .	71
7.3	Interview 3 . . . . .	74
7.4	Interview 4 . . . . .	77
7.5	Interview 5 . . . . .	80

## List of Figures

1.1	Greenhouse Gas emissions by the Economic Sector (U. S. E. P. Agency, 2018) . . . .	2
1.2	Greenhouse Gas Emissions by the transportation sector in the recent years (E. E. Agency, 2017) . . . . .	3
1.3	Greenhouse gases in the EU by different modes of transportation (E. E. Agency, 2017)	3
1.4	Evolution in transportation modes since the 18th century (Rodrigue, 2020) . . . . .	4
1.5	Historical and projected world population (Gapminder & UNPD, 2019) . . . . .	5
1.6	A comparison of space taken by buses vs cars (“Bus & Coach - Smart Move . The new environmental champs.” 2019) . . . . .	6
1.7	E6 Fjerdingen–Grøndalselv (Vegvesen, 2021b) . . . . .	10
1.8	Rv706 Nydalsbrua project (Vegvesen, 2021a) . . . . .	11
2.1	How to write a research question (Bouchrika, 2020) . . . . .	12
3.1	Impact of constructability for the Contractor (Garcia, 2009) . . . . .	23
3.2	Impact of Constructability on the owner (Garcia, 2009) . . . . .	23
3.3	Stage of constructability analysis (Arditi et al., 2002) . . . . .	24
3.4	Factors that effect constructability (Arditi et al., 2002) . . . . .	25
3.5	Constraints that hinder constructability (Arditi et al., 2002) . . . . .	26
3.6	Benefits of constructability for design firm (Arditi et al., 2002) . . . . .	27
3.7	The cost-quality and time ‘Iron Triangle’(Walker & Lloyd-Walker, 2012) . . . . .	29
3.8	The ECI model adapted from the decision gate model (Walker & Lloyd-Walker, 2012)	32
3.9	The Phase Gate model (Daly, 2020) . . . . .	33
3.10	Various ECI Approaches in the Norwegian Transport sector (Wondimu, Hosseini, et al., 2016) . . . . .	34
3.11	Advantages and trade offs between interweaving and parallelization- (Lenferink et al., 2012) . . . . .	36
3.12	Benefits of Early Contractor Involvement according to different studies (Laryea & Watermeyer, 2016) . . . . .	37
3.13	Relationship between uncertainty and information available in a project (Samset & Volden, 2016) . . . . .	38
3.14	Relationship between cost and flexibility of making changes in a project with time (Samset & Volden, 2016) . . . . .	39

4.1	Traditional method of project delivery . . . . .	47
4.2	Illustration of early contractor involvement in projects under study . . . . .	48

## List of Tables

7.1	Interview #1 . . . . .	69
7.2	Interview #2 . . . . .	72
7.3	Interview #3 . . . . .	75
7.4	Interview #4 . . . . .	77
7.5	Interview #5 . . . . .	81

# 1 Introduction

Due to the industrial revolution and advances in science and technology, the world has changed much rapidly as it did a few centuries back. Massive development has been seen since the industrial revolution (Mullen, 2009). When machines were created and involved instead of manual labour, slowly every aspect of life has been mechanized in one way or the other. On top of that, creation of the internet has accelerated progress even more by bringing the world closer together. Information is no longer hidden and anything can be accessed with one click.

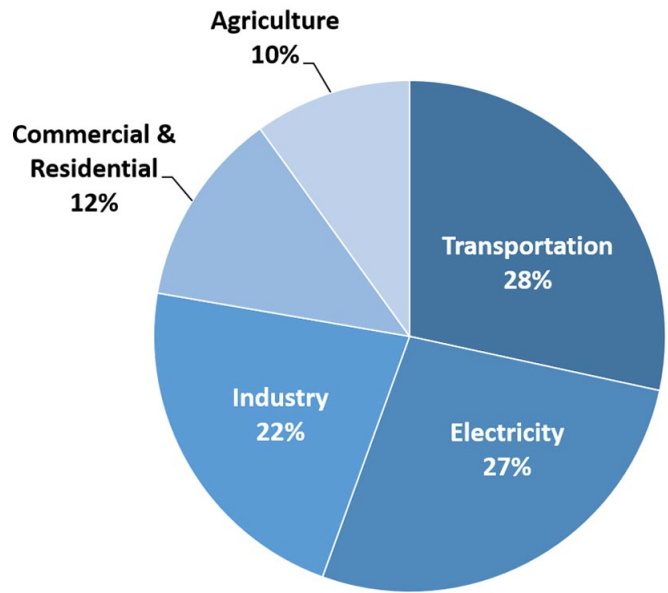
## 1.1 The cost of development

This development comes at a cost i.e. a rapid use of resources. Development in the past 200 years has been much more as compared to e.g. 1400s to 1600s. Credit goes to the industrial revolution (Mullen, 2009). As countries began to expand they used up more and more resources without paying attention to the side effects (This can be debatable but it is out of the scope of this thesis). Resources such as oil, wood and coal etc. which are necessary for construction and development of infrastructure. With this development the standard of life also increased which demanded even more resources. This does not mean that humans did not discover the devastating effects of climate change late enough to realize that it was too late to change anything. The greenhouse effect was discovered by a Swedish Scientist Svante Arrhenius in 1896 (Weart, 2012). Hence, it was known well in advance that burning fossil fuel is not good for the environment and will lead to an increase in temperature of the planet.

## 1.2 Transportation industry and emissions

Transportation sector is the largest producer of greenhouse gases in 2018, according to the US EPA, having a share of 28,2% (U. S. E. P. Agency, 2018). This is shown in the figure 1,1 below.

## Total U.S. Greenhouse Gas Emissions by Economic Sector in 2018



U.S. Environmental Protection Agency (2020). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018

Figure 1.1: Greenhouse Gas emissions by the Economic Sector (U. S. E. P. Agency, 2018)

Europe presents a somewhat similar scenario, where transportation accounted for 27% of the green gases in 2017 (E. E. Agency, 2017). Greenhouse gas emissions in the past years due to the transportation sector are shown in the figure 1,2. (PTO)

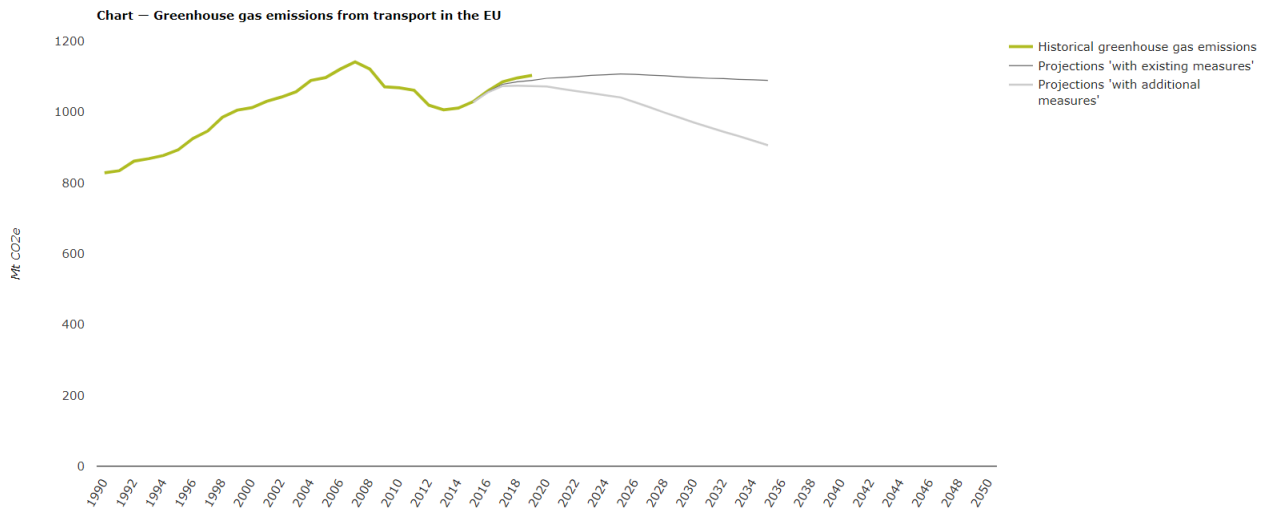


Figure 1.2: Greenhouse Gas Emissions by the transportation sector in the recent years (E. E. Agency, 2017)

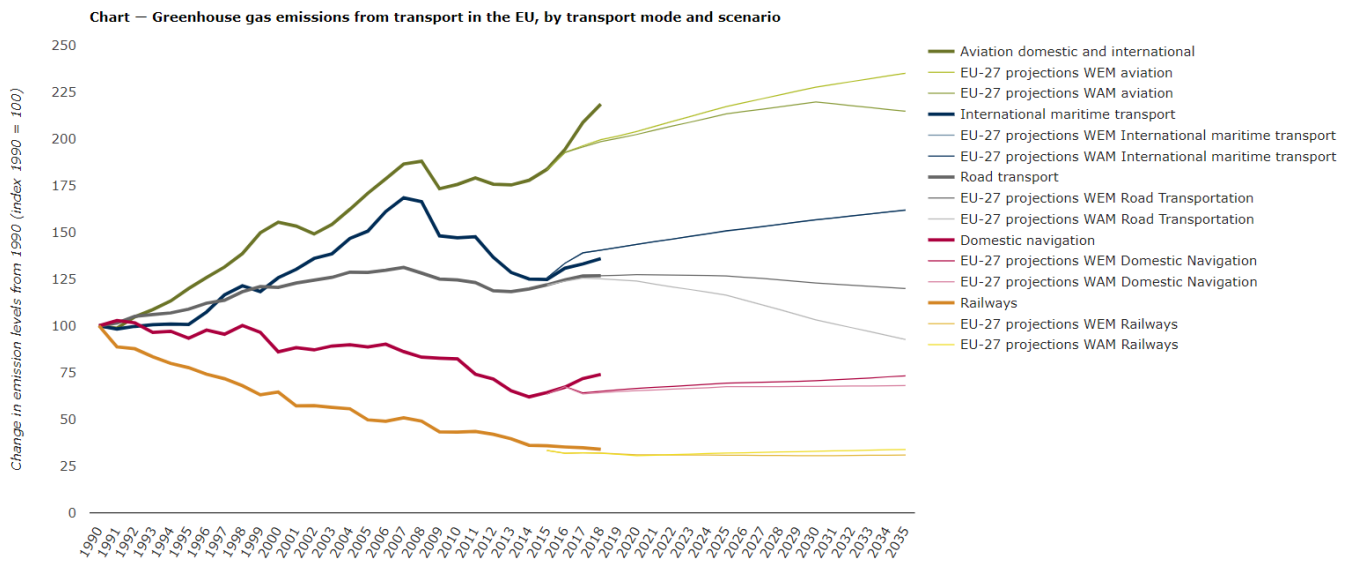


Figure 1.3: Greenhouse gases in the EU by different modes of transportation (E. E. Agency, 2017)

It is evident why transportation produces the highest amount of greenhouse gases, as it is one of the most, if not the most essential part of our society. People and resources need transportation

infrastructure in order to move from one place to the other. Being the highest contributor, it is obvious that this will be the first place to start if one wants to reduce the greenhouse gases.

### 1.3 Need for sustainable and efficient transport

#### 1.3.1 A brief history of Transportation Systems

Human beings have used different modes of transportation throughout history. Before the invention of machinery (e.g. combustion engines), humans used animals for land transport and ships for water. As engines were invented and employed, transportation became more rapid and efficient. A brief history of the evolution of transportation systems since the 18th century is shown in the figure 1,4 below.

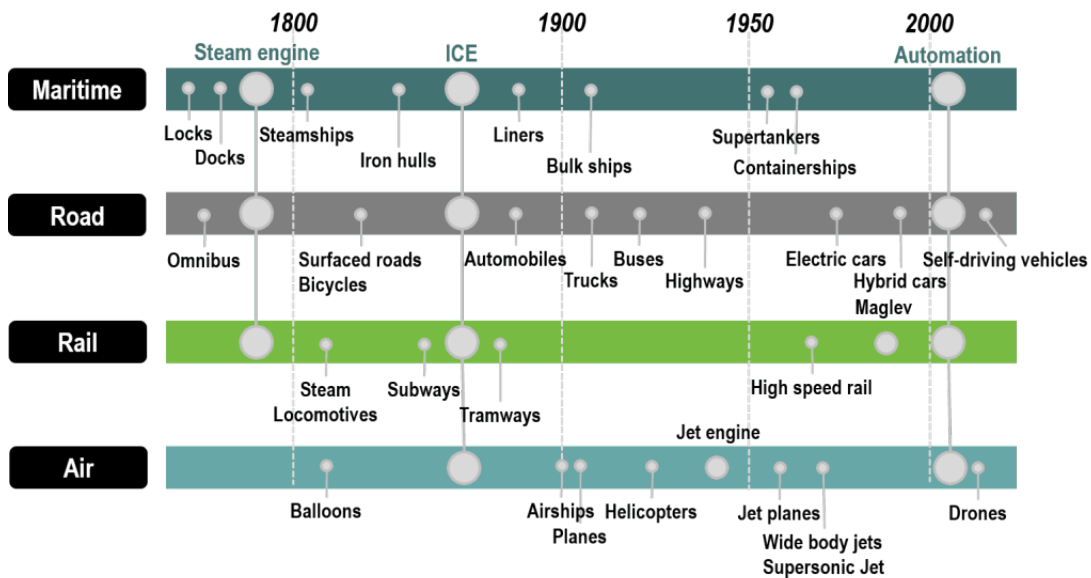


Figure 1.4: Evolution in transportation modes since the 18th century (Rodrigue, 2020)

#### 1.3.2 Rise in Population and transportation

As advances were made in the modes of transport, population was, and still is growing at a high rate. It is expected that the world population will exceed 10 billion in 2060 compared to the current population of 7.65 billion. Following picture 1,5 demonstrates the increase in world population.



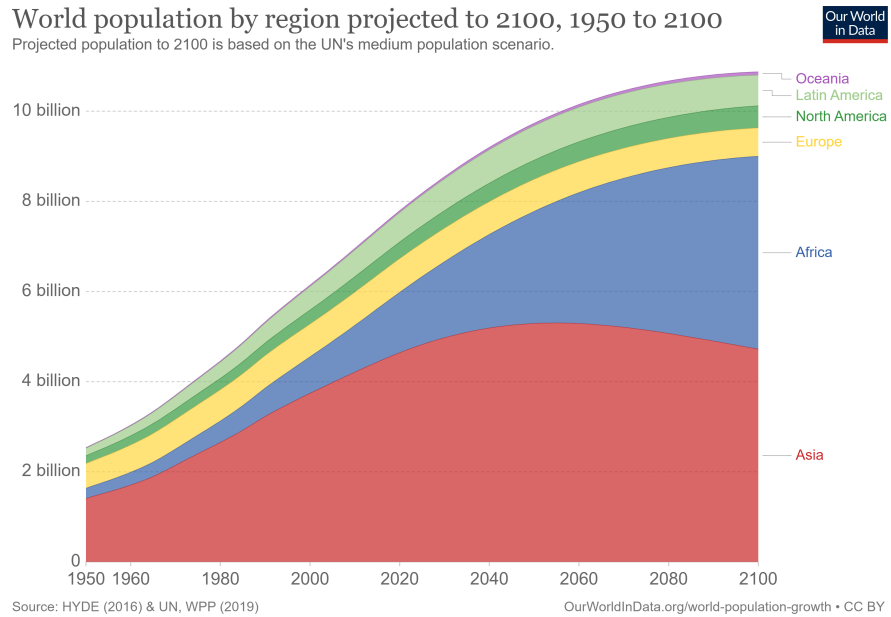


Figure 1.5: Historical and projected world population (Gapminder & UNPD, 2019)

This increase in population also means that there will be a high demand for transportation infrastructure which is efficient, especially in the developing countries and countries with rapidly increasing population. Not all people can afford to have their own car. As population rises it will be next to impossible to accommodate every car on the road since there is a threshold to which roads can be widened. An efficient method is to make public transport cheap and effective. This way, more people would have the incentive to use it. When someone buys a car, it is not just the initial cost of buying the car but also the maintenance costs that are incurred repeatedly. Collective transportation modes like buses and trains are more efficient and take up less space on the road which is demonstrated in the figure 1,6 below.

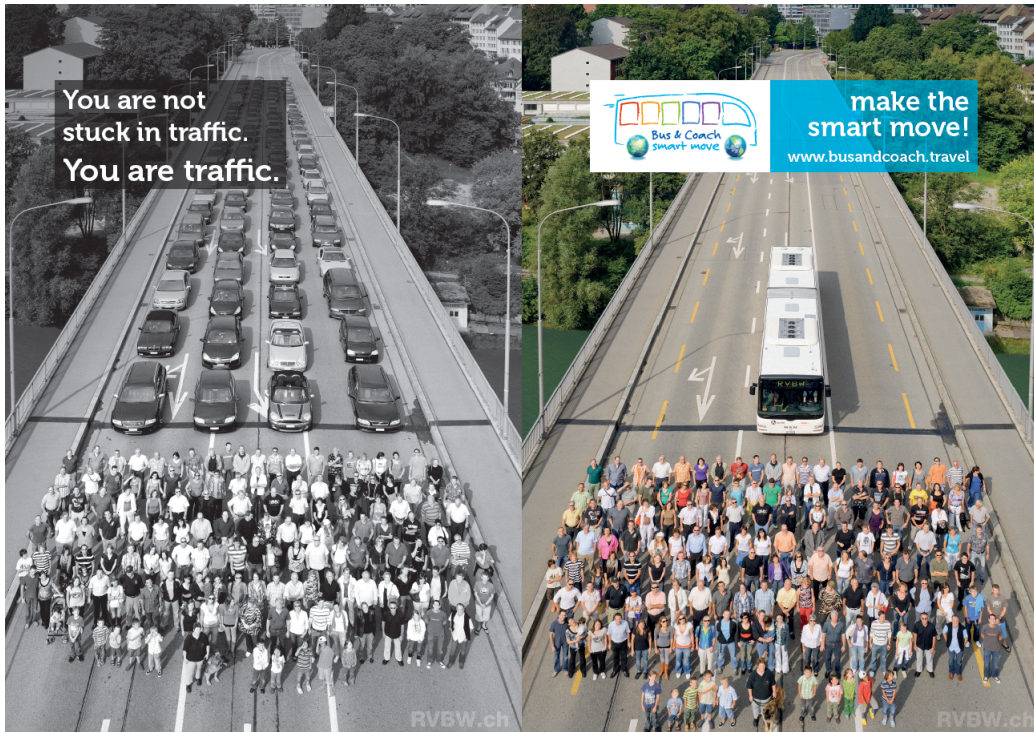


Figure 1.6: A comparison of space taken by buses vs cars (“Bus & Coach - Smart Move . The new environmental champs.” 2019)

Fewer cars on the road means lesser traffic. Which leads to shorter travel times and lesser fuel consumption.

### 1.3.3 Rationale for Sustainable Transportation Systems

A good place to start would be making sure that the future transportation projects are built on the basis that they are actually needed and have a positive contribution to the society that outweighs the environmental impacts in some way. Not because of the reason that resources must be spent somewhere and transportation projects look good on paper or produce good PR for the politicians. This is the domain in which this master’s thesis aims to contribute to. As seen in the literature review done in (Bukhari, 2020) public infrastructure projects are often overestimated in benefits and underestimated in costs with something called as *strategic underestimation of costs* (Andersen et al., 2016). It was also revealed through a study of transport infrastructure projects by (Flyvbjerg, 2009) that famous transportation projects ,e.g. the Channel tunnel were sold as highly beneficial to the end user with predictable cost escalations. The real picture was much different with a cost escalation of 80% over the specified budget. Post evaluation of the project revealed

that the British economy would be better without the construction of this project. This speaks volumes in terms of priorities of decision makers. Before even talking about the environmental impact the main question should be the misuse of resources. (Flyvbjerg, 2009) Also emphasizes that developed countries can get away with such failures but projects like these can have a heavy impact on developing countries.

#### **1.3.4 Why study Early Contractor Involvement?**

Why go through all the hassle and study this new method of public procurement? This is an important question that needs to be answered. The traditional method of project delivery focuses heavily on selecting the lowest bid. It does not incorporate the contractor's knowledge in the design phase. In order to apply a new method it should be thoroughly studied and observed. It should be evaluated in different settings and frameworks to give the full picture. As explained in Chapter 3, several different studies are presented from different countries which give a broad overview of how this method is being studied in different settings. A look on the concept of constructability also gives an interesting outlook on how the benefits of involving the contractor were realized much earlier but applied on a broader scale at a much later stage.

#### **1.3.5 Optimaltid and delimiting**

Apart from the much needed environmental benefits of efficient and effective transport, correct allocation of resources is also an important issue which needs to be addressed. This is where the project Optimaltid comes into play. Optimaltid (Optimal Time in English) is a project carried out by NTNU, Statens Vegvesen (The Norwegian Public Roads Administration) and several other companies. The project will run from 2020 to 2024. The objective of this project is establishing what is the optimal time to involve the contractor in public transportation infrastructure projects. The master's thesis although draws inspiration from Optimaltid should be treated as a separate entity. This master's thesis is being carried out in collaboration with Statens Vegvesen (The Norwegian Public Roads Administration, hereby referred to as NPRA).

At first the thesis meant to explore the possibility of a benchmark that could measure the success of ECI but as described in Chapter 2, certain hurdles made it difficult. Therefore, the problem statement was changed.

Being a broad topic, it is important to delimit the scope of this study such that definitive answers can be delivered at the end. The problem statement as written below is accompanied by some

research questions. This will help with setting up boundaries and defining scope.

### **1.3.6 Research Question and purpose of this master's thesis**

The problem statement has been changed owing to the past experiences which were caused due to the situation with COVID-19. This is further explained in the methodology chapter.

Early Contractor Involvement is a relatively new method of project delivery. The main purpose of this method is to involve the contractor's competence earlier in the project. The contractor has better experience with the execution phase than the client and the consultant, hence their input earlier in the project can be useful for the project (Song et al., 2009).

Being a new method, it has various interpretations. Definitions of ECI can vary based on company, location and the type of project at hand. It also means that some methods that are considered ECI can have different names. An example of this is that ECI can also have the name *pre-construction services* (Finnie et al., 2021). Another example can be (Wondimu, Hosseini, et al., 2016). Here 12 approaches of early contractor involvement are described. It should be kept in mind that these approaches were identified by a study carried out only in Norwegian public infrastructure projects. This tells about the scope of how differently this approach can be applied.

This masters thesis is not trying to make any kind of standard nor set a benchmark when it comes to the topic of Early Contractor Involvement. What it is trying to do is to study the effect of Early Contractor Involvement in a specific framework. The framework being transportation projects carried out under the administration of NPRA.

Carrying out research in the said framework would get results that are applicable in that certain framework. While a literature review will help in understanding the ECI from a broader point of view, a study of the said projects would help with bridging the gap between research and the practical field.

### **1.3.7 Problem statement and research questions**

*The problem statement of this thesis is as follows:*

**'Effect of early contractor involvement in statens vegvesen projects'**

*The following research questions can be derived from this problem statement:*

- What kind of information can be gathered by interviewing the project personnel working on ECI projects?

- How useful is that information given that the projects are at such an early stage in their life-cycle?
- What is the extent of knowledge of project personnel working with ECI on these projects?
- A contractor who has taken part in the negotiation process but was not able to win the project. How different is their view from the contractor who won the project?
- What is the extent of tangible and intangible information based on the interviews?

### 1.3.8 Information about the projects

There were two projects chosen for this masters thesis. Both of them involve Early Contractor Involvement of some sort. The two projects are:

- E6 Fjerdingen-Grøndalselv
- Rv. 706 Nydalsbrua med tilknytninger

**E6 Fjerdingen-Grøndalselv** The current road between these 2 towns (Fjerdingen and Grøndalselv) is narrow, has lower capacity, steep curves and the speed limit is not too high. The newer section of the road that is to be built between these towns will be broader with a continuous width of 9 meters, will have a higher speed limit of 90km/h, will subsequently shorten travel time and increase the traffic capacity. (Vegvesen, 2021b). The road map is shown in the figure below (The road is demarcated by the two location tags). PTO

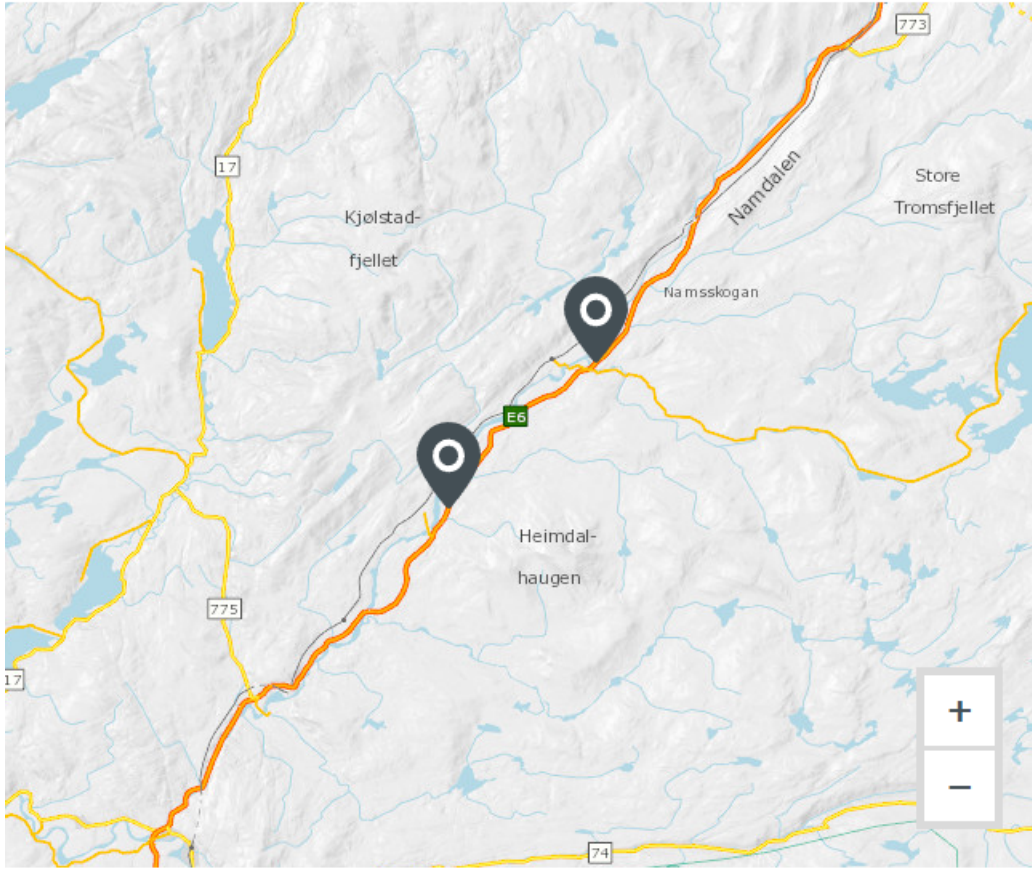


Figure 1.7: E6 Fjerdingselvs-Grøndalselvs (Vegvesen, 2021b)

**Rv. 706 Nydalsbrua med tilknytninger** This project involved a new bridge and tunnel that will facilitate the cyclists and pedestrians. The project is carried out in the vicinity of Trondheim city (Vegvesen, 2021a). The project is funded by the state, municipality and the toll tax. It is part of an environmental initiative carried out by the Trondheim municipality called 'miljøpakken' (the environmental package) (Kommune, n.d.). The bridge is shown in the picture below (orange colored road):

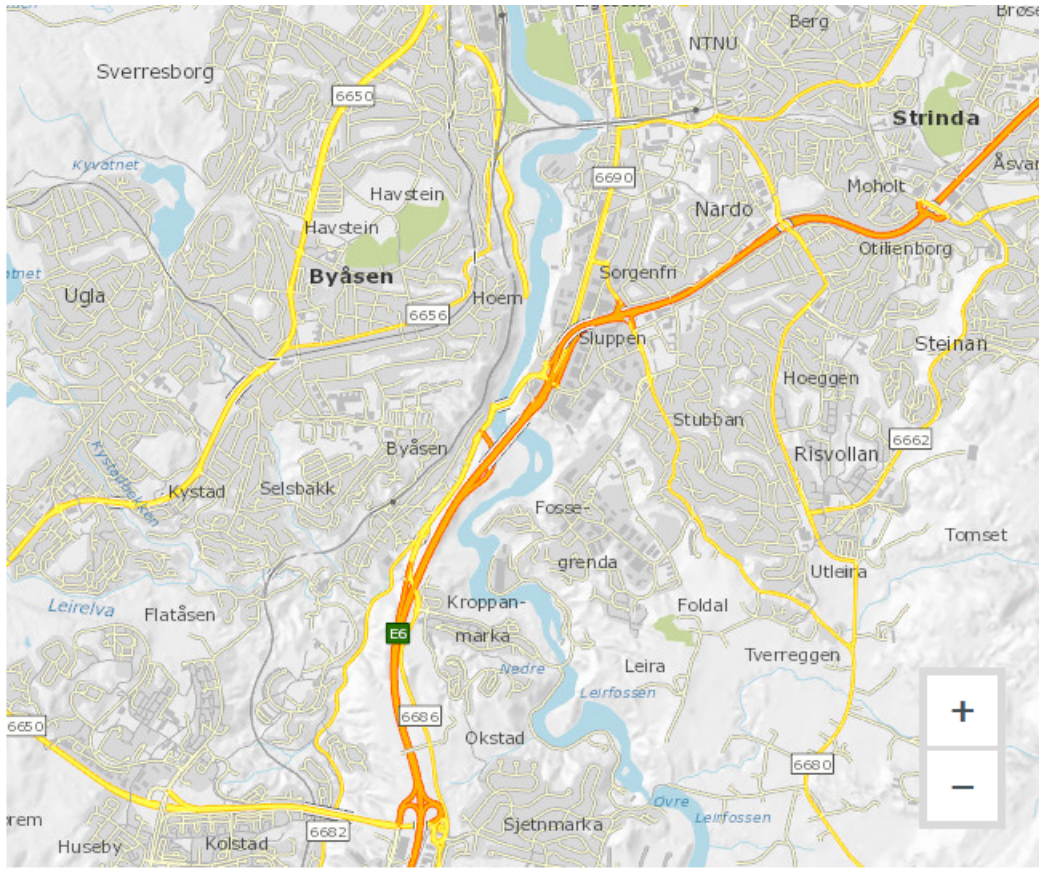


Figure 1.8: Rv706 Nydalsbrua project (Vegvesen, 2021a)

## 2 Methodology

This chapter of the master's thesis shall outline the intended plan of execution. The purpose of writing this chapter is to explain to the reader what approaches were taken to answer the research question. The methodology can be divided into two main parts. Methods used to select and gather information from the projects and the methods used to select the relevant literature. The step by step approach is explained in the paragraphs below. This chapter is of significance in the thesis as it helps with understanding the framework.

### 2.1 Research Question

Research question is the key to a thesis, literature review or any kind of research. As evident by its name it is first and foremost a Question. A question that has been asked as a part of a research. The research question is defined as:

**”A research question is a question that a study or research project aims to answer. This question often addresses an issue or a problem, which, through analysis and interpretation of data, is answered in the study’s conclusion. In most studies, the research question is written so that it outlines various aspects of the study, including the population and variables to be studied and the problem the study addresses. (Bouchrika, 2020)”**

A step by step guide of formulating a research question is shown in the picture below 2.1:



Figure 2.1: How to write a research question (Bouchrika, 2020)

As mentioned earlier, this masters thesis precedes a specialization project (Bukhari, 2020). With



reference to the figure above (Bouchrika, 2020), the specialization project helped with the following steps.

- **Selecting the Topic**

The term 'topic' is very generic and can mean several things but in the context of this thesis topic means the broad topic of study within the field of project management (within the domain of civil engineering). Here the topic chosen is Early Contractor Involvement. Other topics can be cost estimation, conflict management in construction projects and project delivery models etc.

- **Working knowledge of the topic**

Working knowledge is defined as 'A knowledge of how to make something work without any deeper understanding of why it works, or of how to fix it if it breaks.' (Yourdictionary, n.d.). In this context it can be thought of having an idea of Early Contractor Involvement method so that one can understand when it is being implemented. This was achieved in the specialization project. Research papers read for literature review provided the basic information of Early Contractor Involvement method.

- **Working Questions**

The working question is one step behind the actual research question and helps with narrowing down to the actual problem statement. Early Contractor Involvement in itself is a method of project execution, but as described in Chapter 1.3.6 ECI is a huge topic with multiple interpretations. Once again the specialization project helped out with this step. But due to the situation with Covid-19 and the hurdles regarding collection of data, this step had to be repeated again. The cause of change and delay is described further in this chapter.

- **Research Question/s**

The circumstances made it necessary to change the research question from what it was in the start. The specialization project aimed at setting a benchmark by studying non-ECI projects. This was not fully achieved during the autumn semester of 2020 and the result was a literature review along with a potential questionnaire. The masters thesis under discussion set out to answer the same question but this time it faced several hurdles which will be described further. As a result of the hindrances faced, it was felt necessary to extend the thesis to

another semester. The research question was also changed to try out a new approach. Hence work done in the previous semesters did not go to waste but helped in actually narrowing down the question we have right now.

The specialization project (Bukhari, 2020) acted as a mini/trial thesis. The biggest advantage it provided was with the collection of literature and learning how to narrow down the literature that is relevant to our study. The time spent looking for literature was saved as there was already plenty of literature shortlisted for the specialization project. This meant more time to spend on projects and collection of data from projects.

## 2.2 Literature Review

Selecting the method for literature review is the most challenging task. Considering the diversity of topics that come under the problem statement (explained in Chapter 3), it had to be made sure that the plan is followed strictly as it is easy to get stuck in irrelevant literature. Reading tons of research papers is never possible considering every project has a limited time frame. (Keshav, 2007) was of great help in this regard. It introduces a method named as **The Three-pass Approach**. It also explains how to look for more relevant literature based on the papers read and selected. The three-pass approach, as the name suggests has three steps as explained below:

- First pass, which is done to ensure if the literature is relevant or not and gives a general overview
- Second pass, tells about the key points written in the literature and the key concepts explained
- Third pass, done to gain an in depth understanding of the literature

This method was adopted to quickly shortlist the relevant research papers and save time. Many times there are research papers which have titles that seem relevant, when they are read they are totally different. Hence, instead of reading the whole paper it is better to skim through the paper to ensure that the paper is relevant and will add value to the thesis.

The next part described in (Keshav, 2007) explains how to look for further relevant literature. Looking through the common papers in citations of 3-4 research papers helps in getting an overview. It tells what sources the authors used and what authors are the most common in the given field.

## 2.3 Selection of Literature Review method

There is a plethora of literature review methods available. Searching for the term 'types of literature review' gives 975 million hits on google and 10.5 million on Bing. There are various methods of literature review, each with their own advantages and disadvantages. They are divided into different types. The objective of research and the data available. One more factor is that early contractor involvement is a topic open for interpretation and every individual has their own interpretation. The 'right' kind of literature review method in one's opinion might not be the most suitable in the eyes of the other individual. Before kicking off with the literature search, it had to be made sure that a method of literature search is implemented and followed properly.

For the sake of convenience, following sources were looked at and two methods were shortlisted for evaluation (BusinessResearchMethodology, n.d.), (GriffithUni, 2020) and (UniAlabama, 2019). Based on the sheer volume of search results, it was not possible to look through every source on the internet. Following are the two methods that were selected for evaluation.

- Systematic Literature Review
- Scoping Literature Review

### 2.3.1 Systematic Literature Review

Systematic literature review is defined as:

*'Seeks to systematically search for, appraise and synthesize research evidence, often adhering to guidelines on the conduct of a review' (Grant & Booth, 2009)*

### 2.3.2 Scoping Literature Review

On the other hand scoping literature review is defined as:

*'Preliminary assessment of potential size and scope of available research literature. Aims to identify nature and extent of research evidence (usually including ongoing research)' (Grant & Booth, 2009)*

### 2.3.3 Selecting the method

Systematic review is the one that is more suited to this thesis as the aim of the method is to gather scientific knowledge regarding the problem statement. Scoping method on the other hand aims to uncover the extent of knowledge in a given field of research.

## 2.4 Collection of Data

In the original research question, the main intention was to collect data from already finished projects (that did not include ECI) and then introduce the concept of ECI. That was done by creating a questionnaire which was a part of the specialization project. Due to the situations surrounding the pandemic it was not possible to have physical interviews. Hence, the questionnaire was sent out via email to project managers and people who were working on the project. The first downside of this was that certain projects were old and it was difficult getting information about them. The project managers were busy working with ongoing projects hence it was difficult for them to go back to an older project.

The autumn semester presented with much better circumstances and it was much easier to set up interviews with employees working at the Norwegian public roads administration. An interview guide was prepared which contained basic information about the thesis and the questions that were to be asked during the interview. More details are presented in the section below. It is important to mention here that the data collected via interviews is empirical data.

### 2.4.1 Preparing the interview guide

The interview guide was made to serve two purposes; give information to the interviewees about the project, and list the questions that were to be asked in the interviews. The interview guide can be found as attachment in appendix. The interview guide was made keeping the client in mind but later it was decided to also involve the contractor's perspective. Hence the guide was slightly modified to suit the contractor. The main problem statement is given as:

**'Effect of early contractor involvement in statens vegvesen projects'**

The statement above is too wide for an interview. To divide the statement into manageable parts the following sub sections were made (please note that the questions below are different from the research questions stated in Chapter 1. Their purpose is to make the interview guide easier to understand where as the questions in Chapter 1 are supposed to be broader in perspective):

- **How was the contractor involved?**

This part discusses the time, type, method and task of involvement. The purpose is to ask the client and the contractor in detail how the contractor was involved. How were the contractors shortlisted and what tasks were they assigned.

- **What was the effect of said early involvement?**

The next part of the interview would be to ask about the effect that ECI has had so far on the project. It should be noted that the Norwegian Public Roads Administration has recently begun with using ECI as a method of project execution. This means that almost all of the projects that involve ECI are either in the planning or execution phase. Hence the feedback received is based on the how long a specific project has been executed so far. The purpose is to document both positive and negative effects of ECI. It is roughly divided into tangible and intangible effects. But it should also be noted that the tangible effects cannot be reported in the form of numbers because the projects are still ongoing.

- **What could have been done to improve it even further?**

The interviewees would then be asked about any suggested improvements in the method. This also includes asking if a different method would have been more suitable for the project.

#### **2.4.2 Projects selected for the study**

Two projects were selected for the study. These projects are as follows:

- E6 Fjerdingen-Grøndalselv
- Rv. 706 Nydalsbrua med tilknytninger

The projects were selected primarily because they had Early Contractor Involvement and the secondly the project managers and the project team had their office in the Trondheim or near Trondheim. It was therefore much easier to have physical interviews with them. Also, the projects were significant in size and scope. Larger projects with varied scope of work and different stakeholders would give a better picture of the effect of Early Contractor Involvement. A small project with limited scope would not have as much uncertainty and significance.

#### **2.4.3 Analyzing the interviews**

After obtaining the contact information from the co supervisor at the NPRA, the relevant personnel were contacted via email. In that email, an introduction of the candidate was given along with a short description of the masters thesis, request for interview and the questionnaire as an attachment which also contained further information about the thesis. Compared to the response rate in the previous semester the response rate in this semester was exceptionally positive with almost all of the people responding to the emails. After the response a time and date was set for

the interviews. Some of the interviews were carried out digitally but most of them were physical. The interview guide served as a reminder for the important points that had to be discussed. Otherwise the interviews were more like a discussion. The Project Managers were very expressive and gave lots of information regarding their experience. The co-supervisor was also in all but one of the interviews. The co-supervisor asked meaningful questions which helped with gathering even more information. Since the projects were ongoing, the project managers could not give a full account of their experience with ECI and concluding remarks on questions like cost and quality.

The questionnaire and all the written material was written in English but the project managers preferred to speak Norwegian during the interview as they were more comfortable with speaking their mother tongue. The interviews were therefore recorded in Norwegian but all the key information that is to be included and analyzed as a part of this thesis would be translated to English. Initially it was thought to transcribe and translate the interviews in English. However, the interviews lasted more than 1,5 hours. This made it very difficult to translate and transcribe given the time frame that we are in right now. Hence it was decided to only use the important information from the interviews. The author of this thesis is not proficient enough in the language so it would be too time consuming to transcribe all the interviews. The results are presented in the form of a table with questions and their respective answers. Important data which was not a part of the interview guide was noted down separately and has been included in the discussion chapter.

The reason why this approach was chosen was to get the most amount data in the given time frame. The previous experience of collecting data was that collecting data is a very time consuming process. Hence getting the interviews done as soon as possible was the first step. The interviews would need to be translated, analyzed and discussed afterwards which is a time consuming process.

## **2.5 Challenges**

This master's thesis was written in the wake of a pandemic. The world was put on hold and physical activities were minimal. Due to this reason the thesis had to be extended to another semester and the problem statement had to be changed. Since the thesis was carried out in special circumstances it is important to state the challenges faced. Below is a short descriptions of the challenges.

### **2.5.1 Challenges with collection of Data**

Getting data constitutes the most important part of this master's thesis. In a normal setting, it would be easier to meetup physically with the project managers and conduct face to face interviews.

This would give a better chance to interact with the professionals and gather required data. Given the situation, it was difficult to approach relevant project managers. Emails were inefficient and it took a lot of time to gather responses. Emailing someone meant waiting for their reply which can take from one day to seven days or even more and then replying them back. Hence a small conversation of two emails can take two weeks. Often times the project managers referred to someone else in the organization which made the whole process more exhaustive and time consuming. Sometimes no response was received even after two emails.

Originally the plan was to work at NPRA's office in Trondheim and physically meet the project managers who were available, but that was not possible since most of the people were working from home.

As discussed in (Bukhari, 2020) there has been a reorganization in the NPRA. Project managers who had worked on previous projects have been relocated or left NPRA. This was another hindrance in the way of collecting data. There used to be evaluation reports of completed projects which would summarize the whole projects and the challenges faced. They also had the numerical data such as cost. It was informed that NPRA no longer makes evaluation reports for completed projects. An evaluation report would serve as a great source for gathering relevant information and would save a lot of time. The information that could have easily been gathered from a report would now require interviews or going through multiple documents. This also made collection of data time consuming and in the end the approach had to be changed. Instead of looking at older projects attention was turned to undergoing projects which had ECI.

After the approach was changed, a lot of the restrictions were also fortunately lifted. Collecting data became much easier. A combination of physical and digital interviews were carried out.

### 3 Theory

Early contractor involvement is a wide topic. A scientific literature study is important to grab necessary understanding of the topic at hand. It would also help with drawing meaningful conclusions from the interviews. Systematic literature review shall be used for this thesis. The method used to formulate the questionnaire as described in Chapter 2 can also be used to divide the problem statement into small parts which can be easily explained. In this case a different approach will be taken. The problem statement will be divided into smaller parts so that it will be easier to find the literature that corresponds to that specific part. The problem statement can be divided as follows:

- Early Contractor Involvement
- Effect of Early Contractor Involvement

Breaking down the problem statement into small pieces can give valuable information about the theoretical background. This way it is easier to identify the research areas to study. This was inspired by (Keshav, 2007). The main keywords were used to search for literature. Literature that came up as a result of keywords was then used to get even more relevant literature. In the reference list of the literature studied there are multiple sources available. This also gives good grounds for comparison between two research papers. By comparing the reference list it can be found out how similar or dissimilar two research papers of the same topic are.

#### 3.1 Keywords used and description of results obtained from Google scholar

In order to retrieve relevant literature from the sources available, it is important to use the right keywords. Key terms from the problem statement gave a good head-start on how to start the literature search. The concept of constructability as explained in 3.2 is related to Early Contractor Involvement, therefore literature in constructability was also searched. Google scholar was used as the primary search engine for literature search. When the above mentioned keywords were searched, following number of results were achieved.

- Early Contractor Involvement: 149,000 hits
- Pre-Construction services: 20,200 hits
- Constructability analysis: 27,200 hits
- Analysis of constructability: 26,600 hits



- Success and effects of Early Contractor Involvement: 170,000 hits

### 3.2 Constructability

The concept of constructability is relevant to the concept of Early Contractor Involvement. its relevance will be explained further in this section after constructability has been explained.

Compared to construction projects of the past, modern projects have become more and more complex and fragmented (Uhlik & Lores, 1998). Following are the reasons described in (Uhlik & Lores, 1998) which explain why:

- Diversity of materials that can be used for construction.
- Rapid advancements in science and technology meaning it is hard to catch up on the latest technology.
- People with specialized knowledge need the project to be divided in fragments (because a project as a whole has become more complicated) if they wish to apply their methods of execution.
- Different people working on the same project different perspectives. They have different end goals.

When the traditional model is applied to such projects, it leads to delays in schedule and escalations in cost among other inefficiencies (Arditi et al., 2002). A traditional model does not involve the contractor before the design is finalized. That way the contractor's 'perspective' is not incorporated into the design phase. Since the contractor is more focused on the financial aspect of the project i.e. winning the project for the sake of profit, more attention is paid on bidding process than studying the design. This aspect can vary from contractor to contractor and the location where the project is being carried out. That's why the concept of constructability is important. Which is defined in the next paragraph.

Constructability is defined by the Construction Industry Institute (CII) as follows:

**"The optimal use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives."** (CII, 1986)

Constructability can also be defined as:

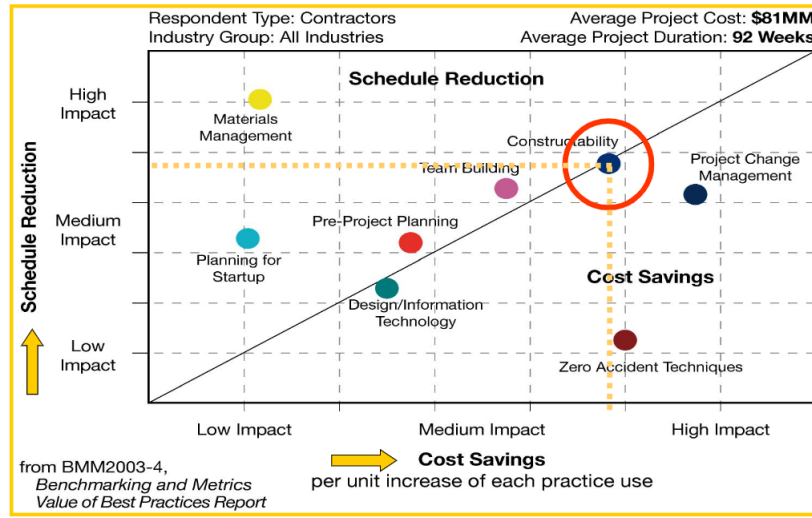
**”Constructability is a project management technique for reviewing the whole construction process before commencing with project implementation. Constructability reviews will reduce or prevent design errors, delays, and over expenditure by identifying potential obstacles to construction.”** (Thirion, 2019)

Another definition of constructability from literature is given as:

**”Constructability programs aim at integrating engineering, construction, and operation knowledge and experience to better achieve project objectives.”** (Arditi et al., 2002)

Constructability is an important concept behind the idea of Early Contractor Involvement. As explained later in chapter 3.3, the main reason for adopting Early Contractor Involvement is to incorporate the contractor’s knowledge in earlier phase of the project. It can be said that the two terms have the same meaning i.e. incorporating contractor’s knowledge for a better project. They are used in different contexts. Early Contractor Involvement is more of a project execution method which has a broader spectrum. Meanwhile, constructability deals with how contractor’s knowledge is used in the design/planning phases of the project. It can be confusing to differentiate between the two, but the most simple explanation is to think of ECI as much broader than constructability. The concept of constructability was introduced by the Construction Industry Institute in 1986 (CII, 1986). This explains the reason why almost all of the research conducted on constructability can be found after the 1980s. The following graph 3,1 and 3,2 shows the benefits of constructability for the owner and the contractor.

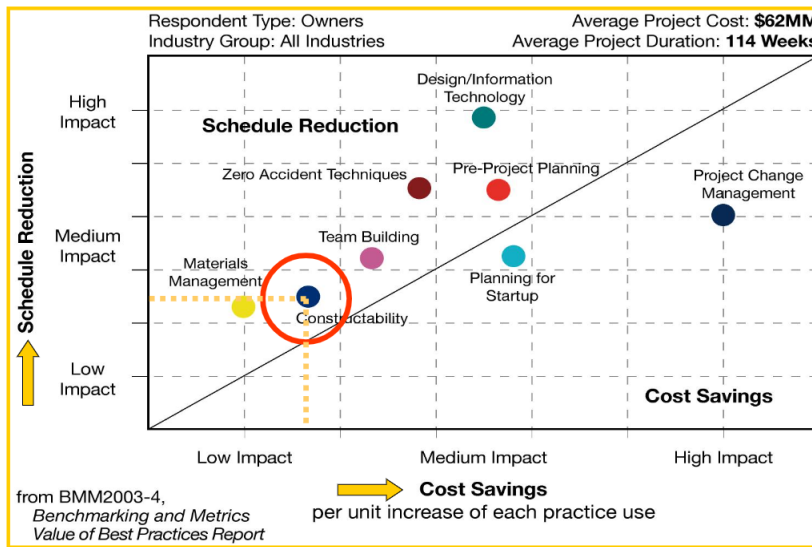
**Figure 1-2 Contractor Benefit of Practice Use**



91

Figure 3.1: Impact of constructability for the Contractor (Garcia, 2009)

**Figure 1-1 Owner Benefit of Practice Use**



90

Figure 3.2: Impact of Constructability on the owner (Garcia, 2009)

The graphs above indicate that the contractor benefits much more from Constructability in terms of saving time and cost as compared to the owner.

The idea stems from the rise of complexity in modern construction projects. Involving people with

the right competence at the right time is important for complex projects to succeed (Jergeas & der Put, 2001). Furthermore, the technologies and methods are changed and updated on a much faster basis. This means that the stakeholders involved need proper knowledge to make sure that the resources are being used in the most efficient way. The building industry in Norway has prime focus on sustainability and environmentally friendly methods.

The benefits of constructability in the light of the literature studied are:

- Better relationship and communication among the stakeholders.
- Better understanding of the project.
- Reduced costs (Jergeas & der Put, 2001)
- Reduction in delays
- Lesser change orders

It is not only the contractor who is concerned with the idea of constructability. The designer/consultant, whose job is to design the project is also involved in it. This means that the design should also learn how to incorporate the contractor's knowledge in the early phase. For that purpose studies are needed to be carried out by design firm and that is what exactly the paper (Arditi et al., 2002) discusses. Following graphs 3.3 and 3.4 visualize the results of the study:

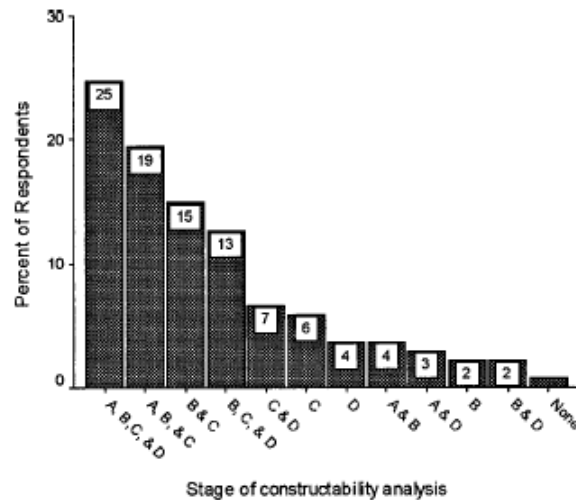


Fig. 2. Timing of constructability reviews: A, conceptual planning stage; B, preliminary design stage; C, developed design stage; D, after finishing the design

Figure 3.3: Stage of constructability analysis (Arditi et al., 2002)

This graph shows the timing of constructability reviews. It is obvious that such reviews are done when the project is started because it is about the involvement of knowledge in the early phase. Since the designer has to finalize the design they are also interested in the effect of such involvement when the design is finalized. Most of the designers are involved in the whole design stage instead of just one part of it as shown in the figure.

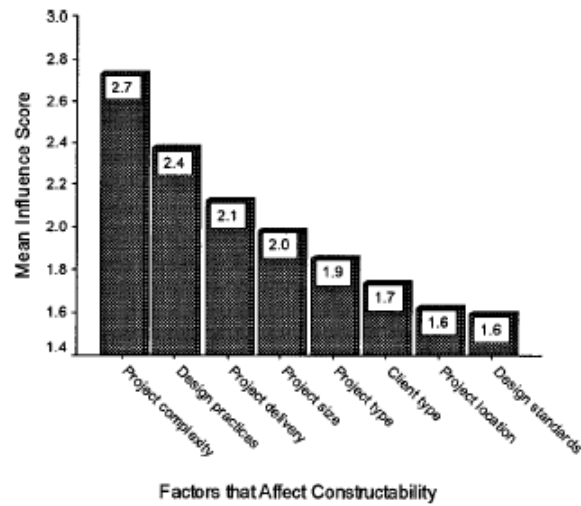


Fig. 3. Factors affecting constructability

Figure 3.4: Factors that effect constructability (Arditi et al., 2002)

In this graph, factors that impact constructability are shown. It is again clear that the complexity of the project has the highest impact on constructability. Complexity in a project can be defined as the complexity in the scope of work/design, involvement of multiple disciplines and increased uncertainty. A contractor that has experience of working with different phases of a complex project would definitely impact the constructability process.

Design practices are the second factor and that can vary depending on the design firm and their working methods. Designing a project can depend on many factors such as the input from the client, the local laws and regulations and the funding involve for instance. Constructability knowledge will have a major impact on such practices as this goes after what approach does the designer take to tackle the problem. The approach taken would obviously take into account the contribution of the contractor and the designer sometimes might have to change their approach.

The project delivery method can also have effect on constructability. The client or the contractor can take part in the constructability phase and that can have different effects. Project delivery

methods are of different kinds, some of the most common ones are described as follows (Killough, 2021):

- Design-Bid-Build (Traditional method)
- Design Build (The contractor is also responsible for designing the project)
- Construction Management at Risk (CMAR)
- Construction Management Multi Prime (CMMP)
- Public private partnership (PPP)
- Integrated project delivery

The next factor is project size which can be somewhat related to the complexity factor. It is not being stated that smaller projects are not complicated but complication can also be related to increased scope of work which needs more resources and time. Speaking of factors which don't have significant effect, project location and design standards are not as relevant. Project location is not relevant to contractor/client giving their knowledge in the design phase. It is also the designer who is more involved with the design standards and other technical aspects of the design and it does not have a lot to do with the practical, experience based knowledge that the contractor has to offer.

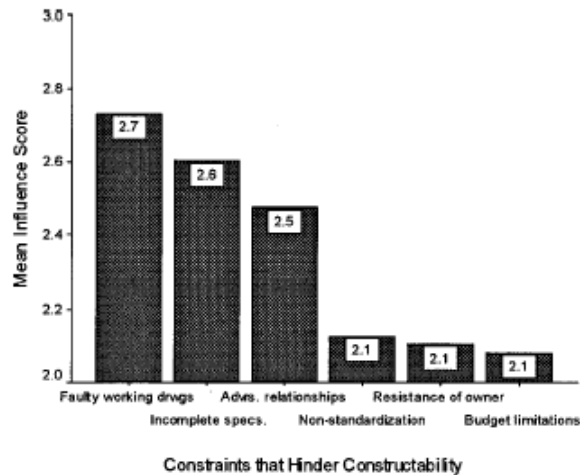


Fig. 4. Constraints on constructability

Figure 3.5: Constraints that hinder constructability (Arditi et al., 2002)

Transitions and changes are often difficult to adopt to. The same can be said for this method. Whenever people/organizations have to adopt to new methods of working, there are some hindrances. The graph 3.5 demonstrates exactly that.

The first two of the causes are related to the design of the project. Faulty working drawings and incomplete specifications hinder constructability the most. Whereas adverse relationships between the stakeholders are the next reason. The reason for that could be conflict of interest. Different stakeholders can have different objectives and the clash between them might lead to an adversarial relationship. Rest of the three factors shown in the graph have not so much effect.

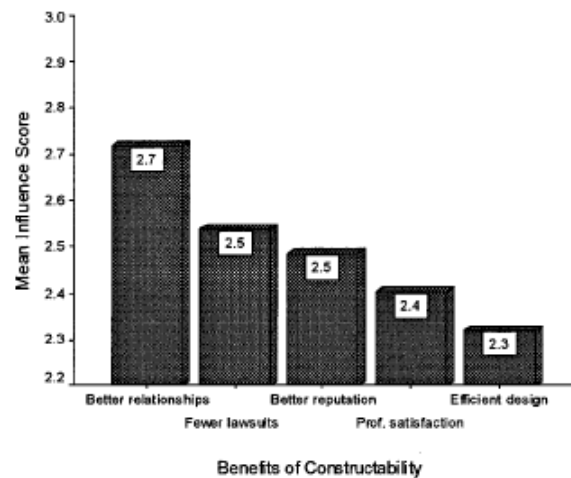


Fig. 5. Benefits of constructability

Figure 3.6: Benefits of constructability for design firm (Arditi et al., 2002)

Benefits observed by the design firm after practicing constructability are exhibited in the graph 3.6. The biggest benefits is improved relationships among the stakeholders. When knowledge is shared at an earlier stage and the stakeholders have worked with each other before the execution stage has started, they have a better understanding of each other and their working methods. This leads to the next benefit that is lesser lawsuits/conflicts among the stakeholders. When the stakeholders have better understanding of each other it is less likely that they will enter into conflicts and they will rather try to solve the matter internally rather than involving a third party.

It can be said that there are costs associated with the constructability process. If this is compared with what the designer gets out of it i.e. better relationships and understanding, a project that has a more robust design and avoiding lawsuits/conflicts then it is worth spending the extra money. Plus the designer gains valuable experience for future projects which can lead to betterment of

reputation of the designer.

In the light of literature, constructability is beneficial for all of the stakeholders involved in the project.

### **3.3 Early Contractor Involvement**

(Bukhari, 2020) has dealt with the topic of Early Contractor Involvement before. The thesis will attempt to gain a deeper understanding of the concept of Early Contractor Involvement. What is Early Contractor Involvement, how it is implemented, what are the benefits when it is implemented and what are the barriers that hinder its implementation in the light of scientific literature?

#### **3.3.1 Drawbacks of the Traditional Method**

The design-bid-build method has since been the most popular method (Hale et al., 2009) especially within the public sector. As there were laws and regulations made around the design-bid-build method, the entities got more and more used to the procedure.

As described in 3.2 the benefits of contractor's knowledge were realized early in the 80s. The major drawback of the design-bid-build method was that it separated the various phases of the project. It was good to realize the importance of the design stage and use time and resources on it, but the laws and regulations made it so that the contractor had no involvement in the design phase. They had to go through a bidding process, win the project and then have some say in the project. At that time the design was finalized and did not have room for changes. The design-bid-build method was too rigid to incorporate changes after the project was handed over to the contractor for execution. Changes in the project have to go through a lengthy phase of approval which would use a lot of extra time and resources.

Another drawback described in (Walker & Lloyd-Walker, 2012) is that the traditional method focuses too much on the cost-quality-time triangle. This is also more commonly known as the 'iron triangle'. The figure 3.7 illustrates such a triangle:





Figure 3.7: The cost-quality and time 'Iron Triangle'(Walker & Lloyd-Walker, 2012)

In this figure, the project's success is determined by three factors. Named cost, time and scope. Cost involves the tax-payers money and the human resource involved in the project. Time can have different frameworks. Time spent in the execution phase or time spent concept phase to end of the execution phase. Scope is defined as the amount of work in terms of features and functionality etc. If a project fulfills all these three criteria than it is said to be successful. This puts too much focus on the execution phase of the project. It should be noted here there is not a lot of focus on what happens before and after the execution phase. The design phase where all the decisions are made and it is decided whether the project should be built or not has little to do with this model. Furthermore, when a project is finished, it is important that it fulfills needs that it was made for. The scope can be said to cater for this but the scope is defined before the execution phase has started. Contractor has competence which can also be utilized in the design phase of the projects. It can be said that the traditional method has put it's focus on a few things and rather simplified the process. A project is much more than just the execution phase. Phases where important decisions are made should also be given the attention and importance they deserve.

As described in chapter 3.2, contractor's knowledge of construction became valuable when the projects became complicated. This has been described in (Lenferink et al., 2012). When the pre-construction phase is too complicated the design-bid-build method does not do justice. As there is little room for change and innovation by the contractor, their knowledge is not being used to the full extent. All the major changes and decisions were made in the initial phase when the contractor

was not a part of the process.

### 3.3.2 What is Early Contractor Involvement?

Early contractor involvement is a broad topic. The definition and meaning can vary among entities and people. Hence in order to give a broader overview multiple definitions from scientific literature will be presented and explained.

Before the rapid increase in knowledge and research into the materials involved, design-build was the most common method used in the construction industry (Minchin et al., 2013). After the rapid advancement in science and technology, new materials and methods became readily available. This meant that the design process must be separated from the construction phase. Along with that came entities and companies who were specialized with knowledge of designing projects. As they took the role of design the contractors shifted more and more into the execution phase of the project.

Early contractor involvement is defined as:

**”Early contractor involvement (or ’ECI’) is a method of construction contracting that allows a builder to become involved, and potentially start work, before the design has been completed”** (Henry, 2018)

The term ’potentially start work’ can be debatable and depends on the type of project delivery method involved. If the contractor is to start work then he must win the project and sign the contract first. Involvement of the contractor can be of different types. The next definition tells about the involvement of contractor in the design phase of the project:

**”Early contractor involvement in design is defined here as a relationship between a contractor and an owner or a designer that engages the contractor from the early design stage and allows the contractor to contribute its construction knowledge and experience to design.”** (Song et al., 2009)

In this definition, contractor is involved earlier in the project so that their knowledge can be incorporated into the design phase. (Song et al., 2009) observed that by involving the contractor earlier in the project, the project duration and man hours were decreased. Which directly contributes to decreased costs. Another way to define ECI can be:

**”Early Contractor Involvement (ECI), as the name suggests, has the Contractor being an integrated member of the team in the early stages of a project. This can be from as early as the feasibility stage if required, rather than after the main details of the**

**project are already established, by which time many opportunities for improvement may have been missed.”** (Hill, 2019) Here the term opportunities is used. A contractor has more knowledge of execution of the project. That way they can come up with suggestions that can make the design more **Constructable**.

Early contractor involvement has been practiced in many countries around the world. A useful definition of ECI from Australia is given as follows:

**”An ECI (sometimes referred to as ‘ECE’ – early contractor engagement) is a procurement model that allows the contractor of a project to be involved in the early phases of design between parties such as the Principal and designers. It is usually a two-stage process.”** (Law, 2018)

The two stages mentioned in this definition are the design and execution stage. The contractor can be hired for giving their input in the design phase of the project and then they can start the execution which is the next stage. This also helps with building relations early in the project. The stakeholders have worked with each other for sometime so the transition into the execution phase is smooth. The contractor was a part of the design hence they already have understanding of the technical aspects of the project. This means that they won't have to spend the time and effort in understanding the project before starting with the execution. As explained in the previous paragraph, there can be multiple definitions and interpretations of ECI. This means that entities can have different ways of interpreting it and there can be varying methods of applications. There can be only contractor involved in the design phase or multiple. The contractor can have varying degrees of involvement from just being consulted on important issues to having being completely involved in the design phase. The contractor can be involved earlier or later in the design phase or all the way in the beginning of concept phase.

These different models have been displayed in the form of the figure by (Walker & Lloyd-Walker, 2012) as shown in 3.8:

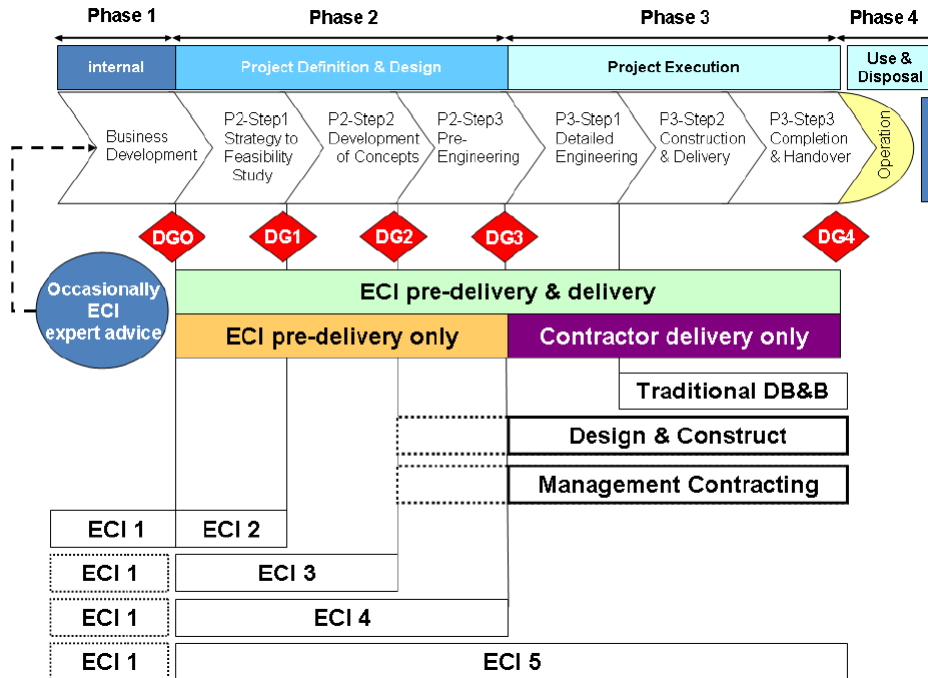


Figure 3.8: The ECI model adapted from the decision gate model (Walker & Lloyd-Walker, 2012)

The word DG here means decision gate which is derived from the stage gate or decision gate model. The model can be known as 'Stage Gate Model', 'Decision Gate Model' or 'Phase Gate Model'. This model is based upon the fact that for an idea to become a product or reality, the process must have some checks in between or more precisely 'stage gates'. It can be formally defined as follows:

**"Similar to the waterfall methodology, the phase-gate process is a linear project management concept punctuated by stages of development followed by benchmarks for assessment."** (Daly, 2020)

A figure displaying the model is shown below:

# Phase gate process

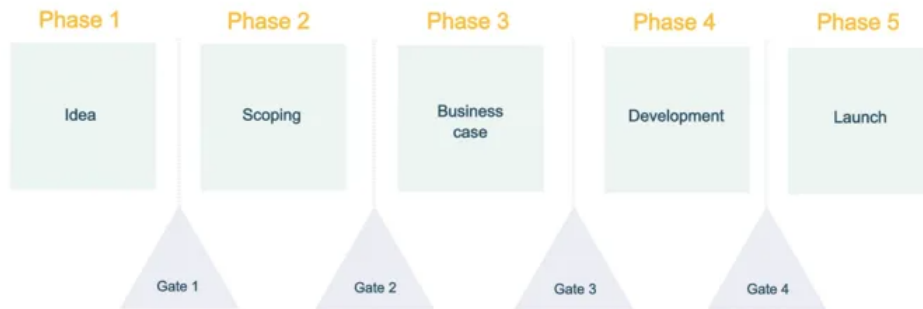


Figure 3.9: The Phase Gate model (Daly, 2020)

The concept is that in order for a project to be successful. It should be evaluated frequently. The process has divided the project into separate phases. Before jumping to the next phase, the work done in the previous phase is evaluated and then the decision is taken to go to the next phase or drop the project/re-do the work. This method gives the opportunity to look back on the work done and evaluate it with a new perspective. Then the decision to move on/re-do can be made.

Figure 3.8 has shown different types of ECI formats. ECI can be only be for the design phase or the contractor can be involved from when feasibility study till all the way to the execution and handover phase. Although some ECI models don't make use of the decision gate method, the decision gate method can be useful in checking the effectiveness of early contractor involvement. If the contractor is involved much earlier when the decision to build is not finalized, i.e. ECI 1, then the contractor can also have some valuable input as to whether the project should be built or not. The very early phases of a project are more concerned with identifying need for the project and not much has been decided about the project itself (i.e. regarding the execution). But the contractor can also contribute in making the suggestions even better.

The span of early contractor involvement is shown in figure 3.8. According to the figure if the contractor is involved to varying degrees in any of the phases from 1-3 then it can be considered as Early Contractor Involvement. In this thesis, early contractor involvement in public projects will be the main point of focus since these are more regulated and the results are entirely based on interviews from public projects.

Public sector can have different formats and methods of involving the contractor earlier. Some

of these are very well summarized in (Wondimu, Hosseini, et al., 2016). 11 Projects were studied in the Norwegian Transport sector and 13 approaches were identified as a result. And they are summarized in the following figure.

**Table 1: Frequency of the ECI approaches (1-13) in the investigated projects (1-11)**

<b>Approaches vs Projects</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>Total</b>
1. Indirect approaches	X	X	X	X	X	X	X	X	X	X	X	11
2. Information meetings	X			X	X		X	X	X	X	X	8
3. A front-end partnering process	X			X	X	X	X	X	X	X		8
4. Announcing the project with alternative technical solution	X	X	X	X			X		X	X		7
5. Design build contract (DB) or function description					X	X	X	X			X	5
6. Direct contact with specialist contractor in the front-end phase of projects	X			X								2
7. Idea competition				X								1
8. Contractors sell their idea to the owner in the early phase							X					1
9. Negotiated bidding procedure					X							1
10. Opening for alternative tender												0
11. Competative dialogue												0
12. Project partnering												0
13. Project alliancing												0

Figure 3.10: Various ECI Approaches in the Norwegian Transport sector (Wondimu, Hosseini, et al., 2016)

The crosses on the right side of every approach indicate how many projects used the said approach. It can be seen that indirect approaches are used in every project. This indicates that ECI is a relatively new method and not as standardized as the traditional method. If client has a standard way of contacting the contractor then this approach would not be as common. It is also possible that the contractor has never heard of the approach when they are contacted by the client. Information meetings are also common. When the project is in the early phase and not much is decided then the client can have meetings with one or more contractors where they can discuss the project and the proposed solutions. The client can present the project and the contractor/contractors can pitch in with their ideas. Involvement on a more advanced degree can include an alternate solution where

the client gives the contractors the opportunity to develop their own solution of the project. Hence they have more degree of freedom in this case. Here the project can be thought of as a problem and the contractors are supposed to develop the best and often cost effective solution. This model helps bringing the costs down as the contractors are often competing with each other and they have the incentive of winning the project. This makes them develop the most cost effective solution.

Figure 3.10 also shows the variety of ECI. Although the study was carried out in a single country and in a single sector i.e. Transportation. The methods of involvement can be very different. If there is a study involving more countries and more sectors then even more methods can be identified. This is an exhibit of vastness of the method.

Transportation industry in the Netherlands has also tried with the concept of Early Contractor Involvement. (Lenferink et al., 2012) identifies how ECI was involved and recommendations on it. But first it is important to look at the two formats of ECI described in literature.

- Parallelization: Simply put, in order to save time the concept development and procurement stage are carried out in parallel. But there is no connection between the two i.e. there is no flow of information
- Interweaving: This is the same process as parallelization but here the two processes, i.e. concept development and procurement are collaborating.

If compared to what is described in (Wondimu, Hosseini, et al., 2016), interweaving model corresponds to idea competition. A project can either be completed too fast while putting less emphasis on the quality or too slow putting more than required emphasis on the quality of work. The figure below taken from (Lenferink et al., 2012) describes exactly that.

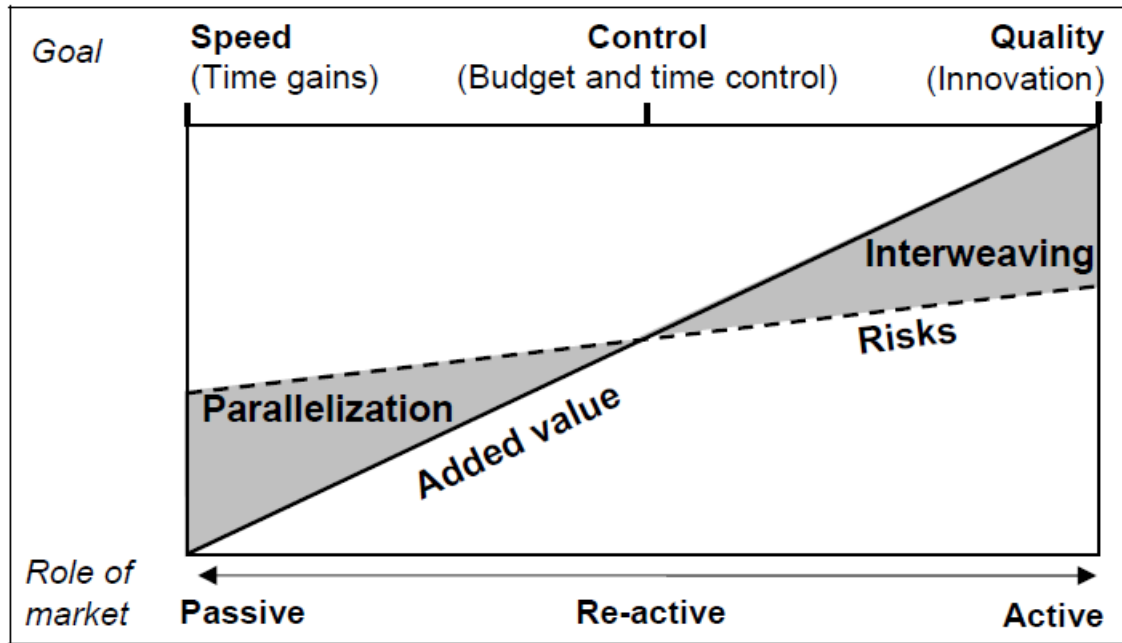


Figure 3.11: Advantages and trade offs between interweaving and parallelization- (Lenferink et al., 2012)

The middle point of the figure describes the perfect balance between the two where one has total control over the project with zero risk. This is obviously not possible practically as there will always be factors beyond the project that can effect the project in a positive or negative way. One more thing to be noted here is that a project can have added innovation because of early involvement but it is also important that it is the right innovation and it does not have adverse effect on the project. On the other hand, a project can be highly time efficient but it should make use of the contractor's knowledge that can spark the innovation needed for the project. In conclusion, the 2 methods described above have their own benefits but should be used in balance to get the most out of early involvement of the contractor.

The application of ECI is also an important topic, i.e. how is it applied in public projects. The traditional model is based on the contractors bidding for the project after the design is completed. Communication between the stakeholders before the bidding process is finished is highly sensitive and regulated. As ECI is involvement before the design is finished this can be a point of contention with the rules and regulations that have been designed around the traditional model. If the model is applied without paying attention to the rules and regulations then there can be negative consequences. This also means that there should be a degree of trust among the contractor and the



client. (Finnie et al., 0) has pointed out some of the possible risks associated with the method. If the contractor is involved informally without some concrete and the project does not go through then there can be consequences in terms of costs and time spent. Also, since there are not rules and regulations governing the method, responsibility and risks are not equally divided among the stakeholders.

### 3.4 Success and effects of Early Contractor Involvement

The benefits of Early Contractor Involvement have been studied in different contexts (geographical location, contractor type etc.). As described in chapter 3.3.2, ECI can have various interpretations and understandings. In the same way the benefits can also have different effects depending on how ECI is applied. The following table 3.12 (Laryea & Watermeyer, 2016) gives a brief description of some of those studies. It tells about the type of project/projects that were studied, countries where the study was conducted and the benefits that were observed.

Description of project	Geographic location	Benefits of ECI	Reference
Roads projects	UK	Cost savings, supports risk management on larger schemes	Eadie and Graham (2014)
Gibe III Dam/hydro power plant	Ethiopia	Evolution of design features	Asnake et al. (2013)
Port of Brisbane motorway upgrade	Australia	Buildability issues	Evans and Tran (2013)
Hurricane protection levee and system	United States	Developed a stringent set of specifications in order to ensure quality product was installed	Schmutzler et al. (2012)
Hurricane protection levees and walls	United States	Minimised construction time through close relationship among the project owner, contractor and designer	Call et al. (2012)
Public infrastructure projects	Netherlands	Adds value in terms of time gains, improved project control and more innovative solutions	Lenferink et al. (2012)
Flood protection system	United States	Optimisation of design based on contractor's experience	Cooling et al. (2012)
National Partnership Agreement on Remote Indigenous Housing	Australia	Risk management of projects	Martel et al. (2012)
Bridge construction	United States	Waste avoided by the use of prefabricated elements	Chan (2011)
Transportation projects	New Zealand	Improvements in value for money and project delivery time	Scheepbouwer and Humphries (2011)
Industrial construction projects	United States	Improved drawing quality, material supply, information flow, and consequently improved construction schedule performance	Song et al. (2009)
Highway projects	UK	Contractor's knowledge and experience at an early stage to ensure cost reduction	Conway (2009)
A3 Hindhead twin-bore road tunnel	UK	Optimisation of design	Ireland and Rock (2008)
Tunnel projects and underground facilities in Europe	Europe	Innovative and improved tunnelling technologies, methods and equipment systems for mechanised excavation and ground support	Fulcher et al. (2006)
Oil, gas and petrochemical projects	Netherlands	Provides an efficient solution and facilitates a co-operative owner-contractor relationship	Berends (2006)
Blackpool's Central Gateway scheme	UK	Optimal buildability in design	Cunningham (2005)
Highway projects	UK	Greater scope for innovation, improved risk management, better planning of resource requirements, minimisation of environmental impact, improved consideration of buildability, improved consideration of health and safety factors and reduced programme period from preliminary design to completion of construction	Skanska (2005)
Tunnel rail, sewage transfer station and New Southern railway	UK, Hong Kong and Australia	Introduces project alliances/contract partnering, common risks and risk sharing on tunnel projects	Caiden et al. (2005)
Highway projects	UK	Asset management optimisation	Webster and Allan (2005)

Table 1. International examples of projects involving ECI in the design development

Figure 3.12: Benefits of Early Contractor Involvement according to different studies (Laryea & Watermeyer, 2016)

The benefits realized by the use of ECI can be further divided into the following categories.

### 3.4.1 Cost Savings

Cost is one of the three members of the traditional 'iron triangle' used to judge the success of projects. It is one of the most if not the most important aspect of a project. Projects consume a lot of tax money and it is important that the new method makes use of resources in the most efficient way. Several papers have reported that ECI has led to cost savings. (Eadie & Graham, 2014) states that as a result of involving the contractor early, there were significant savings in cost. The main factor that led to the cost savings was the buildability of design. Contractor was able to incorporate his knowledge and expertise earlier in the project which led to a design that would require lesser changes.

The reduction in cost can also be associated with other factors such as reduction in risks. As the project has lower risk, there are lesser changes in the project runs more smoothly. Design optimisation is another factor mentioned that can lead to cost savings. A contractor's knowledge will make the design more buildable/constructable as mentioned in chapter 3.2.

For some context it is important to talk about the uncertainty, changes and information available in a typical project with regards to the time. (Samset & Volden, 2016) has described the uncertainty and information available in a project in the figure 3.13 below:

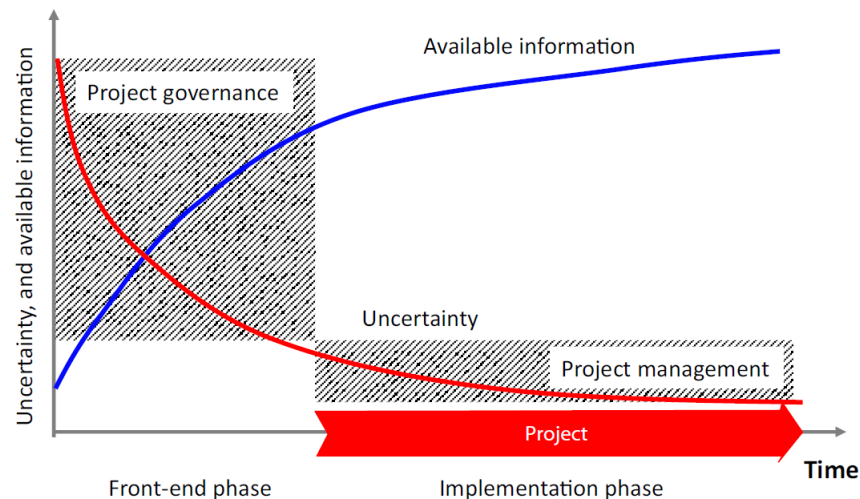


Figure 3.13: Relationship between uncertainty and information available in a project (Samset & Volden, 2016)

The figure above demonstrates that as time passes, more information becomes available regarding the project. On the other hand as more information is available the uncertainty decreases. It can also be noted that the uncertainty never becomes zero but decreases rapidly and then remains constant towards the end of the project. This is because there are some factors beyond the project's domain that can affect the project. E.g. weather conditions, economical conditions and earthquakes etc.

The relationship between cost of making amendments and the flexibility to make amendments is shown in the figure 3,14 below. Taken from (Samset & Volden, 2016)

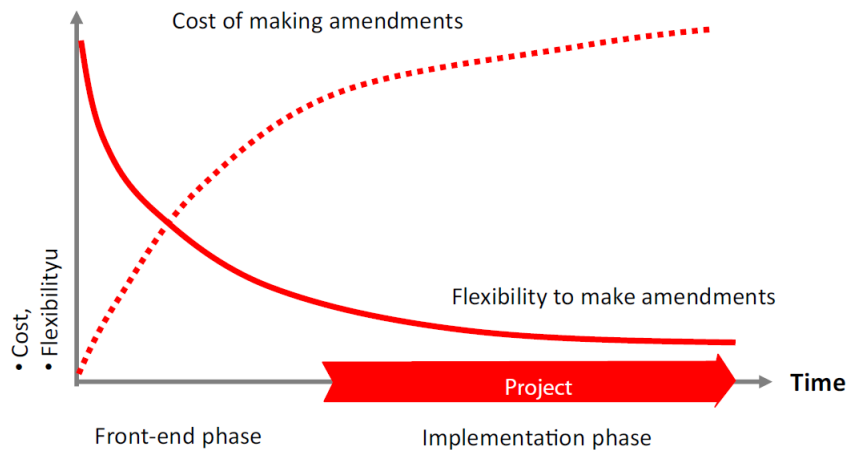


Figure 3.14: Relationship between cost and flexibility of making changes in a project with time (Samset & Volden, 2016)

The flexibility of making changes is the highest in the beginning of the project. This is pretty self explanatory as the project is in the design phase, things are not finalized. But as the project gets into the execution phase the flexibility drastically decreases. It would cost money and time to dismantle something and build it again differently. Similarly, the cost of making changes starts from zero when the project is in the design phase. As the project enters the execution phase, the cost increases much more.

### 3.4.2 Time Savings

(Song et al., 2009) has described the effect of ECI on the schedule in detail. But before that it is wise to look at the some of common reasons that lead to delays in construction projects.

- Revision of Drawings

As the project is started and execution is carried, drawings can be modified depending on new information that is available. It can be also because of errors that are discovered later on. The client can also change their minds and ask the consultant to change the drawings. This means a change in scope. Time is needed to incorporate changes in the design.

- Shortage of Material

Even though the contractors are experienced, they can miscalculate the amount of material required. If they are not involved in the project early enough the probability can be even higher. Miscalculation of material can lead to shortages and delays in progress.

- Non-conformance report (NCR)

The design document is also accompanied by a contract, which dictates how the work is to be performed. Usually it contains the standards that the contractor has to adhere to and the quality assurance parameters. If the contractor fails to execute works in line with the standards then an NCR (Non conformance report) can be issued. This gives the consultant the right to stop payment until the faults have been corrected. This not only uses more time but also uses more of the contractor's resources that they will not be compensated for later on.

- Request for Information (RFI) If there is something in the design that is not clear enough, then the contractor can ask the consultant for further clarification. This can take time and even lead to changes in design if errors are uncovered.

When the fabricator's input was incorporated earlier into the project. It led to a design that was more buildable. Following factors lead to time savings:

- Better quality of drawings

When the contractor was able to incorporate their knowledge in the design phase. The quality of drawings became better. They had lesser errors in them and the contractor had more time to study and understand the drawings.

- Material supply

Similar to the drawings, the contractor has more time and information to study the drawings. Drawings are vital tool when calculating the quantity of material required. Accurate calculations avoid delays and make the process smoother.

- Information flow

The contractor and consultant have already had the opportunity to interact with each other in the design phase. The formal and informal communication channels have already been established which saves time in the execution phase.

### **3.4.3 Better relationships**

The relationship between the client and contractor might be temporary, but the relationship is complicated. The client has to get the most out of the resources they are spending meanwhile the contractor has to get the most profit out of the project. A good relationship between the two makes it less likely that there will be unnecessary conflicts and the work will be carried out smoothly. (Rahman & Alhassan, 2012) has reported that contractors are in favor of ECI and rate better relationships as one of the top benefits of the method. (Laryea & Watermeyer, 2016) has also reported that ECI has lead to good relationship between the parties involved. As the parties have the chance to interact with each other in the design phase, they have an easier time transforming into the execution phase. Also, they are already comfortable working with each other. The time spent in establishing and understanding the working relationship will be spent in focusing on other important things which are more beneficial for the project. Relationship between two working partners is an intangible term. But the following aspects can help explain it (Jergeas & der Put, 2001):

- Mutual trust
- Respect
- Credibility
- Shared vision and commitment
- Cooperation and teamwork

### **3.4.4 Risk management**

Chapter 3.13 shows how risk and the cost of making changes change over a project's life cycle. Information is one of the key factors that affects the risk involved in the project. Literature has indicated that the early inclusion of contractor's knowledge has lead to a reduction in overall risk in a project. Zero risk is impossible as risk depends on several factors some of which are out of the

project's control.

(Uhlik & Lores, 1998) indicates that the contractor benefits from early involvement in the design phase. This is indicated by better drawings, specifications, and buildable projects. Better drawings and specifications lead to a project that has more information and has less confusion. More information leads to reduced risk from sources like change in drawings and specifications. The contractor has more time to work with the design and that helps with creating a better understanding of the project.

### **3.4.5 Innovation**

Innovation is defined as:

*'The word "innovation" is derived from the Latin verb innovare, which means to renew. In essence, the word has retained its meaning up until today. Innovation means to improve or to replace something, for example, a process, a product, or a service.'* (innolytics.ag, n.d.)

ECI gives more time and opportunity to the contractor to play with design. As the contractor has more experience of execution of projects than the other stakeholders, they can spend time on improving the methods and/or developing new methods (Laryea & Watermeyer, 2016). The contractor can also be the one solving the problem for the client in a model of ECI called 'idea competition' (Wondimu, Hosseini, et al., 2016) here different contractors compete with each other to develop a solution which would satisfy the needs of the client. The contractor with the best solution would then go on winning the project.

### **3.4.6 Project control**

(Lenferink et al., 2012) talks the most about project control. Project control is a broad term and can have different interpretations. But in this context it means the control over different parameters of the project. Such as time and resources. Project control can also mean having a better understanding of the project which leads to better construction. Early involvement of the contractor means that the contractor has more time spend on studying and understanding the project's needs and requirements. At the same time their opinions make a difference on the project. This means that they go on building a project knowing that they understand the task at hand and are more confident with it.

### 3.4.7 Change management

When the contract is signed between the client and the contractor. The contractor agrees to execute the work within conditions mentioned in the drawings and specifications. The price at which the contractor agrees upon to work is dictated by those specifications and drawings. When the execution phase has started the following scenarios can be possible. Some details might be missed, new needs are identified as more information is available or other uncertainties. All these factors might lead to a change in design. The contractor if involved earlier in the design phase can manage the changes in a better way. It is also possible that the contractor's knowledge leads to lesser changes in the execution phase. As the contractor had the opportunity to incorporate 'constructability' in the design. It can be seen in figure 3.13 that the information available is lower in front end phase of the project, here the contractor can contribute with their knowledge earlier to make more information available. That way it would be easier to make changes since the cost of making changes is lower and the flexibility is higher.

### 3.5 Technical terms used in the interviews

Below is a list and comprehensive explanation of some of the technical terms used in the interviews.

- **Enhetspriskontrakt (Unit Price Contract):** 'In a unit price contract, a construction company prices individual portions, or units, of work to estimate a total project cost. Each unit is based on several variables, in combination or on their own, such as materials, labor and overhead. If the scope of a project changes along the way, units can be added or removed. A unit price contract, typically used for public construction projects, is especially handy for projects with an incomplete scope of work and that involve repetitive tasks and resources. A unit price contract also helps remove a contractor's risk of submitting an inaccurate estimate during the bidding process.' (Clancey, 2021)
- **Gjennomføbarhet (Constructability):** 'The optimal use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives.' (CII, 1986)
- **Reguleringsplan (Zoning Plan):** 'Zoning Plan means the plan of area or part thereof or supplementary layout plan approval by the Chief Town Planner and maintained in the office of Competent Authority showing the permitted use of land and such other restrictions on the

development of land as may be prescribed in the zoning regulations, for any part or whole of the area such as sub-division of plots, open spaces, streets, position of protected trees and other features in respects of each plot, permitted land use, building lands, height, coverage and restrictions with regard to the use and development of each plot in addition to such other condition as laid down in these regulations hereafter.’ (“Zoning Plan Definition — Law Insider”, n.d.)

- **Prekvalifisering (Pre-qualification):** ‘Contractor pre-qualification is an information gathering and assessment process that determines a contractor’s capability, capacity, resources, management processes, and performance. Typical subject matter areas include financial capacity and surety, work history, licensing and qualifications, management standards and, regulatory, quality, safety, and environmental performance data.’ (“What is Contractor Pre-qualification? - Definition from Safeopedia”, 2019)
- **Totalentreprise (Turnkey Contract):** ‘Turnkey contract is typically a construction contract under which a contractor is employed to plan, design and build a project or an infrastructure and do any other necessary development to make it functional or ‘ready to use’ at an agreed price and by a fixed date. In turnkey contracts, most of the time employer provides the primary design. The contractor must follow the primary design provided by the employer.’ (“What is Turnkey contract? Meaning, definition and usages — Business Novice”, n.d.)
- **Konkurransesgrunnlaget (Competitive basis):** The actual meaning is different from the literal meaning, here it refers to the *tender documents*. A translation of the definition is as follows: ‘The tender documents include all documents that the client designs or refers to in order to describe or determine the elements of the procurement or competition, with the exception of the announcement and the European self-declaration form. [1] This includes “documents describing what is to be procured, the terms of the contract and how the client is to carry out the competition, qualification basis and any supplementary documents and additional information’ (“Konkurransesgrunnlaget - regjeringen.no”, 2017)



## 4 Discussion

The aim of writing this chapter is to co-relate the results with the theory and define the basis for conclusion. Theoretical part gathers information from available literature. Meanwhile the results make use of the interviews of project managers and other professionals working hands on with the project. The research question of this thesis was:

### **'Effect of Early Contractor Involvement in Statens Vegvesen projects'**

The main purpose of this thesis is to find out the effect of early contractor involvement methods applied in the Norwegian Public Roads Administration. The method chosen was to interview the people working with the project. The data from the interviews is then presented in Appendix. Chapter 3 describes information obtained from the literature review. Here these two will be discussed. The research questions mentioned in Chapter 1 are stated below:

- What kind of information can be gathered by interviewing the project personnel working on ECI projects?
- How useful is that information given that the projects are at such an early stage in their lifecycle?
- What is the extent of knowledge of project personnel working with ECI on these projects?
- A contractor who has taken part in the negotiation process but was not able to win the project. How different is their view from the contractor who won the project?
- What is the extent of tangible and intangible information based on the interviews?

### 4.1 Summarized interpretation of results

There were some correlations and patterns observed in results. Which are described below.

- All of the parties were equally satisfied when it came to improvement in trust and relationship. Even the contractor that did not win the project. They mutually agreed upon the fact that a round of negotiation before actually starting the projects helps with building and expectations.
- Everyone taking part in the interviews also agreed that risk is better managed by ECI than the traditional method. The contractor has more time to incorporate for unforeseen circumstances that might occur in the project.

- The information available about the project at an early stage was also much more as compared to the traditional model.
- The overall effect of ECI, regardless of which side one is on is positive based on the data obtained from the interviews.

The problem statement was kept open-ended on purpose. I.e. the problem statement was not 'Positive/Negative effect of ECI in NPRA projects'. Because it was expected that if applied properly, the effect of ECI on projects will be positive. The amount of literature available that talked positively about ECI made this assumption possible. So, it can be said that the results were what was expected.

## **4.2 Detailed interpretation of results**

The most important part is to understand and interpret deeply what the results mean. To get a deeper look into the results obtained, below is a detailed account of different aspects of a project and how ECI effected them in light of the literature presented in chapter 3.

### **4.2.1 Previous experiences with ECI**

It is mentioned multiple times in chapter 3 that ECI is a relatively new method of project delivery. This was also proved by the interviews, all of the professionals working from the client's side (NPRA) had never worked with ECI before. However the story is a bit different when looked on the contractor's side. Both of the contractors representatives had worked with some form of early involvement before in their professional careers. Meanwhile the client's representatives were more used to working with the traditional methods. There is an age difference between the experience of client and contractor. The contractor is more used to being involved in the design phase than the client is handling the contractor in the design phase.

### **4.2.2 Type of ECI in the projects**

What type of ECI is involved in the projects in this thesis? This question is not easy to answer. The ECI involved in both of the projects does not refer to a fixed type mentioned in the literature. This fact is made even more complicated by the fact that ECI being a new method, has different definitions and interpretations. So one can say that the project involves 'this' type of ECI but literature would label it as something else.

In the project **Rv. 706 Nydalsbrua med tilknytninger** the original design made by the contractor was way over budget. This meant that it was not possible to execute the project. The client invited 5 contractors to suggest a cheaper alternative for the project. At the end of the project each contractor would submit a bid and the contractor with the cheapest bid will eventually win the project. out of these 5 contractors 2 pulled and 3 contractors eventually submitted the bid. The competition between the contractors was to bring the prices down. There were also information meetings and negotiation rounds where the contractor and client sat together and discussed the project. During the interviews the interviewees did not put a name on the type of ECI involved but instead explained how the contractor was involved earlier in the project. According to literature (Wondimu, Hailemichael, et al., 2016) and (Wondimu, Hosseini, et al., 2016) the type of involvement is **Idea Competition**. As the contractors had to compete with one another in bringing the costs down and suggest newer ideas.

Coming to the next project, **E6 Fjerdingseng-Grøndalselv** the type of ECI is somewhat similar but how they lead to choosing this method of involvement is a bit different. For this project the zoning plan was already made. The client wanted to have the contractor's ideas incorporated in the project. A total of 3 contractors took part in the ECI process. The negotiation round was similar to the other project where the contractors met with the client and discussed what they had done so far on the project. However the main difference is that the driving force for ECI was better design. Not cost. The client was not anticipating that the prices quoted by all of the contractors would be less than what they had calculated.

The traditional method of involvement can be illustrated by the figure below:

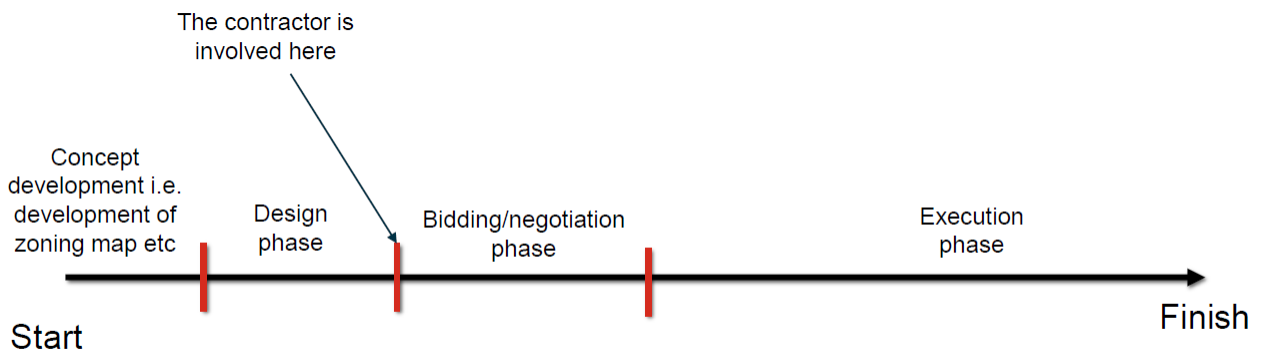


Figure 4.1: Traditional method of project delivery

Whereas early contractor involvement in the two projects in this thesis is illustrated by the following figure:

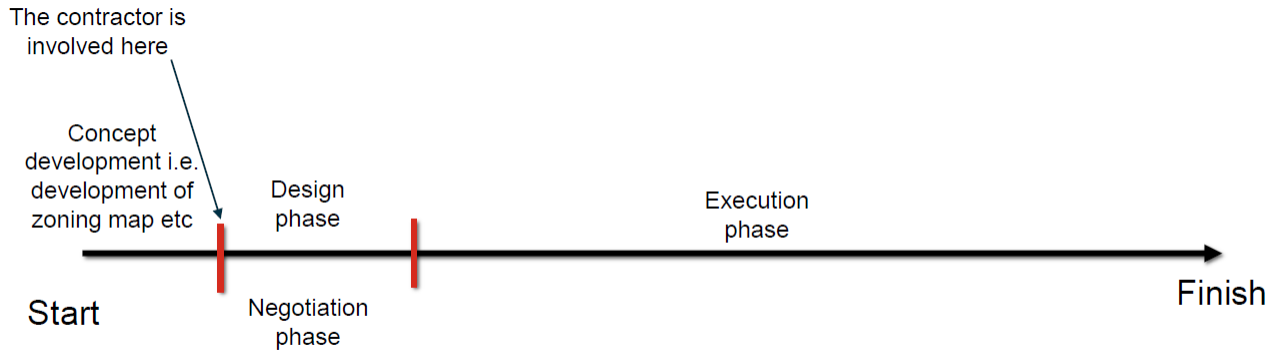


Figure 4.2: Illustration of early contractor involvement in projects under study

ECI incorporates the design and negotiation phase and the contractor gets involved in the design of the project. (Lenferink et al., 2012) has given another perspective on ECI. As discussed in chapter 3 there are two methods of ECI used in Netherlands, named parallelization and interweaving. If the method used in the two projects in this study is compared with what is state in (Lenferink et al., 2012) then it would be interweaving. Concept development (design) and procurement are carried out at the same time and there is free flow of information between the two, i.e. the contractor has insight in the design process.

The following sections discuss the effects of ECI on different aspects of a project in light of the results and literature discussed in Chapter 3.

### 4.2.3 ECI and Cost

Driving the costs down by developing more efficient solutions, was one of the main reasons ECI was used in the project 'Rv. 706 Nydalsbrua med tilknytninger'. The client could not execute the project with the current estimate so the contractor had to be involved earlier. In the other project main objective was better design but reduced cost came as an added advantage. All of the estimates presented by the bidding contractors were less than what the client had estimated. This is in line with what is presented in theory i.e. (Eadie & Graham, 2014). ECI lead to reduction in costs in the British construction industry.

As discussed in chapter 3, the reduction in costs was associated to the relationship between information available and risk 3.13. The results also suggest that contribution of contractor's knowledge to a decrease in perceived risk and better planning.

It is worthy to mention here that the effect of cost can be divided into two categories, effect of ECI before execution of the project and effect of ECI after the project is executed. Since both of the projects have not been completed the aftereffect of ECI is unknown. It can be useful to study the effects of ECI during execution.

#### 4.2.4 ECI and Risk Management

The advantage in managing and handling risk has been seen both in the literature and the interviews. The client had incorporated risk management as a part of the ECI negotiation process. The client had to perform risk management checks such as risk register and listing risks and opportunities. A risk register serves as an important part of the risk assessment process. It is defined as follows:

**A risk register is a tool in risk management and project management. It is used to identify potential risks in a project or an organization, sometimes to fulfill regulatory compliance but mostly to stay on top of potential issues that can derail intended outcomes.** (Ray, n.d.) This helps the contractor stay on top of what issues can come. More involvement leads to the contractor having more information about the potential risks. This makes them better prepared for the project.

According to the client the contractor had more time to understand the project and they were allowed to contact the client during the negotiation phase which made them understand risk better. The client was of the opinion that they had more time and space to understand the project and ask questions. Therefore, it makes them more confident. As discussed in chapter 3 risk is related to the information available about the project 3.13. The risk decreases as the project is carried on and more information is available. As the contractors spend more time with studying and designing the project more information becomes available and consequently the risk decreases. Furthermore if the contractor designs their own solution, they are well aware of the ups and downs and have a better idea of what risks can be expected.

#### **4.2.5 ECI and Trust and Relationships among stakeholders**

The theory tells us that trust and relationships are not only about having good vibes at work, it leads to less conflicts and promotes mutual benefits (Jergeas & der Put, 2001). Different aspects of relationships between two working parties have been discussed in chapter 3. The improvement in such aspects has been supported by literature on ECI (Rahman & Alhassan, 2012) and (Laryea & Watermeyer, 2016). Both the client and the contractor were very positive about the effects of ECI on trust and relations among the stakeholders during the interviews. The reason of the betterment in relationships is that the stakeholders get to know each other first in the negotiation/design phase. They participate in meetings and discuss and evaluate solutions. This makes them get a better understanding of each other and more information about their working methods. This increases the trust and mutual relationship between them..

The interviews also pointed out that there was improved mutual trust, respect, credibility, shared vision and commitment (both of them have the incentive to design a better project), and improved cooperation and teamwork.

This is very positive news. Both the theory and the results agree with each other. This means that ECI is not only a method that provides financial benefits to the projects, but the people working on the project also feel good about using it. It promotes teamwork.

#### **4.2.6 ECI and time**

Although literature suggests that ECI leads to time savings (Song et al., 2009). The interviews tend to give a different perspective. The interviewees basically had 2 opinions. Either they were of the opinion that ECI does not have a significant effect on the schedule since the time saved in the execution phase is balanced by the time spent in the negotiation phase. Or they simply said that as the projects are ongoing so it is difficult to get a full picture of the effect of ECI on time/schedule. Here the literature and interviews do not agree with each other. Maybe a different ECI approach in these two sources of information is the reason for the difference? It is to be noted that not all of the literature that reports the positive effects of ECI has listed time gains as one of the benefits. So both the interviews and literature can be taken with a grain of salt.

(Song et al., 2009) talks about ECI and time savings. However the project discussed in the literature is very different from what is being dealt with here. The direct input of contractor lead to a tangible savings in time. The projects in this study are much more complicated. They involve

multidisciplinary work and coordination among different disciplines. Therefore, the results cannot be compared directly with each other. The end of the project will give the final answers on actual time savings.

#### **4.2.7 ECI and conflicts among stakeholders**

Chapter 3 indicated that ECI has a positive effect on reducing conflicts among stakeholders. This conclusion has been made in theory by the fact that the increase in quality of relationship and trust leads to lesser conflicts arising at the later stage. Another factor is that early involvement leads to the contractor having more knowledge about the project which reduces potential uncertainty which in turn reduces conflicts and litigation.

There is an interesting observation in the results. The contractors were of the view that ECI does lead to lesser conflicts. Meanwhile the client's representative did not rule out the possibility of conflicts and did not say that ECI reduces conflicts. It can be assumed that the client came to that conclusion as the project was not finished. It can also be automatically assumed that better relationships among the stakeholders lead to lesser conflicts. However conflicts in construction projects are complex and can arise from complicated and unforeseen situations. Hence there needs to be a specific focus on how and if ECI has lead to reduction in potential conflicts. Also, it cannot be expected that ECI has the total responsibility for conflicts that arise in the project. If ECI has a somewhat positive effect then that is a great advantage for ECI.

#### **4.2.8 ECI and constructability**

Chapter 3 talks a lot about constructability. Constructability is an important concept when it comes to understanding ECI. The benefits of constructability as seen in chapter 3 are somewhat similar to the benefits of Early Contractor Involvement. The interviews however, again show a slightly different picture. The client praised ECI for its role in constructability. One project manager went as far as saying that constructability was the biggest advantage achieved by ECI. Meanwhile, on the other hand the contractors did not value constructability that much. They valued other aspects like relationships and trust more than constructability. This can be because constructability is something the contractor always has in mind. They are closer to the execution process and it is something by default that they have to deal with. Or in other words, it can be said that the owner is in a better place to realize the benefits of constructability than the contractor. The lack of input in this aspect can be credited to the fact that the concepts of ECI and con-

structurability are very similar to each other (discussed in Chapter 3) it becomes harder to distinguish between them and talk about them separately in the same conversation/interview.

#### **4.2.9 ECI and quality of work**

As described in earlier chapters. Construction projects can be highly diverse. Therefore, the quality can also be defined in various ways. A simple definition of quality in construction projects is:

'At its core, quality in construction means that a project is completed within the defined guidelines set out in the Scope of Work. This document serves as a set of guardrails for the project based on the owner's expectations, and sheds light on how to execute the project in a way that meets these standards.' (Ellis, 2021)

Overall the interviewees had a positive overview of quality and ECI. This is due to the fact that the quality of design was much better as the contractor had more time to work with the project. Quality of work can be divided into two parts, quality of design and the quality of construction work. On one hand the interviewees had a positive outlook of design quality but on the other hand they were unsure about the quality of construction work. One of the projects i.e. Nydalsbrua is in the construction phase meanwhile the other project E6 Fjerdningen-Grøndalselv has not started with the construction phase.

#### **4.2.10 ECI and Pre-qualification of contractors**

The pre-qualification phase is an important phase of a construction project. In this phase the client is supposed to make sure that the contractors that are shortlisted to make a bid have the necessary competence and capital to carry out a project. As the traditional bidding process mostly values cost, the client also has to use pre-qualification as a tool to determine the competence of the contractor.

The interviews suggest that the pre-qualification procedures in projects involving ECI are more or less the same as a traditional project. In further projects, as ECI evolves and more contractors get their hands on experience with this method, the client can have ECI specific clauses.

The pre qualification phase also tells about the number of candidates that are suitable for this method. Having too many candidates can be time and resource consuming and will have the opposite effect. Whereas having too less candidates will not give the best result.



#### **4.2.11 ECI and planning**

While this topic has not been discussed in Chapter 3, it was brought up in the interviews. The topic was mostly covered by time saved by ECI in the theory chapter. The interviewees were positive and praised ECI for giving them more time to plan the construction activities. The contractors were of the opinion that ECI gave them the opportunity to have a better overview of risk. The client said that the negotiation rounds made it easier for them to communicate their expectations. As the contractor and client got closer in the negotiation phase, more things were cleared up and the contractor was able to get a better idea of the project which helps with planning activities.

## 5 Conclusion

The objective of this study was to find out the effect (positive/negative) of early contractor involvement method of procurement for public projects. The problem statement is:

*'Effect of Early Contractor Involvement in Statens Vegvesen projects'*

### 5.1 Overall experience with ECI

There are some aspects that the interviewees did not agree upon as discussed previously in this chapter. However, one aspect that everyone agreed upon is that they will use ECI again. Depending upon the type of the project of course. If the project necessitates that ECI method be used then they would be more than happy to choose this method. Clients pointed out that ECI helped them improve the quality of design and bring the prices down meanwhile contractors where of the opinion that ECI helped them gain a deeper understanding of the project and have a better overview of risk.

The two main aspects that seem to sway from what is discussed in theory is constructability and time savings. Both the contractors and clients have said that ECI does not have a significant impact on these two factors. It can be debated that time savings can be compared theoretically if ECI was not involved in the project. However, in one of the projects, ECI made the project possible, without ECI there is not project. Hence it is impractical to think of what the project would be like without ECI.

The interviews carried out for this thesis gave a valuable insight into the method of ECI. Which is still very new at least here in Norway. As seen in theory other countries have also tried with ECI, but studying ECI in this context was highly important. The projects that were studied in other literature are different in the road projects. Added to that each country has their own set of rules and regulations. So the results from other countries can be used to draw inspiration but cannot be used as a direct comparison. One can also argue that the interviews were carried out early in the project and do not give the whole picture. Which is true, but the professionals working with ECI have praised ECI so far. One of the projects hasn't even started with the execution, but the advantages of ECI in the design phase are clearly realized by client and the contractor. This also serves as an important benchmark for future researches on the same projects.

After discussing the results, the research questions which were accompanied with the problem statement can be answered.

- *What kind of information can be gathered by interviewing the project personnel working on ECI projects?*

So far, in the initial phase most of the information is descriptive and an account of personal experiences of ECI based on the benefits observed by the personnel working on the project. There is also tangible information like reduction in costs and improvement in quality of design etc.

- *How useful is that information given that the projects are at such an early stage in their lifecycle?*

Given that ECI lead to realization of one of the projects and significant cost reductions in the other. The information obtained is useful and tells that benefits of ECI can be realized very early before the project is even started.

- *What is the extent of knowledge of project personnel working with ECI on these projects?*

The project personnel have worked with varying project delivery methods in the future, hence the level of confidence and information is high. The contractor also feels comfortable working with this method.

- *A contractor who has taken part in the negotiation process but was not able to win the project. How different is their view from the contractor who won the project?*

The contractor that did not end up winning the project also praised ECI. However, they pointed out the use of resources in the initial phase and demanded adequate compensation and more standardization of the method that would not leave out contractors who did not manage to win a previous negotiation round. Meaning that if a contractor has not managed to win a previous round of negotiation, they should have an incentive to take part in the next round of ECI.

- *What is the extent of tangible and intangible information based on the interviews?*

Apart from cost and improvement in design most of the parameters are intangible. This is understandable, as the project has not finished and things can change. It is difficult to put a concrete number on something before the project has finished.

One more thing that was concluded from the interviews was that, both the client and the contractor were very eager when it comes to trying new methods. They were quick to point out the benefits observed in the initial phase and were looking forward to working on this method again in future projects.

## 5.2 Recommendations for future practitioners

Based on the results obtained from the interviews and literature review, the author has following recommendations for practitioners of this method for future projects:

- **Involving contractors early enough:** It is very important to involve the contractors early enough so that their knowledge can actually make a difference in the project. In case of the two projects it can be seen that the most meaningful change is in the cost. Both projects had significant cost cuts when the contractor was given the task to design the project.
- **Realizing the complexity of the project:** It was also pointed out by the interviewees that not all projects are suited to ECI. Especially those which are not complicated enough. ECI seeks out to solve a problem i.e. making the project more efficient and if the project is simple enough that the contractor's knowledge will not have any effect on it. Then it won't be useful spending resources on early involvement of the contractor.
- **Choosing appropriate number of candidates:** The process of ECI can be resource intensive. The client has to set aside time and money to involve the contractor earlier. In a perfect scenario the client can have infinite number of choices but realistically that is not possible. It is important to have a reasonable number of candidates that client can manage within the given timeframe. The interviews pointed out that both of the projects had 3 contractors competing in the final stage which is a reasonable number. Too many and too less would affect the effectiveness of ECI.
- **Finding the optimal time for involvement:** The client and the contractor through further experience of this method, have to find out what is the optimal time for involvement. Sure, the projects and scope can differ significantly from one another but this would help with effective use of resources. Finding out the optimal time would pave the way for future projects, and would help with standardization of this method.

### **5.3 Limitations**

One of the limitations of this work that is worth-mentioning is that both of the projects studied are in their initial phases. Nydalsbrua is under construction and E5 Fjerdningen-Grøndalselv has not started with construction yet. In order to get a deeper understanding of ECI, a study should be carried out when these projects are finished.

This study revolves around road projects. Further studies can include projects from other public sectors such as healthcare, housing etc. This would also mean that a broader spectrum of companies and entities are involved.

In another framework the consultant can also be interviewed. Their perspective and experiences can also be studied as a part of

### **5.4 Suggestions for further research**

It is highly recommended to look at more projects which involve ECI. It would also be relevant to interview more contractors which were involved in the negotiation phase, plus the consultant. This would give more valuable information. A research spanning a broader spectrum of projects and stakeholders. It will also be relevant to carry out a study that can put definitive numbers on tangible aspects of a project. This will give more credibility to the ECI method. Speaking of optimal time of involvement, a research comparing different times of involvement in projects involving ECI would help see the effectiveness of when the contractor is involved in a project.

The involvement of the contractor can be studied in detail.

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## 6 Appendix A

### 6.1 Interview Guide for the client (Norwegian Public Roads Administration)

#### Introduction and Background

My name is Hamza, and I am a second-year student of Master of Science in Project Management at NTNU. I have a bachelor's degree in Civil Engineering and 3 years of professional experience as a Civil Engineer in two large construction projects. As a part of my master's degree, I am writing a thesis within the domain of Project Management and since I have a civil engineering background, I have chosen to focus on construction projects.

Early Contractor Involvement (hereby referred to as ECI) is a relatively new method of project execution where the contractor is involved earlier in the project as compared to the traditional method of execution (in the traditional method the contractor is only involved when they have won the project after some form of competitive bidding based on a specified solution). The main purpose is to incorporate contractor's knowledge and expertise in the design phase (or even earlier) of the project such that delays, changes and other uncertainties can be avoided.

The problem statement for this master's thesis is:

#### **'Effect of Early Contractor Involvement in Statens Vegvesen Projects'**

This thesis is being written in collaboration with the Norwegian Public Roads Administration (Statens Vegvesen). And as a part of this thesis, interviews will be carried out which aim to gather experiences and knowledge of ECI from SVV project managers. You have therefore been contacted because the project that you are working with has some form of Early Contractor Involvement.

OptimalTid, is a project that is being headed by SVV in collaboration with NTNU and other stakeholders. The purpose of this project is to find out the right time for involving the contractor earlier in the project so that the resources are used in the most efficient way possible. You can read more about the project on this link (<https://www.prosjektnorge.no/forskning/optimaltid/>).

The purpose of this thesis would be to document the experiences with ECI so that it can form as a source of information for future projects that are considering ECI as the method of execution.

ECI is a broad topic, and everyone has their own definition/interpretation. Therefore, this study by solely focusing on SVV projects would be more relevant for future projects within the same domain. This thesis will start with interviewing two projects that have ECI and then depending on the availability of time further move onto documenting the experiences of the contractor and/or more projects that have ECI. For now, the two projects that will be studied are:

- E6 Fjerdingen-Grøndalselv  
(<https://www.vegvesen.no/vegprosjekter/europaveg/e6soknedal/>)
- Rv. 706 Nydalsbrua med tilknytninger  
(<https://www.vegvesen.no/vegprosjekter/riksveg/rv706nydalsbrua/>)

### Interview Guide

The problem statement of this thesis is:

“Effect of Early Contractor Involvement in Statens Vegvesen Projects”

The problem statement can be broken down into the following research questions:

- **How was the contractor involved?**
- **What was the effect of early involvement?**
- **What could have been done to improve it even further?**

To simplify them even further, the research questions can be subdivided into the following parts.

#### 1. **How was the contractor involved?**

- (a) What kind of Early Contractor Involvement is applied in the project under study?
- (b) Are there any other types of ECI you have worked with? If so which ones?
- (c) How was the contractor involved? (This can be divided into the following questions)
  - i. On what task was the contractor involved?
  - ii. To what degree was the contractor involved?
  - iii. What kind of formal/informal agreements were made for early involvement?
- (d) How many contractors (if more than one) were involved?
- (e) How were the contractors approached and what was their reaction to this new method of involvement?
- (f) How did you select the contractors that were to be approached? I.e., the process, criteria and how were the contractors compared with each other?
- (g) How early was the contractor involved? (As a benchmark compared with the time of involvement in the traditional model).

#### 2. **What was the effect of early involvement? (Both positive and negative effects)**

- (a) What was the effect on cost of the project?
- (b) What was the effect on quality of work on the project?
- (c) How did ECI effect the schedule?
- (d) Did ECI play any role in reducing conflicts between the stakeholders? If so, how?
- (e) Was there any connection between HSE (Health, Safety and Environment) and ECI? If so how did ECI effect HSE on site?
- (f) Did ECI play any role in increasing the safety parameters of the road? i.e., made the road more or lesser safer for drivers.
- (g) What was ECI's role in constructability?
- (h) Did ECI contribute to making the project more sustainable (e.g., decreasing carbon emissions)? If so, how?
- (i) What role did ECI play in risk management and reduction of overall risk in the project?
- (j) Effect in intangible terms e.g., How did ECI contribute towards trust between the stakeholders and the relationship between stakeholders?
- (k) After your experience with ECI, do you wish to use this method in the future or not? What is reason for using/not using the method?

### **3. What could have been done to improve it even further?**

- (a) Is it relevant to involve them even earlier? If yes how early? Would involving them even earlier be beneficial for the project?
- (b) What could have been the effect if the contractor was involved later than the original time?
- (c) What could have been the effect if you used another ECI approach?
- (d) What are the legal/practical implementations/limitations of ECI? I.e., how early is too early?
- (e) Is it possible to use another method? If yes, what can be that method?
- (f) What was the optimal time for involving the contractor in this project considering your experiences with ECI?

## Additional Questions

- I Can you give me contact information of other persons (from the client, contractor and or consultant) that could be relevant for this study?
- II Can I get project specific and general documents that could be useful for this study?
- III Is it possible to contact you further in connection with this study? E.g., quality control of the interview and further information regarding the study.

## 6.2 Interview Guide for the contractor

### Introduction and Background

My name is Hamza, and I am a second-year student of Master of Science in Project Management at NTNU. I have a bachelor's degree in Civil Engineering and 3 years of professional experience as a Civil Engineer in two large construction projects. As a part of my master's degree, I am writing a thesis within the domain of Project Management and since I have a civil engineering background, I have chosen to focus on construction projects.

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The problem statement for this master's thesis is:

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The purpose of this thesis would be to document the experiences with ECI so that it can form as

a source of information for future projects that are considering ECI as the method of execution. ECI is a broad topic, and everyone has their own definition/interpretation. Therefore, this study by solely focusing on SVV projects would be more relevant for future projects within the same domain. This thesis will start with interviewing two projects that have ECI and then depending on the availability of time further move onto documenting the experiences of the contractor and/or more projects that have ECI. For now, the two projects that will be studied are:

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(<https://www.vegvesen.no/vegprosjekter/europaveg/e6soknedal/>)
- Rv. 706 Nydalsbrua med tilknytninger  
(<https://www.vegvesen.no/vegprosjekter/riksveg/rv706nydalsbrua/>)

### Interview Guide

The problem statement of this thesis is:

“Effect of Early Contractor Involvement in Statens Vegvesen Projects”

The problem statement can be broken down into the following research questions:

- **How was the contractor involved?**
- **What was the effect of early involvement?**
- **What could have been done to improve it even further?**

To simplify them even further, the research questions can be subdivided into the following parts.

#### **1. How was the contractor involved?**

- (a) Have you worked with ECI before? If so which type?
- (b) What kind of Early Contractor Involvement is applied in the project under study?
- (c) How were you involved in the project? (This can be divided into the following questions)
  - i. What was the first task in which you were involved?
  - ii. To what degree were you involved?
  - iii. What kind of formal/informal agreements were made by the client (byggherre) for early involvement?
- (d) How were you approached by Statens Vegvesen about ECI?

**2. What was the effect of early involvement? (Both positive and negative effects)**

- (a) What was the effect on cost of the project?
- (b) What was the effect on quality of work on the project?
- (c) How did ECI effect the schedule?
- (d) Did ECI play any role in reducing conflicts between the stakeholders? If so, how?
- (e) Was there any connection between HSE (Health, Safety and Environment) and ECI? If so how did ECI effect HSE on site?
- (f) Did ECI play any role in increasing the safety parameters of the road? i.e., made the road more or lesser safer for drivers.
- (g) What was ECI's role in constructability?
- (h) Did ECI contribute to making the project more sustainable (e.g., decreasing carbon emissions)? If so, how?
- (i) What role did ECI play in risk management and reduction of overall risk in the project?
- (j) Effect in intangible terms e.g., How did ECI contribute towards trust between the stakeholders and the relationship between stakeholders?
- (k) After your experience with ECI, do you wish to use this method in the future or not? What is reason for using/not using the method?

**3. What could have been done to improve it even further?**

- (a) Do you want to be involved even earlier in the project? If so, how early?
- (b) What could have been the effect if you were involved later than the original time?
- (c) What could have been the effect if you used another ECI approach?
- (d) What are the legal/practical implementations/limitations of ECI? I.e., how early is too early?
- (e) Is it possible to use another method? If yes, what can be that method?
- (f) What was the optimal time for involving the contractor in this project considering your experiences with ECI?

### Additional Questions

- I Can you give me contact information of other persons (from the client, contractor and or consultant) that could be relevant for this study?
- II Can I get project specific and general documents that could be useful for this study?
- III Is it possible to contact you further in connection with this study? E.g., quality control of the interview and further information regarding the study.



## 7 Appendix B

### 7.1 Interview 1

Table 7.1: Interview #1

<u>Interviewee (Project Manager Statens Vegvesen) Rv. 706 Nydalsbrua med tilknytninger</u>		
Sr#	Question	Answer
Section#1 How was the contractor involved?		
1	What kind of ECI is involved in the project under study?	Competition. Negotiation procedure with the contractor.
2	Are there any other types of ECI you have worked with? If so which ones?	First time working with ECI.
3	<p>How was the contractor involved?</p> <p>I. On what task was the contractor involved?</p> <p>II. To what degree was the contractor involved?</p> <p>III. What kind of formal/informal agreements were made for involvement?</p>	<p>I. The cost was too high after getting the first prices from the contractors. They used the method to negotiate prices with the contractors.</p> <p>II. Type of contract is 'unit price contract' 13:05.</p> <p>III. There was a formal agreement.</p>
4	How many contractors were involved?	5 initially and then 2 dropped out. 3 came up with an offer.
5	How were the contractor(s) approached and what was their reaction?	The project was advertised as a usual project, and it was listed there that they will use ECI. The contractors were very positive about it.
6	How was the contractor selected? I.e. the process, criteria and how were they compared with each other?	There was a pre-qualification round where 3-5 were shortlisted and then the competition among the shortlisted was started.

7	How early was the contractor involved?	After the design was finished. After involvement they had three rounds of negotiation to see what the best option is.
Section#2 What was the effect of Early Contractor Involvement?		
1	What was the effect on cost of the project?	The initial project was above the budget hence the early involvement helped bringing the prices down. It made the project possible.
2	What was the effect on quality of work on the project?	Yes, the quality was increased. The contractor had more time to study the project and work with it before it was started.
3	How did ECI effect the schedule?	No, the time needed for procurement offset the time saved by ECI so there was no change in the schedule.
4	Did ECI play any role in reducing conflicts between the stakeholders? If so, how?	ECI has contributed to a good working environment, but it is too early to rule out the possibility of a conflict.
5	Was there any connection between ECI and HSE?	HSE plans were a part of the ECI procedure and ECI was not only about costs and quality it was also about making the project safer.
6	Did ECI play any role in increasing the safety parameters of the road? i.e., made the road more or lesser safer for drivers.	No, the road was already planned to be safe so ECI did not have any contribution.
7	What was ECI's role in constructability?	Constructability was the biggest factor to be effected by ECI. The effect was positive.
8	Did ECI contribute to making the project more sustainable (e.g., decreasing carbon emissions)? If so, how?	The award criteria also included HSE and the contractor had to satisfy these in order to be able to win the project.
9	What role did ECI play in risk management and reduction of overall risk in the project?	ECI played a very positive role. Gave the opportunity and the time to list risks and opportunities.

10	Effect in intangible terms e.g., How did ECI contribute towards trust between the stakeholders and the relationship between stakeholders?	There was a high level of trust among the competing contractors and vegvesen. ECI contributed positively towards these factors.
11	After your experience with ECI, do you wish to use this method in the future or not? What is reason for using/not using the method?	Yes, especially in a project with high complexity and a little degree of freedom. ECI encourages dialogue and discussion among the stakeholders.
Section#3 What could have been done to improve it even further?		
1	Is it relevant to involve them even earlier? If yes how early? Would involving them even earlier be beneficial for the project?	Not in case of this project.
2	What could have been the effect if the contractor was involved later than the original time?	In this case it was not relevant to involve them earlier as they could not have more effect.
3	What could have been the effect if you used another ECI approach?	Then it would have been a totally different project with a different solution.
4	What are the legal/practical implementations/limitations of ECI? I.e., how early is too early?	There are no legal hinderances which limit from even earlier involvement.
5	Is it possible to use another method? If yes, what can be that method?	Then it would have been a totally different project. The method adopted was the right one under the given circumstances.
6	What was the optimal time for involving the contractor in this project considering your experiences with ECI?	The time at which the contractor was involved in this project i.e. after the zoning plan was finished and the procurement process was started was the optimal time for involvement.

## 7.2 Interview 2

Table 7.2: Interview #2

<b><u>Interviewee (Estimator) and (Technical Director) from contractor project</u></b>		
<b><u>Rv. 706 Nydalsbrua med tilknytninger</u></b>		
Sr#	Question	Answer
Section#1 How was the contractor involved?		
1	Have you worked with ECI before? If yes, which type?	Yes we have been in some dialogue phases since 2018.
2	What kind of ECI was involved in the project under study?	Idea competition. The contractors had to come up with solutions to the problems given by the client.
3	How was the contractor involved? I. On what task was the contractor involved? II. To what degree was the contractor involved? III. What kind of formal/informal agreements were made for involvement?	I. Getting to know the project and people working for the client was the first task. II. We were involved until delivering the final offer. Everything on the engineering side was already decided so we did not have a large degree of freedom to suggest improvements and change things. III. We got a message from NPRA after pre-qualification that we are a preferred bidder.
4	How were you approached by NPRA about ECI?	ECI was mentioned in the invitation to bid documents.
Section#2 What was the effect of Early Contractor Involvement?		
1	What was the effect on cost of the project?	If you go through a relatively long and detailed dialogue phase, the quality increases. But doesn't mean that the price goes down. It is both positive and negative. Price goes down as we have better knowledge of the project but more investigation can also lead to need for more construction especially on complicated projects.
2	What was the effect on quality of work on the project?	The quality increases if you work with the project more than usual.

3	How did ECI effect the schedule?	There was not a significant effect on schedule as per our experience.
4	Did ECI play any role in reducing conflicts between the stakeholders? If so, how?	Yes because the stakeholders have a better time to get to know each other.
5	Was there any connection between ECI and HSE?	HMS was an important part of the dialogue process.
6	Did ECI play any role in increasing the safety parameters of the road? i.e., made the road more or lesser safer for drivers.	No, there was no effect on the safety parameters of the road itself.
7	What was ECI's role in constructability?	The project was already constructable, so ECI did not affect constructability to a huge degree. But it did help with discussing and solving technical problems in the dialogue phase.
8	Did ECI contribute to making the project more sustainable (e.g., decreasing carbon emissions)? If so, how?	Yes, since more time was used on studying different aspects of the project the effect is positive. Focus on CO2 emissions was an important part of the criteria.
9	What role did ECI play in risk management and reduction of overall risk in the project?	The effect was positive as more time was spent on studying the project.
10	Effect in intangible terms e.g., How did ECI contribute towards trust between the stakeholders and the relationship between stakeholders?	Trust increases because you get to work with the same people throughout the process. However, the effect can be negative if the whole team changes.

11	After your experience with ECI, do you wish to use this method in the future or not? What is reason for using/not using the method?	Yes, but we want to win the project too! This is a great method to understand the project. But we have been in many dialogue phases, and this is method requires a lot of resources in the front end. The contractor wants to see the result of these results.
Section#3 What could have been done to improve it even further?		
1	Do you want to be involved even earlier in the project? If so, how early?	No, we were involved on the right time from a technical standpoint.
2	What could have been the effect if the you were involved later than the original time?	Then the quality and risk assessment would have suffered.
3	What could have been the effect if you used another ECI approach?	The effect would not be as positive as we had. The method used was the right one.
4	What are the legal/practical implementations/limitations of ECI? I.e., how early is too early?	There is nothing that binds the contractor that they must deliver an offer and commit. They can back out any time. In other countries you must have good reasons not to deliver an offer. So there is need for an ECI contract that bounds contractor to deliver an offer at the end of the process.
5	Is it possible to use another method? If yes, what can be that method?	No we don't have any suggestions for a different method.
6	What was the optimal time for involving the contractor in this project considering your experiences with ECI?	4-6 Months of dialogue phase is the optimal time spent. The time of involvement in this project was the right one.

### 7.3 Interview 3

Table 7.3: Interview #3

<u>Interviewee (Project Manager, contractor) Project Rv. 706 Nydalsbrua med tilknytninger</u>		
Sr#	Question	Answer
Section#1 How was the contractor involved?		
1	Have you worked with ECI before? If yes, which type?	Yes, ECI in a public-private-partnership project and a turnkey contract model.
2	What kind of ECI was involved in the project under study?	Idea competition among contractors. The project was over budget so main task was to bring the price down.
3	How was the contractor involved? I. On what task was the contractor involved? II. To what degree was the contractor involved? III. What kind of formal/informal agreements were made for involvement?	I. The procurement processes. The contractor had to make plans for traffic handling and risk assessment. II. The communication was open, and the contractor had the opportunity to talk about their opinions and recommendations for the project. But the contractor could not make significant changes to the project. III. Standard agreement in addition to the early involvement but the limits of involvement were clearly stated.
4	How were you approached by NPRA about ECI?	ECI was mentioned in the invitation to bid documents.
Section#2 What was the effect of Early Contractor Involvement?		
1	What was the effect on cost of the project?	The reduction in cost made the project possible.
2	What was the effect on quality of work on the project?	We have a better plan which means we are in a better position to avoid mistakes and improve the quality.

3	How did ECI effect the schedule?	More time was spent in the negotiation phase to develop a plan and risk assessment. But that lead to a faster execution. But the overall effect in not known since the project is not completed.
4	Did ECI play any role in reducing conflicts between the stakeholders? If so, how?	Stakeholders had better understanding of each other's position which reduces conflicts.
5	Was there any connection between ECI and HSE?	Mainly focused on the maximum time allowed to close traffic in order to carry out the work. An improvement overall.
6	Did ECI play any role in increasing the safety parameters of the road? i.e., made the road more or lesser safer for drivers.	No, there was no effect this parameter.
7	What was ECI's role in constructability?	Not so much.
8	Did ECI contribute to making the project more sustainable (e.g., decreasing carbon emissions)? If so, how?	Sustainable goals were part of the award criteria so the contractor had to put in efforts to make the solution more sustainable.
9	What role did ECI play in risk management and reduction of overall risk in the project?	Risk assessment was a part of the negotiation process so the contractor came up with a better assessment of risk.
10	Effect in intangible terms e.g., How did ECI contribute towards trust between the stakeholders and the relationship between stakeholders?	The relationship was very good between the contractor and the client. Earlier teamwork lead to increased trust.
11	After your experience with ECI, do you wish to use this method in the future or not? What is reason for using/not using the method?	Yes. Better relationships, trust, more time to understand the project are some of the reasons to use this method again.



Section#3 What could have been done to improve it even further?		
1	Do you want to be involved even earlier in the project? If so, how early?	The contractor would like to be involved earlier but they would not like to take part in the political decisions and aspects of the project.
2	What could have been the effect if the you were involved later than the original time?	The price would have been much higher than it originally is. And the project would be delayed.
3	What could have been the effect if you used another ECI approach?	Other methods would not suit as much as the one used here so the effect would not be positive in terms of risk and price.
4	What are the legal/practical implementations/limitations of ECI? I.e., how early is too early?	Too early is when the contractor must take the political and regulation related risks. Also, too early if the project becomes a totally different project by the time the contractor wins it.
5	Is it possible to use another method? If yes, what can be that method?	Yes, but it comes down to the value you get from that method. There can be a mixture of methods too. Right people with the right competence is the most important thing.
6	What was the optimal time for involving the contractor in this project considering your experiences with ECI?	Yes, the time for involving was optimal. But the contractor potentially get even more value if some of the solutions had a greater degree of flexibility.

#### 7.4 Interview 4

Table 7.4: Interview #4

<b><u>Interviewee (Construction Manager, Statens Vegvesen) E6</u></b>		
<b><u>Fjerdningen-Grøndalselv</u></b>		
Sr#	Question	Answer
Section#1 How was the contractor involved?		

1	What kind of ECI is involved in the project under study?	Making the zoning plan was part of the contract. Contractor was involved in the design phase of the project. Contract was awarded after a competition driven dialogue.
2	Are there any other types of ECI you have worked with? If so which ones?	No, this is the first time.
3	How was the contractor involved? I. On what task was the contractor involved? II. To what degree was the contractor involved? III. What kind of formal/informal agreements were made for involvement?	I. Development of the zoning plan was the first task. II. They had all the technical information and came up with suggestions in the dialogue meetings where they got feedback from NPRA. III. Usual procurement contract but it was stated
4	How many contractors were involved?	7 showed interested, 5 took part in pre-qualification and finally 3 were shortlisted for the ECI process.
5	How were the contractor(s) approached and what was their reaction?	The contract was listed out along with the details about ECI. The listing was standard used by NPRA for projects.
6	How was the contractor selected? I.e. the process, criteria and how were they compared with each other?	There were specific requirements for pre-qualification. After that the contractors were judged based on criteria like price, construction time, quality of work and execution plan.
7	How early was the contractor involved?	Before the zoning plan was made.
Section#2 What was the effect of Early Contractor Involvement?		
1	What was the effect on cost of the project?	The cost was minimized. All of the three offers we got were below what we anticipated for the project.
2	What was the effect on quality of work on the project?	The quality of design is better i.e. the road curvature is better. But construction has not begun so we are not sure about the effect on quality.

3	How did ECI effect the schedule?	The overall effect is not fully known. More time was spent on the dialogue phase but the zoning plan and construction plan was executed at the same time.
4	Did ECI play any role in reducing conflicts between the stakeholders? If so, how?	Not sure about the execution phase but in the dialogue phase ECI did help with reducing conflicts.
5	Was there any connection between ECI and HSE?	HSE was a part of the procurement phase. The execution hasn't started yet so it can't said how ECI affected it in the execution phase.
6	Did ECI play any role in increasing the safety parameters of the road? i.e., made the road more or lesser safer for drivers.	I cannot say a lot about this. Safety is already a parameter when we design the roads so ECI did not have any effect on it.
7	What was ECI's role in constructability?	The contractor was involved earlier so they came up with constructable and simple suggestions.
8	Did ECI contribute to making the project more sustainable (e.g., decreasing carbon emissions)? If so, how?	These things were already part of the award criteria.
9	What role did ECI play in risk management and reduction of overall risk in the project?	Since the contractor has better understanding of the design the overall risk is reduced. They know the situation and project better e.g. the contractor had to study ground conditions thoroughly before submitting a bid.
10	Effect in intangible terms e.g., How did ECI contribute towards trust between the stakeholders and the relationship between stakeholders?	We had the opportunity to meet the contractors several times before starting the execution, so we understood each other better. That lead to increased trust and better relationships.

11	After your experience with ECI, do you wish to use this method in the future or not? What is reason for using/not using the method?	The experience is positive so far. In this project we don't have the consultant working directly under us so that can be a problem. If the project suits the method then I will gladly use it again.
Section#3 What could have been done to improve it even further?		
1	Is it relevant to involve them even earlier? If yes how early? Would involving them even earlier be beneficial for the project?	No, that would be too early. Then we are talking about the municipal plan and the concept phase.
2	What could have been the effect if the contractor was involved later than the original time?	Then the cost would be not be as low as it is now.
3	What could have been the effect if you used another ECI approach?	I don't have a lot of experience with other ECI approaches so I cannot say anything about that.
4	What are the legal/practical implementations/limitations of ECI? I.e., how early is too early?	This is a difficult question. It mostly depends on the procurement law. But the method should be so that it does not totally change the project. I.e. the concept and the final product are totally different from each other.
5	Is it possible to use another method? If yes, what can be that method?	We could have used turnkey contract but that would have gives us far less opportunity to make changes.
6	What was the optimal time for involving the contractor in this project considering your experiences with ECI?	As far as we get a good offer, good zoning plan and execution phase the time at which the contractor was involved in this project was the right time. But it is too early to decide it now as the project has not begun.

## 7.5 Interview 5

Table 7.5: Interview #5

<b>Interviewee (Planning lead, Statens Vegvesen) E6 Fjerdningen-Grøndalselv</b>		
Sr#	Question	Answer
Section#1 How was the contractor involved?		
1	What kind of ECI is involved in the project under study?	Contractor was responsible for the zoning plan, execution plan and risk assessment of the project. These were prerequisites to submit a bid. Consultant was under the contractor.
2	Are there any other types of ECI you have worked with? If so which ones?	No I haven't worked with ECI before.
3	How was the contractor involved? I. On what task was the contractor involved? II. To what degree was the contractor involved? III. What kind of formal/informal agreements were made for involvement?	I. The contractor was a part of development and analysis of different alternatives. There was a cost limit for the alternatives. II. From zoning plan to construction phase. III. Formal agreements involving the terms for ECI were made with the contractors who were qualified.
4	How many contractors were involved?	A total of 3 pre-qualified contractors were involved.
5	How were the contractor(s) approached and what was their reaction?	Standard procedure of listing projects. The reaction was positive, and the contractors were interested in the method.
6	How was the contractor selected? I.e. the process, criteria and how were they compared with each other?	The interviewee does not have experience of this phase in this project.

7	How early was the contractor involved?	The contractor was involved when the development of zoning plan was started.
Section#2 What was the effect of Early Contractor Involvement?		
1	What was the effect on cost of the project?	The cost will go down. It is easier to make changes in the negotiation process. This means more time to find a cost-effective solution.
2	What was the effect on quality of work on the project?	Improvement in the quality of technical plan and the engineering phase of the project.
3	How did ECI effect the schedule?	The engineering and management phase starts earlier. Combine that with a lesser probability of changes and the time decreases.
4	Did ECI play any role in reducing conflicts between the stakeholders? If so, how?	It is too early to say anything but so far there hasn't been a big conflict among the stakeholders.
5	Was there any connection between ECI and HSE?	HSE was also taken care of in the early involvement process. The contractor spent time on making the execution safer.
6	Did ECI play any role in increasing the safety parameters of the road? i.e., made the road more or lesser safer for drivers.	No, the safety parameters are already a part of designing a road.
7	What was ECI's role in constructability?	Constructability was an important focus for the whole process. The contractor spent time from the start making efforts to increase constructability.
8	Did ECI contribute to making the project more sustainable (e.g., decreasing carbon emissions)? If so, how?	CO2 emissions and minimizing the environmental impact was a part of the award criteria.
9	What role did ECI play in risk management and reduction of overall risk in the project?	The contractor sees risk from a different perspective i.e. from design phase to finishing construction. The involvement of contractor helped with better risk management.

10	Effect in intangible terms e.g., How did ECI contribute towards trust between the stakeholders and the relationship between stakeholders?	ECI contributed positively when it comes to trust and relationship among the stakeholders i.e., contractor and the NPRA.
11	After your experience with ECI, do you wish to use this method in the future or not? What is reason for using/not using the method?	Yes, because in this method we have more contact with the contractor in the early phase. But in this specific method the client wasn't steering the consultant which can be disadvantage in eyes of the client.
Section#3 What could have been done to improve it even further?		
1	Is it relevant to involve them even earlier? If yes how early? Would involving them even earlier be beneficial for the project?	No, I don't think so. Because then we are working with the concept and municipal plan and that would be too early for the contractor to be involved. Zoning plan is a better stage of involvement because then we have a better idea of where approximately the road is going to be.
2	What could have been the effect if the contractor was involved later than the original time?	More uncertainty in the design and construction phase, more changes in plan. More changes might also lead to increased costs and an increased probability of conflicts.
3	What could have been the effect if you used another ECI approach?	Not as positive as the one we used in this project.
4	What are the legal/practical implementations/limitations of ECI? I.e., how early is too early?	There are no big limitations. Involvement in the municipal plan and concept phase is too early in my opinion.
5	Is it possible to use another method? If yes, what can be that method?	Since the consultant was not in contact with the client (they were acting as a sub-contractor under the contractor), a model where the consultant is also in contact with the client would be more suitable.

6	What was the optimal time for involving the contractor in this project considering your experiences with ECI?	The time at which the contractor was involved was the optimal time.
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