EARLY CONTRACTOR INVOLVEMENT APPROACHES IN PUBLIC PROJECT PROCUREMENT

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ABSTRACT

Early contractor involvement (ECI) faces many barriers when it is implemented in public procurement, given that it is different from traditional business practices. Primarily, public owners face a major challenge, as they should treat all bidders equally. The purpose of this paper is to explore suitable ECI approaches that public owners could use. In addition to a literature and document study, fourteen semi-structured in-depth interviews with key personnel from eleven cases selected from Norwegian public bridge projects were carried out. In all, 23 unique approaches of ECI were identified during this research (16 from literature and 7 new from case projects). The findings provide a new direction to ECI through introducing new approaches of ECI from the case projects.

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INTRODUCTION

Public owners have the objective to realize projects in a timely and cost-effective manner, but they are increasingly facing complex projects. For example, the Norwegian Public Roads Administration (NPRA) is currently planning a mega project, E39 Coastal Highway Route, along the west coast of Norway. One of the main ambitions of this project is to make the E39 ferry free. Eight long and deep fjords need to be crossed by bridges and tunnels. Most of them will be crossed by bridges of unprecedented complexity. The project is estimated at a cost of approximately 40 billion U.S. dollars (NTP, 2016). NPRA needs innovative solutions for this project. How to procure contractors for these complex bridge projects to obtain innovative solutions– and how to use their knowledge and experience to make the project time and cost-effective – is challenging for the NPRA. In response to this challenge, early contractor involvement (ECI) has been identified as one of the solutions proposed by an NPRA group of experts (Vegvesen, 2012).

In the literature, it is widely accepted that contractors have better construction knowledge and experience than the client and the designer (Song et al., 2009; Walker and Lloyd-Walker, 2012). Traditional project delivery methods (for example, Design-Bid-Build with unit price contracting, open bidding and owner quality control) facilitate transparent checks and balances. One shortcoming of the traditional methods is that contractors – who are going to carry out the projects – are not involved in developing them. However, the growth of increasingly more complex projects demands alternative (evolving) project delivery methods to ensure appropriate project delivery, contract compliance, and quality assurance (Molenaar et al., 2007). One of the evolving approaches is ECI (Lahdenperä, 2016; Molenaar et al., 2007).

The main ambition of ECI is typically understood to be bringing construction knowledge and experience into the pre-construction phases of projects. Of particular interest is the improvement in value for money and project delivery time in comparison to traditional project delivery methods (Scheepbouwer and Humphries, 2011).

The integration of construction knowledge and experience is most beneficial in the early phases of the project (Lahdenperä, 2013). These phases are usually characterized by having the largest potential to influence the design with minimum impact on cost (Kristensen et al., 2015; Rekonen and Björklund, 2016). Research identifies that the construction industry has had positive experiences from practicing ECI (Lahdenperä, 2013; Naoum and Egbu, 2016).

Even if ECI has several advantages, it faces many barriers to implementation. These barriers mainly arise from the fact that the practice involved differs from traditional business practices (Song et al., 2009; Lahdenperä, 2013). Of particular importance are the formal barriers - such as international and national legislation - to the implementation of ECI (Kolman, 2014). Predominantly, public owners face a major challenge if they want to implement ECI since the contractor selection methods involved typically defy established standards (Lahdenperä, 2013). For instance, it is demanding for European public owners to involve the contractor before the project is described in detail since EU public procurement directives oblige owners to use competitive and transparent team selection procedures. It is difficult to use competitive and transparent team selection procedures before the project is detailed. Furthermore, they are obliged to use both price and quality as selection criteria during the early team selection. However, in an early phase of a project, it is challenging to use price as one of the selection criteria due to various uncertainties (Lahdenperä, 2013; European Parliament, 2004; European Parliament, 2014).

Norwegian public owners are obliged to follow international agreements throughout national public procurement regulations. This includes the World Trade Organization (WTO) and European Economic Area (EEA) agreements (Lædre, 2006). The main purpose of these agreements is to achieve the equal treatment of all bidders by obliging public owners to specify clearly what procurement procedures they intend to use before starting to procure (Lædre, 2006; Schnitzer, 2010). However, these agreements create additional challenges for public owners considering early contractor involvement (Lahdenperä, 2013).

The few sources identified from within the EU context have documented how public owners implement ECI in their projects and faced the existing (mainly legal) barriers. Likewise, many authors have not discussed the success factors of ECI with the intention of increasing the understanding of the ECI concept from a public procurement perspective. By using a multiple-case study approach, this paper addresses the knowledge gaps.

The research questions addressed are:

- What do public owners do to implement ECI?
- What are the success factors for ECI?
- How could the implemented ECI approaches be improved in practice?

The first research question is addressed through a literature review and empirical research in eleven Norwegian bridge projects. The second research question is addressed through empirical research into these bridge projects. The third research question is addressed by analyzing the findings from the first and second research questions.

METHOD

The research reported in this study was based on a multiple case study approach, carried out according to the recommendations of Yin (2013). The multiple case study approach was favored in order to understand the topic better by studying similarity and differences between the cases. Furthermore, it was favored to discover the research questions from a wider perspective, to generate strong and reliable evidence and to create a more convincing theory (Gustafsson, 2017). Following the initial literature study, a document study of selected cases, in addition to fourteen interviews with key actors from the selected cases, were carried out.

The review of the contemporary literature was undertaken using the search engines Oria and Google Scholar. Oria is a Norwegian University library resource that includes academic journal papers, conference papers, reports, dissertations, etc. The search words used included ECI, public procurement, EU, infrastructure projects, success factors and the combination of these. Besides, citation chaining according to the principles laid out by Ellis (1993) was also used to find new literature. To filter the relevant literature, abstracts of the articles were read. Based on the literature review, a theoretical framework with case-specific challenges was established after the recommendations of Blumberg et al. (2014).

Based on recommendations from 20 key professionals with several years of experience with in NPRA and from studying NPRA's yearly internal project reports from 2001-2013, eleven bridge projects were identified as cases relevant for study. The cases are presented in Table l.

Table 1: Description of the Projects and Informants

Cases	Informants	Project description	
		Length	Year completed
1.Tresfjordbrua	PM([1]) &CM	1,290m	2015
2.Gullibrua	CM & the contractor PM	740m	2014
3.Paradisbrua	PM, PuM &DM	53m	Not started
4.Sykkylvsbrua	CM	860m	2000
5.Lepsøybrua	PM & CM	800m	Not started
6.E6*E16 Flyplasskrysset	CM	350m	2016
7.Smålenenebrua	DM	300m	2011
8.E39 Godsterminalenbrua	APM	-	Planning phase
9.Linesøybrua	CE	315m	2011
10.Tjønnøybrua	PM([1])	270m	2003
11.Straumsbrua	PM ([1])	290m	2004

[1]In three of the projects the project manager (PM) was the same person.

The 20 key professionals (most of them are regional managers of NPRA and the rest are senior representatives from NPRA's head office) recommended these projects. The argument behind their recommendation was that these projects were announced for bid in a manner that was relatively open to using contractors' knowledge and experiences. The 11 bridge projects included in the study were characterized by using a contract form (design-build) and implementation strategy (announcing with alternative technical solutions) that differ from the traditional design-bid-build. Four of the projects were/will be announced for bid using design-build contracts, six projects were/will be announced for bid with alternative technical solutions, and one was announced with both.

Given that one of the authors was an employee with NPRA during the research, full access to the internal digital case documents and interviewees was ensured. This access was another

determining factor for the choice of case projects. However, some of the projects were old, so digital documents were not available in the NPRA database. In the selected cases, copies of relevant material, including contract documents, project end reports, and tender documents, were requested, obtained, and analyzed. These documents supported opinions and information gathered during the interviews. After the interviews, these documents were scrutinized closely in order to validate the information provided in the respective interviewees.

Fourteen semi-structured, in-depth, case specific interviews were conducted. Each interview was conducted at the interviewee's office based on an interview guide that was established based on research questions (see Appendix). The interviews lasted between one and two hours. All the interviews were recorded and later transcribed into written dialogues. Thirteen of the interviews were with client personnel and one with contractor personnel; all interviews were conducted according to the methodological approach described by Yin (2013). More client representatives were interviewed because this study aims to explore ECI approaches from the client's perspective. Furthermore, the fact that the client is the party that selects the contract strategy supports this selection. The professional role of most respondents was a manager. The functions included one assistant project manager (APM), one purchasing manager (PuM), one control engineer (CE), three project managers (PM), three design managers (DM), and five construction managers (CM). The choice of using semi-structured interviews was based on a desire to give flexibility for the interviewees and to identify new ways of seeing and understanding the topic. The nature of the questions was open-ended with the intention to bring the most out of the respondent's own reflection, while the interviewees were encouraged to express their views on the subject without being restrained by the predetermined questions related to the studied cases.

The interviewees were considered reliable since all the respondents were actively involved in the procurement phase of the case projects. The validity of the interviewees was considered as the case projects were picked based on the recommendation of the 20 key professionals. Then, the project managers of these case projects were contacted in each case. In some of the cases, the project managers were not available, were not the most knowledgeable persons in the procurement process, had changed employer or retired. These unavailabilities resulted in contacting the other key informants through the project managers' channel.

After data collection, data analysis continued based on the description of Creswell (2013). Data analysis steps described by Creswell (2013) are:

1) organizing and preparing raw data (transcripts, field-notes, images, etc.) for analysis
2) reading through all data
3) coding the data (hand or computer)
4) use the coding process to generate themes or description
5) interrelating themes/description
6) interpreting the meaning of themes/descriptions.

The data were hand coded and analyzed hand-in-hand with data collection and findings write up. The codes were developed based on the theory being examined. They are success factors and ECI approaches. Through the coding process, themes or categories were generated. These themes were interrelated and appeared as major findings and are also used as sub-headings in the findings section.

THEORETICAL BACKGROUND

Early contractor involvement definition

Different terms have been used for the phenomena here called ECI (Turner and Riding, 2015). ECI has also been associated with popular terms such as early supplier involvement and supply chain management (Lenferink et al., 2012). The main idea of ECI consists of involving the competence of a contractor in the early stage of a project. Through teamwork with owners and consultants, the contractors contribute construction knowledge to the early processes (Scheepbouwer and Humphries, 2011; Song et al., 2009). Direct and early involvement of the contractor in the front-end phase increases the benefits of ECI. Better cooperation can be facilitated by direct involvement while better contribution can be facilitated by early involvement (Song et al., 2009).

Sceepbower and Humphries (2011) have identified the difference between ECI practices in the U.S. and countries such as the UK and Australia. The ECI approach in the U.S. is a type of construction management (CM) contracting. In this ECI approach, the owner holds two contracts, one with the designer and the other with the contractors. In the ECI approach that is practiced in the UK and Australia, however, the owner holds a single contract with the

contractor. This latter type of ECI resembles alliancing during the design phase and design-build (DB) contract during the project execution phase (Scheepbouwer and Humphries, 2011).

Through the literature review leading up to this paper, it was observed that there is ambiguity on the subject of the definition of ECI.

Song et al. (2009) define ECI as contractor involvement in the design phase of a project, implemented by a design-build (DB) contract instead of design-bid-build (DBB). The aim of ECI in design is to integrate construction knowledge into the design process. Through this type of ECI, it is possible to improve information flow, drawing, material supply and construction schedule performance

Lenferink et al. (2012) and Valkenburg et al. (2008) analyzed road projects and defined ECI as contractor involvement in the planning phase of projects. Based on their definition, the aim of this ECI approach is to involve the contractors in the procurement process before the decision of the route determination is made. The purpose is to gather support from the contractors in determining the route of the road.

Recently, Walker and Lloyd-Walker (2012) have developed a comprehensive definition of ECI and the different models of ECI. According to their definition, ECI can start in the internal or business development phase and can last until the project completion and handover phase. That means it can take place in the internal phase, planning phase, design phase and in the project execution phase. They further divide ECI into five different models depending on which phase of the project the contractor involvement occurs. Their conclusion is that ECI can be implemented by a range of approaches that could include traditional DBB, DB, management contracting, project partnering and project alliancing (Walker and Lloyd-Walker, 2012).

Different owners have developed different ECI models based on their necessities and circumstances. Some owners have developed relationship-based ECI models for the whole life cycle of the project. Other owners developed a more hybrid model. In the later ECI model, the contract starts with a collaborative approach in the early phase of a project and moves to a conventional type of contract in the project execution phase (Rahmani et al., 2013). The contractor can be involved through various approaches to implementing ECI (Rahman and Alhassan, 2012).

Walker and Lloyd-Walker (2012) developed a model that illustrates the various ECI models. Figure 1 illustrates the three contract forms and how the five models of ECI can be mapped onto three of the identified four project life cycles phases.

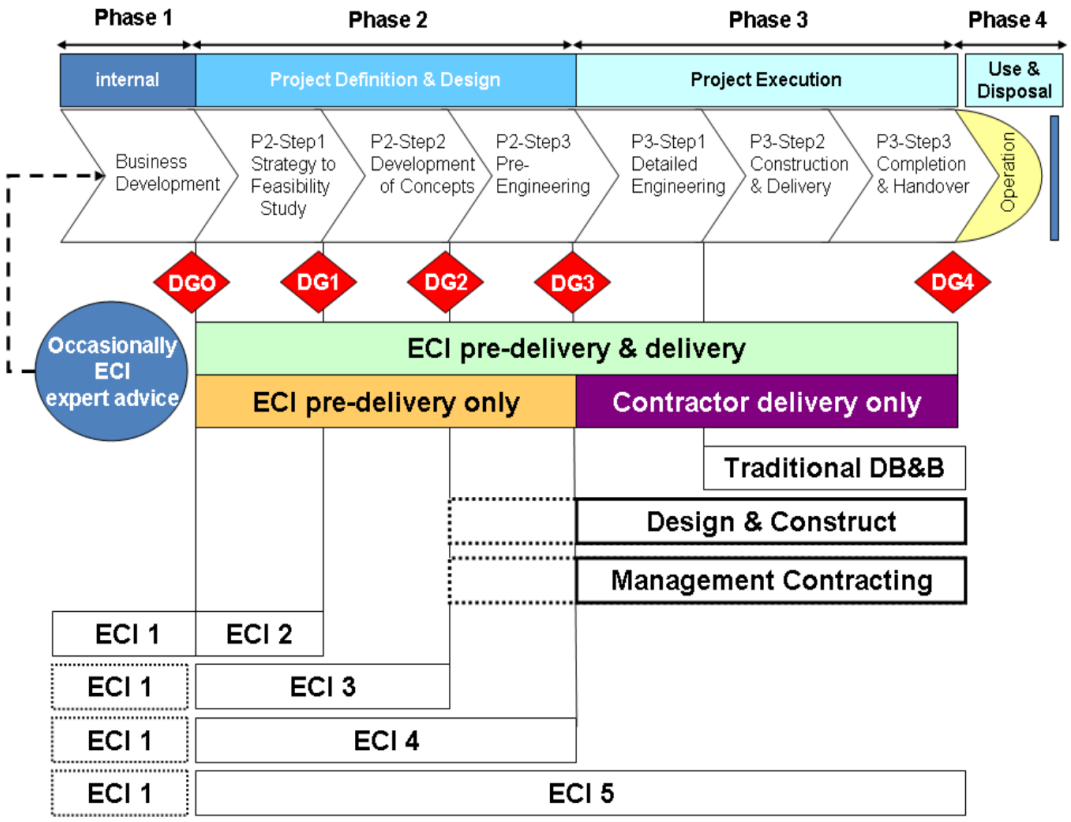

Figure 1: Project Life Cycle Phases.

DG denotes to decision gates: DG0=formally recognized idea, DG1=acceptable initiative to investigate, DG2=choice of concept, DG3=go/no go, DG4=accept outputs for the operation phase: (Walker and Lloyd-Walker, 2012) adapted from (Klakegg et al., 2010):

The main goals of ECI are to facilitate innovation, improve project control and reduce time to completion (Lenferink et al., 2012; Van Valkenburg et al., 2008; Mosey, 2009). Furthermore, the literature has discussed several advantages of ECI, including improved constructability, increased product information, better profitability and feasibility analyses, better communication, better risk management, better plan for construction (Sødal et al., 2014). ECI contributes to better relationships, increases understanding among parties and decreases the potential of adversarial relationships. These beneficial factors stem from the fact that the approach demands frequent interaction and communication. This close interaction and

communication lead to the development of shared goals and objectives that in turn builds cooperative relationships (Rahman and Alhassan, 2012; Scheepbouwer and Humphries, 2011).

The authors understand ECI to be a measure to involve construction knowledge and experience in early phases of a project, directly or indirectly. The early phases of a project are understood in the following as the internal phase, planning phase and design phase. However, in line with the argument of Walker and Lloyd-Walker (2012), we equally consider some ECI activates to take place in the execution phase of a project (see Figure 1).

ECI approaches

Table 2 presents possible approaches of ECI that public owners in the EU can implement. The table is based on a contemporary literature review of the authors of this paper.

Table 2: ECI Approaches Identified from the Literature.

No.	**Approaches of ECI**	**Literature (Authors)**
1	Building Information Modelling (BIM) – tool and process, enabling a high level of design integrity through the common use of BIM platform in early phases.	(Gransberg, 2016), (Kent and Becerik-Gerber, 2010), (Walker and Lloyd-Walker, 2015)
2	Integrated Project Delivery (IPD) – integrates people, systems, business structures and practices through relational contracting.	(Gransberg, 2016), (Kent and Becerik-Gerber, 2010), (Lahdenperä, 2012) (Gokhale, 2011)
3	Most Economical Advantageous Tender (MEAT) – qualifications-based selection of design and construction parties.	(Scheepbouwer and Humphries, 2011), (Lahdenperä, 2013), (Falagario et al., 2012)
4	Open book target pricing – pricing process is to make the contractor to design or construct the project on budget.	(Gransberg, 2016), (Scheepbouwer and Humphries, 2011), (Rahman and Alhassan, 2012), (Molenaar et al., 2007)

5	Cost led procurement – procurement methods that have been developed in the UK comparable to target pricing.	(Ciribini et al., 2016), (Williams et al., 2013)
6	Integrated Project Insurance – an alternative form of insurance providing single cover for the construction project team as a whole.	(Ciribini et al., 2016), (Connaughton and Weller, 2013)
7	Opening for alternative tenders – the client, allow variant solutions by the bidders during the tendering phase.	(Riemann and Spang, 2014)
8	Alliancing – is a project delivery method where the client and contractor participants work together as an integrated, collaborative team and making unanimous decisions.	(Walker and Lloyd-Walker, 2012), (Rahmani et al., 2014), (Lahdenperä, 2012),(Rahman and Alhassan, 2012)
9	Competitive dialogue – procurement procedure for awarding complex public projects.	(Lenferink et al., 2012), (Hoezen, 2012), (Kolman, 2014), (Lenferink et al., 2013), (Marique, 2013), (European Parliament, 2014)
10	Best value procurement (BVP) – It is an award method to procure contractor with the best expertise to complete the task.	(Hoezen, 2012), (Kashiwagi, 2016)
11	Negotiated procedure – Procurement procedure like competitive dialogue but can be applied in simpler public projects.	(Van Valkenburg et al., 2008), (Lenferink et al., 2012), (Hoezen, 2012), (European Parliament, 2014)
12	Partnering – a long-term commitment between the client and contractor for the	(Rahman and Alhassan, 2012), (Walker and Lloyd-Walker, 2012), (Lahdenperä,

	purposes of achieving specific business objectives.	2012), (Löwit and Dostálová, 2014), (Chan et al., 2004)
13	Framework agreement – a procurement arrangement to buy goods and services over a certain period of time.	(Walker and Lloyd-Walker, 2015), (Albano and Sparro, 2010)
14	Design & construct contract / Design & build contract – contract form where the contractor has the responsibility of design in addition to the construction of the project.	(Rahmani et al., 2014), (Song et al., 2009)
15	Management contracting – contract form when a project owner outsources the project management.	(Rahmani et al., 2014), (Walker and Lloyd-Walker, 2015), (Rahman and Alhassan, 2012)
16	Public private partnerships (PPP) –a design-construct-operate-maintain contract and it is similar to Build Own Operate Transfer (BOOT).	(Walker and Lloyd-Walker, 2012), (Rahmani et al., 2014), (Jacobsson and Walker, 2013), (Löwit and Dostálová, 2014), (Hans Voordijk et al., 2016)

All of the 16 approaches fall within the understanding of ECI outlined in the previous section.

Success factors

In order to ensure successful project completion and to minimize surprising variations during the project implementation phase, early identification of success factors is crucial (Torp et al., 2006). The idea behind the identification of success factors is that there are certain major factors that have considerable influence on project performance, and if identified during the front-end phase, will enhance the successful completion of projects (Torp et al., 2004). The purpose of identifying success factors is not to avoid problems; it is rather to aim at knowing how to respond before the problems occur. It is found equally to help project teams minimize

firefighting, minimize spontaneous approaches in managing uncertainties and minimize the changes encountered during project implementation (Torp et al., 2004). For these reasons, the authors of this paper have found it essential to study the success factors of ECI in public projects.

FINDINGS AND DISCUSSION

ECI approaches implemented in the Norwegian public owned bridge projects

Twelve ECI approaches were identified during interviews. A) Findings from interviews and B) discussions as well as recommendations are presented in this section. Of the twelve approaches identified in the interviews, seven are not found in the 16 approaches identified in the literature. The implication of these unidentified approaches is that the literature focuses on advanced ECI approaches that can be implemented for very complex projects; however, the findings from the case studies indicate that there are relatively simpler ECI approaches that can be implemented on less complex projects.

Approaches one to nine have been implemented in the studied projects during different phases of the project. Whereas, approaches ten to twelve were not implemented in the target projects. Instead, interviewees proposed them as a potential approach for future use.

Table 3 presents a matrix of approaches versus projects to show which approaches are mutually implemented in the target projects. Only three ECI approaches occur in an individual manner; i.e., without any other approach being co-implemented. It shows the twelve approaches identified by this study in the first columns and the eleven target projects in the first row. The approaches are presented based on a sequence from most implemented (A1) to least implemented (A12). The projects are arranged by the project that used the most approaches (6) to the project that used the fewest (2). In column two of the table, L stands for approaches identified in literature and P stands for approaches identified by the case projects.

Table 3: ECI Approaches Identified by Interviewees (1-12) x projects (1-11) matrix

No	L/P	ECI approaches	1	2	3	4	5	6	7	8	9	10	11	Total
A1	P	Indirect approaches	X	X	X	X	X	X	X	X	X	X	X	11
A2	P	Information meetings	X	X	X	X	X	X	X		X			8
A3	P	A front-end partnering process	X	X	X	X	X	X	X	X				8
A4	P	Announcing the project with alternative technical solutions	X	X		X		X	X			X	X	7
A5	L/P	Design & construct contract		X	X		X			X	X			5
A6	P	Direct contact with specialist contractors in the front-end phase of projects	X			X								2
A7	P	Idea competition	X											1
A8	P	Contractors sell their idea to the owner in the early phase		X										1
A9	L/P	Negotiated bidding procedure			X									1
A10	L/P	Opening for alternative tenders												0
A11	L/P	Competitive dialogue												0
A12	L/P	Project partnering												0

In the following sections, the twelve approaches identified during the interviews are briefly described and discussed.

1. Indirect approaches

A) This is a set of approaches. The interviewees have mentioned the use of consultant and in-house construction experience as an approach to implement ECI. Furthermore, the involvement

of contractors in the preparation of handbooks and standards are also mentioned. In the case projects, this approach was implemented in all phases of projects.

According to interviewees, there is an ongoing bridge component standardization project initiated by the NPRA. With the intention of integrating contractors' knowledge into the standardization project, the NPRA has invited contractors to participate in this project. Furthermore, the NPRA, depending on necessity, invites contractors into a project's price estimation process as well as to updating handbooks and standards workshops.

B) These approaches of integrating construction knowledge into the front-end of projects are categorized under indirect approaches by the authors of this paper. The reason for this is that there is no direct involvement of contractors in a specific construction project. Even when the approaches are indirect, it is possible to use contractors to integrate construction knowledge into the front-end phase of projects. Furthermore, the approaches do not involve public procurement complications like the other approaches identified by this study.

2. Information meetings

A) The interviewees have mentioned information meetings with the contractors' branch as one of the appropriate approaches to implementing ECI. The approach was used to various degrees by the studied projects. In case project 1, the NPRA has used this approach to obtain feedback from the contractors on the contract strategy plans of the project. On this occasion, a meeting was held during the very early phase of the project and the feedback was used to determine the contract strategy of the project. This was not in conflict with public procurement regulations since the client has invited the entire contractors' branch to this meeting and the same information was provided to all contractors. However, in most of the case projects, information meetings were held during the later phases, just prior to announcing the project for tender or after the tender announcement at the tender conference (see Figure 2). The NPRA's intentions during such meeting, when it is held in the later phases, are to attract contractors to the project, to explain the project, and to answer questions that may arise, but it is not to achieve input from the contractors.

Yet according to most of the interviewees' experience from such informational meetings, contractors do not usually contribute much in these meetings. The primary reason for the lack of contractor contribution in information meetings is a fear of revealing the company's strategies. One of the interviewees stated:

Apparently, no contractor dares to expose the company's strategies for solving the project challenges to competitor contractors.

Indeed, such kinds of information meetings are held publicly while all the contractors are gathered in one meeting room.

B) To obtain the most out of an open information meeting, it is best to hold them as early as possible in the front-end of a project. In addition, the client should be willing to accept the inputs and to implement them in the project. Undoubtedly, this openness by the client should be met by contractor willingness to share their knowledge in public meetings. It appears that it is not easy for public owners to have a closed meeting with contractors in the front-end phase of a project.

The influence of an information meeting is significantly dependent on which phase of a project it is held. If it is held in the early phase of the project, it is easier for the client to include the inputs from the meeting in the front-end phase of a project. However, if it is held during the later phases of the project, like during the case of a tender conference, it is difficult to adopt the inputs into the project. This is because most of the important work is already done and the fundamental decisions have already been made during the tender conference of a project. Encouraging contractors to share their knowledge in early phase meetings is consequently essential.

3. A front-end partnering process

A) According to NPRA internal regulations, all NPRA projects should pass through a front-end partnering process phase. This approach overcomes the legal barriers since this phase starts after the contract signing. This phase should be completed before the contractor commences with construction. The length of this phase can vary depending on project needs. The main aim of this process is to create an opportunity for the project team to get to know each other, as well as to set common goals. However, since the contractor has not started with the execution phase of the project yet, during the front-end partnering process phase there is still the possibility for the contractor to come up with optimization ideas.

According to the interviewees, the success of this approach depends on what optimization ideas the contractor comes up with, and how flexible the owner is to accept new ideas from the contractors during this phase. The common challenges are limited time for the contractors to

come up with new ideas and the fact that it is mostly those in the management level, not technical people, who are involved in this meeting. As a result, it is difficult to discuss technical details. As a solution to the second challenge, in case project 2, the NPRA has arranged two parallel meetings in the front-end partnering process phase. The purpose of the first meeting was to discuss general conditions of the project; the purpose of the second meeting was to discuss technical details to find optimal technical solutions.

In some of the studied cases, the NPRA has not designed the project in detail but instead postponed the detailed design until after contract signing. Eventually, in the front-end partnering phase, both the owner and the contractor worked to find an optimal solution for the project. A pain-share gain-share agreement in this phase motivates the contractor to come up with optimization ideas. In case project 2, the pain-share gain-share agreement was 60/40; that is, 60 % to the contractor and 40% for the client. The reference point for the pain/gain share was related to the bid from the contractor.

B) This approach should be combined with an open contract document, i.e., conditions that can be decided after contract signing, to earn the most benefit out of it. Experience shows that both parties become motivated to work for optimization in a pain-share, gain-share arrangement. This explains why the front-end partnering process should be combined with a more open contract document, proper compensation, and flexibility of the owner to accept changes during this phase to succeed with this approach.

4. Announcing the project with alternative technical solutions

A) As mentioned by interviewees, for some projects the NPRA prepares contract documents with several technical alternatives. The aim of the NPRA in providing alternatives is to give the contractors the ability to influence the production method and material selection during the project delivery phase. The alternatives include all necessary detailed designs and respective procurement documents. The primary motive of the NPRA while using this approach is to reach a wider supplier market and obtain multiple bidders for a project to increase the competition and to obtain the cheapest price to build the project.

This approach has been/will be used in seven of the studied eleven projects. In addition, the NPRA has had a positive experience using it, according to interviewees. The planning cost can be comparatively higher since all the alternatives should be planned to a reasonable detail before the tender announcement. However, the NPRA’s experiences so far verify that it is a

rewarding early investment, considering that the benefit on the latter phase is rather high. One of the interviewees who was involved in several of projects that used this approach stated:

It was possible to get higher market interest for the projects when they were announced in several alternatives. The increase in market interest has secured enough competition for bid. As a result, the NPRA has obtained lower construction cost, which was one of the aims behind using this approach. The approach should be used more in the future complex bridge projects.

In the case projects, this approach has been used in the concept development and pre-engineering phases of the projects. In some of the case projects, the bridge type is announced with several alternatives. In the other cases, the bridge type was already resolved but the construction methods, the foundation type, and other bridge components were announced with several optional technical solutions. During the implementation of this approach in the case projects, legal barriers were not encountered.

B) To implement this approach, it should be technically possible to use alternative technical solutions without affecting the quality of the construction. Apparently, the contractors' willingness to evaluate all the alternatives presented by the owner and to calculate the cheapest option for the owner is equally important. The contractors do not get paid directly for this work but they get an indirect benefit since their probability of winning the bid increases significantly if they consider all options thoroughly.

According to the findings, the direct purpose of the owner while using this approach is to achieve low construction costs for the project. While indirectly, the contractors gain some possibilities of using their experience and knowledge to propose the optimal solution out of the options given by the owner. The limitation of this approach is that the contractors' options are restricted by the owner's options and their involvement is neither direct nor early enough.

5. Design build contract (DB)

A) A DB contract based on an open procurement procedure was used as an approach to involve a contractor starting from the design phase of the projects. In this approach, the contractor gets the freedom and responsibility to design the project even if the NPRA Vegdirektoratet (Head office) for quality assurance should approve the design later on. This approach has been used in the case projects during the execution phase, starting from detail engineering.

The interviewees mentioned four major reasons why the NPRA decided to use a turnkey contract in these projects. The first reason was to save time since they had quite a short time until the opening of the road. The second reason was due to the unavailability of in-house competence, skill, and experience with special construction materials and construction method. The third reason is due to the fact that there was interest from the contractor branch in using turnkey contracts. The last reason is due to the desire of the NPRA to try a new type of contract form.

As declared by the interviewees of case project 6, even if a DB contract is a suitable approach to implementing ECI, the downside of it is that the owner loses some control and the ability to contribute to the detailed-design phase of the project. The interviewee from case project 6 stated:

When the owner loses control in the design phase, consequently it is difficult to regain control in the construction phase.

The interviewee proposed resolving this control issue by implementing a longer front-end partnering process phase and assuring the involvement of the owner in the detailed-design phase.

Both interviewees and the literature argued that there are different types of turnkey contracts. They range from the functions description of one of the processes in a DBB contract, in its simplest version, to public private partnership (PPP) without private financing for complex projects, in its complex version. They also vary depending on to what extent the project owner has designed the project (preliminary design) and based on the compensation format.

In case project 6, the owner has divided the bridge into two contracts. A turnkey contract with a fixed sum compensation format was used for the super structure of the bridge, the part of the bridge where the owner expected less risk and uncertainty. In contrast, a performance contract with a unit-price compensation format was used for the underwater section of the bridge, the part of the bridge where the owner expected high risk and uncertainty. Furthermore, as stated by the interviewees, function descriptions were used in several suspension bridge projects for the steel section of the bridge. This indicates that it is possible to adapt a turnkey contract and use it for a range of projects to achieve ECI.

B) To get enough bidders and decrease the probability of conflict afterward while using a DB contract, the project should have neither very high uncertainty nor high complexity. Therefore, the owner should be able to define the project to an optimal level to minimize the risk and uncertainty and know what the owner expects from the contractors. It can also be discussed that effective control is evidenced by the achievement of objectives. If this can be done by aligning the commercial interests of the contractors with the owner's objectives, it can be considered a different method of control than giving orders or directing contractor decisions and actions.

The challenge in DB contracts is to avoid bids being inflated to buffer against uncertainty and complexity. However, that concern should be balanced with the ability of aligned and collaborative design and construction to handle uncertainty and complexity. The problem, of course, is that many DB projects do not align the commercial interests of the DB players and do not promote collaboration between them. If these elements can be specified as requirements for selection and payment, a DB contract can be appropriate for complex and uncertain projects.

6. Direct contact with specialist contractors in the front-end phase of projects

A) According to the interviewees, in order to implement ECI, the focus should not only be on the main contractors. Instead, enough attention should also be given to specialist contractors. Specialist contractors are those that have special equipment and competence that both project owners and main contractors are dependent on to execute a project. Examples of specialist companies are bridge foundation specialists, diving companies, and pile foundation specialist companies. This approach has been used in the concept development and pre-engineering phases of the case projects.

The NPRA uses this approach often and benefits significantly from the competence of specialist contractors by having a professional discussion in the front-end phase of projects. The approach was described as an effective ECI approach since it is based on direct contact, not indirectly through the main contractors. In addition, it mostly addresses one specific challenge and discusses it with highly experienced and specialist contractors. According to some interviewees, this approach is just on the boundary of the EU public procurement law; others explained that if the owner takes care not to expose project specific information, it is a legitimate procedure. According to the advocates of the approach, since specialist contractors

are not directly involved in the bid for the construction of projects, this approach does not create problems regarding the EU public procurement regulations. In addition, the NPRA takes great care not to expose project specific information.

As argued by interviewees, three important factors should be considered while using this approach. The first factor is that public owners need to have proper competence in the procurement procedures. The second factor is the specialist contractors' ability to understand the owner's challenge with limited information. This factor is important since public owners cannot ask project-specific questions directly for fear of exposing project-specific information that could give them a competitive advantage later on in the bid for the construction phase. Limited information about the project limits the benefits that the specialist contractors can provide the owner. Finally, the client's description of the challenges should be satisfactory.

B) It can be anticipated that this is a potential approach for future projects; however, the owners' public procurement competence plays an important role here. At the same time, it is also important to know which specialist contractor to contact since it might be misleading if the contacted specialist contractor does not have enough experience on what the client is asking. The simplest way to get around the regulatory concern of unfair advantage and still benefit from specialist contractors participation in project design is to award the contract to an integrated team of designers, engineers, specialty contractors, and a main contractor prior to design.

7. Idea competition

A) As identified by both the interviews and the document study, idea competition is one of the approaches used by public owners to implement ECI in the planning phase of projects. Idea competition is an approach in which the client gathers initial ideas about how to solve a project through a bidding process in the front-end phase of a project. In case project 1, this approach was used in the concept development phase of the project. However, the participants in the idea completion are mostly consulting companies and companies that provide both consultancy and construction services. One of the interviewees stated:

The challenge of public owners in using this approach is whether contractors involved in the idea competition should or should not be disqualified from the bid for construction of the same project.

The cause of the dilemma is how to treat all contractors equally during the use of this approach; i.e., not to give project specific information to some contractors that could give a competitive advantage over other contractors during the bid.

Regarding this approach, three undesirable scenarios that could make the competition imbalanced in the bid for the construction were compiled from the interviews. The first one is that bidders that are not involved in the idea competition may not have the same information as those who are involved. The second scenario is that patent and compensation related problems may arise. The last scenario is that contractors who participate in the idea competition may come up with ideas that are suitable for themselves but are not an optimal solution for the project. In all of the undesirable scenarios described above, it is difficult for public owners to practice the EU public procurement requirements. A possible alternative could be design competition, with the award for detailed design, procurement, and construction going to the winner. Competing alternatives could be evaluated for benefits relative to cost.

B) It can be seen that the crucial advantage of the idea competition approach is that it has a high potential to integrate the contractors' knowledge into the project due to its use early on in the front-end phase. The primary disadvantage of this approach is that it is a one-time involvement and lacks continuity and interweaving throughout the whole project life cycle. In order to decrease the probability of occurrence of the undesirable scenarios described above, proper documentation during the idea competition process could be used as a protective measure. In addition, a well-prepared contract document could also be used as protective measures. Furthermore, owners should be proactive in evaluating each idea before selecting one.

8. Contractors sell their idea to the owner in the early phase

A) In case project 2, one contractor has taken the initiative to promote an idea to the NPRA during the pre-engineering phase. The contractor strongly believed that the company had the appropriate knowledge and equipment to deal with the project in an optimal way. In this case, the contractor thought they were the only competitor able to execute their idea. The NPRA used their idea after detail designing as an alternative technical solution in order to avoid legal issues.

B) Obviously, it is not too common that the contractors take such initiative. This is because they don't know the owner's challenges in the front-end phase. By using various approaches,

public owners can inform contractors about the project challenges to motivate them to take the initiative to share their ideas. For example, by using an information meeting and promoting the project challenges, the client can advocate that contractors promote their ideas.

9. Negotiated bidding procedure

A) Negotiated bidding procedure is one of procurement procedures accepted by the EU. The NPRA is planning to use this procedure by combining it with a turnkey contract in case project 3. The reason why the project owner is planning to use this approach is due to a lack of internal competence in the subject matter regarding this specific project. Thus, the NPRA needed to use the contractors' experience in the pre-engineering phase of the project to obtain help for the decision process. This will be the case for all the E39 fjord-crossing projects. The NPRA's challenge in using this approach is a lack of experience with this procedure.

B) By using this approach, it is possible to achieve both direct and early involvement of contractors. However, it can't be used in all types of projects since the procurement process is demanding for both the client and the contractors. To reduce the challenge of a lack of experience, the NPRA can implement various measures. Ensuring proper experience transfer from one project to another can be the first measure. The second measure can be a continuous use of the approach. By taking these measures, the client can ensure the continuous accumulation of experience.

10. Opening for alternative tenders

A) The interviewees mentioned opening the project for alternative offers in addition to what the owner provides. In this approach, the contractors can give bids based on alternative solutions to a project. However, this approach was not practiced in the case projects.

B) In most projects, contractors are not permitted by the NPRA to submit alternative offers because of two major reasons. The first reason is that it is usually challenging to control the features of the alternative offers in the short period between the bid opening and the awarding of the contract. Secondly, it is difficult to compare bidders based on different competition grounds, as the lowest price is most commonly used as the competition base. The first reason is particularly the case with bridge projects since these have relatively longer control and approval process. The entire project delivery will most probably be delayed if the contractors come up with alternative tenders based on a new solution. This demonstrates that the owner

may need to be careful of this approach since the cost and duration of a project could be affected by the variety of alternative offers.

11. Competitive dialogue

A) Competitive dialogue is one of the procurement procedures which are approved by EU. It was introduced in 2004 for particularly complex projects by the European Parliament. This approach was not implemented in the studied projects; however, interviewees have proposed this procurement procedure as a potential approach for the future projects to implement ECI.

B) This approached has only been tried on five road projects by the NPRA so far. The experience from these projects should be studied before further practicing the approach.

12. Project partnering

A) Project partnering is a long-term commitment between the client and contractor for the purposes of achieving specific business objectives. Interviewees have proposed project partnering as a potential approach for the future projects even if the NPRA has no experience with this approach.

B) This approach is practiced more in the building sector than in infrastructure projects in Norway. Therefore, the Norwegian bridge sector should learn from the building sector in order to ensure successful implementation of the approaches.

Success factors for ECI

The interviewees have described several success factors of ECI. The authors of this paper have analyzed, compiled and categorized them into six major success factors. They are presented in Table 4. Brief descriptions and detailed discussions are presented in the following sections.

Table 4: ECI Success Factors

No.	Identified ECI Success factors
1	Timing of ECI application
2	Risk distribution
3	Project owner's competence
4	Appropriate compensation
5	Qualification of the contractors
6	Trust

1. Timing of ECI application

According to most of the interviewees, to involve contractors early enough when they can make a real difference and offer them a real possibility of influencing the outcomes of the project is important.

When the contractors are involved too early, their contribution and influence on major decision-making can be too high. Despite this, for standard and less complex projects there may be less value that can be added by using ECI. Furthermore, contractor involvement too early in the process increases bureaucracy and expenses due to the procurement process. On the other hand, if contractors get involved too late, it is difficult to accept their contributions and implement them in the project. This is due to the time required to complete the control and approval process of projects, as well as due to client resistance.

The findings from the case studies prove that ECI is not a "one size fits all quick fix" solution for all projects. Instead, it is important to develop different models of ECI, depending on the level of contractor involvement needed for each project. The consensus is that if the project is very complex, the contractors should be involved at the earliest during the business development phase (see Figure 1).

2. Risk distribution

The interviewees indicated that having a fair risk distribution between the contractor and the client is a success factor for ECI. Due to lack of information and project uncertainties, the risk level of projects is high in the early phases. A project owner should work on risk

distribution of a project to make it fair in order to make the project attractive for contractors and to motivate them to participate in the early phases. This effort could also help to avoid conflict afterward in the project execution phases. If the project risk level that will be transferred to the contractors is high, it could be difficult to find a capable contractor that is willing to carry it.

This discussion indicates that unfair transfer of risk to the contractor could make the project unnecessarily expensive for the owner. Lack of participation in the bidding of such projects would likely be accompanied by a higher risk buffer being set by the contractors. Based on the experience of the case projects, there could be three different approaches to minimizing project risk. The first approach would be to divide one extra-large project into manageable smaller contracts, which could contribute to significant risk reduction. The second approach would be to have a compensation format that suits the risk level. The third approach would be to try to decrease the uncertainties of the project by performing a detailed study before announcing for bid.

3. Project owner's competence

The project owner's competence and experience in ECI public procurement were raised as an important success factor by interviewees. This concern is due to the fact that ECI procurement procedure can be demanding. If the owner makes a minor mistake during the procurement process, it may cause a major interruption in a project. Furthermore, it may lead to difficult court proceedings and damages.

The interviewees have also raised discrimination issues. Regardless of what the client does to avoid disputes and court proceedings, there is always a certain level of risk if the owner includes some, and not all, of the contractors in the early phase of projects. The contractors who are not included may believe that they have been discriminated against. They may also feel that they do not have the same project background information as those who are included in the early phase.

The project owner's competence should not be limited to ECI public procurement procedure; technical knowledge competence is also essential. Even if, in some of the ECI models, owners transfer a significant amount of a project risk and responsibility of the technical design work to the contractor, the owners should still have control over what they have ordered and what they shall receive at the end of the project. Furthermore, the owners should also be

able to describe appropriately the scope of a project. Therefore, in-house technical competence is vital success factor of ECI. In cases where ECI approaches are used due to the lack of in-house competence, other quality assurance mechanisms should be used. These mechanisms could be transferring the operation/maintenance responsibility of the project to the contractor or selection of the contractor based on past performance like in the case of Best Value Procurement (BVP).

These potential issues demonstrate the significance of using a suitable procurement procedure that outfits a project. Additionally, they identify the necessity for the owner to be competent in technical and public procurement. Similarly, transparency during the procurement process, as well as making available all project information for all contractors afterward, could forestall charges of discrimination.

4. Appropriate compensation

Appropriate compensation for the contractors' contribution is another success factor the informants raised during the interviews. The main goal for contractors is to receive profit from a project. Therefore, a client should compensate contractors properly in order to ensure that the contractors share their knowledge with the client. Based on the experience of the interviewees, the contractors' interest in participating in an early phase of a project and their eagerness to contribute varies significantly depending on the compensation format.

This finding confirms the significance of developing an appropriate compensation format that suits the different ECI models. Furthermore, it also illustrates the importance of developing a compensation format that facilitates a win-win situation for both contracting parties.

5. Qualification of the contractors

Assuring the qualifications of contractors that get involved in the early phase was raised as success factor of ECI by several interviewees. When a public owner permits contractors to become involved during the early phases of a project, the intention is to use the experience the contractors have from other comparable projects. Therefore, the contractor should be generally capable and be able to contribute to the new project based on previous experience. How public owners can be assured that the contractors have the necessary qualifications should be identified in advance of the choice of each contractor. Therefore, the contractor's preceding practice in comparable projects could be used as a selection principle.

The findings validate the significance of using ECI with a combination of various qualifications-based selection criteria, such as the most economically advantageous tender, instead of using only the lowest price. By using qualifications-based selection criteria, public project owners could be relatively certain regarding the qualifications of the contractors that are involved in the early phases of a project.

6. Trust

The trust between the client and the contractor is another success factor identified from interviews. No contractor wants to share their knowledge, experience or ways of solving project challenges with their competitors. Based on most of the interviewees' experience, if an owner brings together several contractors in one place to obtain solutions for project challenges, it is seldom that there will be a beneficial discussion in these meetings. Therefore, public project owners should first develop an appropriate plan to assure a method of keeping the contractors' solutions confidential before inviting them for early involvement. One-on-one dialogue in a closed environment increases the contractors' trust level regarding the client. As a result, their openness to share creative ideas increases significantly.

Mostly, contractors want to have contractual protection for their creative ideas, feel safe and be sure about how the information they deliver will be used by the client. Furthermore, due to the nature of the business, they want to be compensated for their expertise as well.

The importance of trust indicates the significance of closed and one-on-one dialogue between the contractor and the client supported by contractual protection and can result in obtaining the most out of the contractors' early involvement. The higher trust level could lead to a more openness and facilitate more input from the contractors.

On the other hand, interviewees also raised the issue of the client's trust in contractors. The owner's trust level with the contractors is the critical factor for how much accountability the owner transfers. For example, in a DB contract, an owner does not precisely know before the project is completed what he will get at the completion of the project. So when a public owner favors DB instead of DBB, it indicates that the owner has a greater level of trust, allowing him to hand over accountability to the contractors by involving them early.

How could the implemented ECI approaches be improved in practice?

The analysis shows that time of contractor involvement is the most important factor for a successful implementation of ECI approaches. The benefits of ECI in terms of value for money and project delivery time are higher when it is carried out as early as possible. As a consequence, this paper uses *time* as evaluation criteria of the implemented ECI approaches in practice.

Figure 2 illustrates the phases-steps in which the nine ECI approaches were implemented. In addition, it illustrates in which phases-steps the twelve ECI approaches could have been implemented in, based on the understanding of the authors of this paper. The latter information is provided to illustrate the potential of each of the twelve ECI approaches identified during the interview. In the figure, A1-A12 stands for ECI approaches identified by interviewees (see Table 3). Solid lines indicate when the approaches were implemented in the case projects. Dashed lines indicate when the approaches could have been implemented. Solid lines overlay dashed lines.

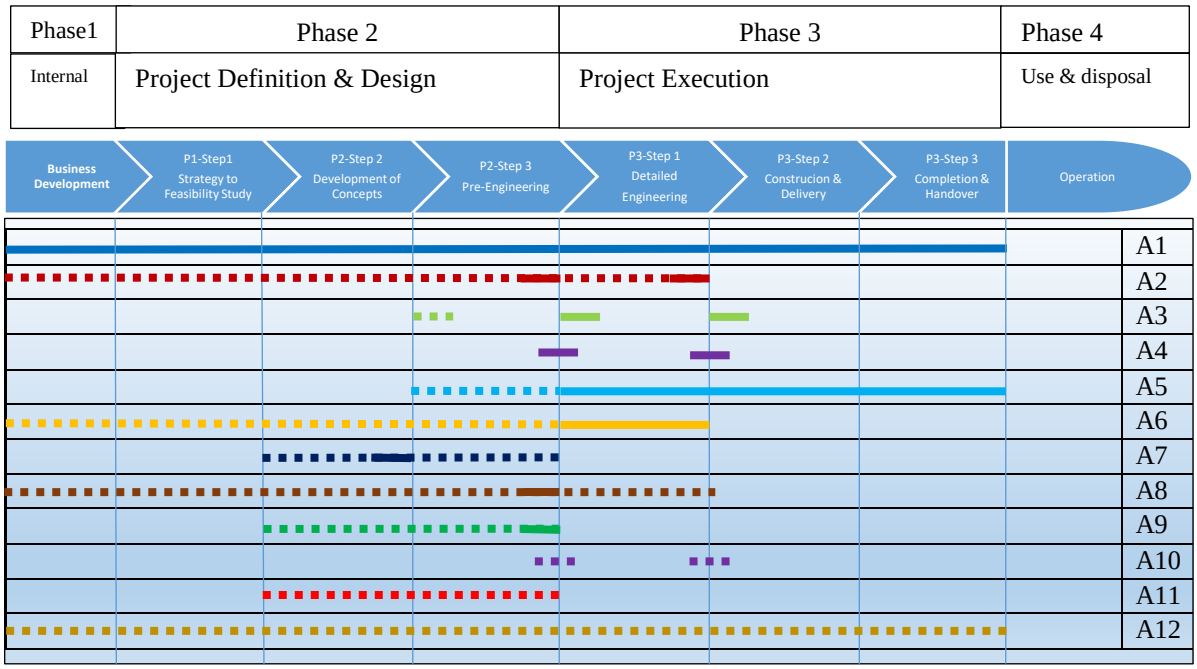

Figure 2: Illustration of the phases-steps during which each ECI approach was implemented and which phases-steps they could have been implemented.

During the evaluation of the implemented approaches by the determined evaluation criteria, *time*, it is observed that most of the identified ECI approaches were implemented during relatively late phases of the projects. However, as shown in Figure 2, most of the approaches have a higher potential of being implemented earlier in the target projects. This disconnect indicates that the full potential of the implemented ECI approaches was not exploited by NPRA. The first success factor that was identified by the client interviewees themselves was not realized when approaches of ECI were in use. Based on this observation, we concluded that with regard to bridge projects, the NPRA has a lot to learn when it comes to implementing ECI. In many cases, the perceived barriers seem to stop public owners from implementing ECI even though they are surmountable. A lack of familiarity with ECI approaches, lack of awareness on the importance of ECI, and a lack of experience in the use of the ECI approaches could all be the barriers to full implementation.

In the future, public owners should give emphasis to the success factors of ECI while implementing ECI approaches. The recommendation of this paper is that the implemented ECI approaches could be improved if public owner give appropriate consideration to the success factors of ECI while implementing the approaches.

CONCLUSION

The research questions addressed in this study are as follows:

- What do public owners do to implement ECI?
- What are the success factors for ECI?
- How could the implemented ECI approaches be improved in practice?

The literature reports that severe barriers exist – primarily legal ones – that exclude the public owners from introducing contractors into the earlier phases of a project. The research reported on in this paper shows that – based on experiences in Norwegian bridge construction– the difficulties of overcoming these hindrances are exaggerated. The analysis presented in this paper shows that lack of experience, lack of awareness regarding the importance of ECI and lack of familiarity with ECI approaches are equally important barriers. ECI is, in fact, possible

and several approaches to it are explored above. The overall finding of this paper is that involving contractors earlier in a project than is practiced today is highly recommended.

The literature study identified 16 approaches and the case studies identified 12 approaches. Of these twelve approaches, 7 are not found in the 16 approaches identified in the literature. The implication of these unidentified approaches is that the literature focuses on advanced ECI approaches that can be implemented for very complex projects; however, the findings from the case studies indicate that there are relatively simpler ECI approaches that can be implemented on less complex projects. The addition of these seven approaches not recognized by the literature enriches the selection possibilities of public owners. Furthermore, it provides a new direction for the literature of ECI by introducing new approaches as potential topics of further study.

This paper has also identified six major success factors of ECI from the interviews, notably the timing of ECI application, risk distribution, project owner's competence, appropriate compensation, qualification of the contractors, and trust.

The evaluation of the approaches was based on *time,* which is also one of the success factors identified by this study: timing of ECI application. The evaluation shows that most of the identified approaches were used in the late phases of the case projects. The analysis shows, however, that most of the identified approaches could have been implemented earlier in the process. Based on this observation, it is possible to conclude that the primary success factor for the use of ECI identified by the owners themselves was not realized when approaches of ECI were implemented. As a result, the potential of the ECI approach was not fully exploited by NPRA. Public owners who plan to implement ECI should also consider the other five success factors. Therefore, the recommendation of this paper is that the implemented ECI approaches could be improved if public owners give appropriate consideration to the success factors of ECI while implementing the approaches.

The study involved some limitations. The empirical study was based only on Norwegian bridge projects, specifically projects of the NPRA. Moreover, the scope of the study was restricted to bridge projects that were completed after 2001 and to bridge projects which were in the planning and design phase during the course of this study.

Although this research is based on Norwegian public bridge projects, the study findings and practical experiences may be used as a basis for similar investigations by other public owners

in Norway or in other parts of the world. The study contributes to the field of public procurement by introducing new ECI approaches from the case studies. Furthermore, it provides useful insights to assist public owners in selecting and implementing ECI approaches.

In the future, more case studies in other infrastructure projects, as well as projects other than bridges, may reveal new approaches and validate the findings. The international experience of ECI could also be studied to investigate what others outside Norway have done. For example, Finland and the Netherlands have extensive experience with engaging contractors in the project definition and design phases within the EU public procurement directives. Furthermore, each of the approaches identified in this paper could be studied in-depth in order to relate them to international experience. It may then be possible to prioritize one approach over the other for future use. This investigation could be conducted by weighing potential benefits against associated efforts and risks.

REFERENCES

ALBANO, G. L. & SPARRO, M. 2010. Flexible strategies for centralized public procurement. *Review of Economics and Institutions,* 1(2).

BLUMBERG, B. F., COOPER, D. R. & SCHINDLER, P. S. 2014. *Business research methods*, McGraw-hill education.

CHAN, A. P., CHAN, D. W., CHIANG, Y., TANG, B., CHAN, E. H. & HO, K. S. 2004. Exploring critical success factors for partnering in construction projects. *Journal of Construction Engineering and Management,* 130(2)**,** 188-198.

CIRIBINI, A. L. C., CARATOZZOLO, G., BOLPAGNI, M., VENTURA, S. M. & DE ANGELIS, E. 2016. The Implementation of Building Information Modelling within an Integrated Public Procurement Approach: The Main Contractor's Perspective.

CONNAUGHTON, J. & WELLER, S. Improving collaboration in construction: an opportunity for action research. Proceedings 29th Annual ARCOM Conference, Reading, 2013.

CRESWELL, J. W. 2013. *Research design: Qualitative, quantitative, and mixed methods approaches,* Sage publications.

ELLIS, D. 1993. Modeling the information-seeking patterns of academic researchers: A grounded theory approach. *The Library Quarterly,* 63(4)**,** 469-486.

EUROPEAN PARLIAMENT, C. O. T. E. U. 2004. Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the Coordination of Procedures for the Award of Public Works Contracts, Public Supply Contracts and Public Service Contracts. *Official Journal of the European Union*.

EUROPEAN PARLIAMENT, C. O. T. E. U. 2014. Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC Text with EEA relevance. *Official journal of the European Union*.

FALAGARIO, M., SCIANCALEPORE, F., COSTANTINO, N. & PIETROFORTE, R. 2012. Using a DEA-cross efficiency approach in public procurement tenders. *European Journal of Operational Research,* 218(2)**,** 523-529.

GOKHALE, S. Integrated project delivery method for trenchless projects. *In:* RESTON, V., ed. Proceedings of the International Conference on Pipelines and Trenchless Technology October 26-29 2011 Beijing, china. American Society of Civil Engineers.

GRANSBERG, D. D. 2016. Comparing Construction Manager–General Contractor and Federal Early Contractor Involvement Project Delivery Methods. *Transportation Research Record: Journal of the Transportation Research Board,* 2573)**,** 18-25.

GUSTAFSSON, J. 2017. Single case studies vs. multiple case studies: A comparative study.

HANS VOORDIJK, D., JANSSEN, R., GRAAF, R. D., SMIT, M. & VOORDIJK, H. 2016. Why local governments rarely use PPPs in their road development projects: Understanding the barriers. *International journal of managing projects in business,* 9(1)**,** 33-52.

HOEZEN, M. E. L. 2012. *The competitive dialogue procedure: negotiations and commitment in inter-organisational construction projects*, University of Twente.

JACOBSSON, M. & WALKER, D. H. Alliancing within a Public-Private Partnership. Steinthorsson RS, The 22nd Nordic Academy of Management (NFF) Conference, 2013 Reykjavik, Iceland. 21-23.

KASHIWAGI, D. 2016. *2016 Best Value Approach*, USA, Kashiwagi Solution Model (KSM).

KENT, D. C. & BECERIK-GERBER, B. 2010. Understanding construction industry experience and attitudes toward integrated project delivery. *Journal of construction engineering and management,* 136(8)**,** 815-825.

KLAKEGG, O. J., ANDERSEN, B., MAGNUSSEN, O. M., WALKER, D. & WILLIAMS, T. 2010. *Early warning signs in complex projects*, Newtown Square, Project Management Institute.

KOLMAN, R. 2014. Early contractor involvement; Improving complex maritime infrastructure projects. *PIANC World Congress* San Francisco, USA 2014.

KRISTENSEN, K., LÆDRE, O., SVALESTUEN, F. & LOHNE, J. 2015. Contract models and compensation formats in the design process *In: Proc 23rd Ann. Conf. of the Int'l. Group for Lean Construction.* Perth, Australia.

LAHDENPERÄ, P. 2012. Making sense of the multi-party contractual arrangements of project partnering, project alliancing and integrated project delivery. *Construction Management and Economics,* 30(1)**,** 57-79.

LAHDENPERÄ, P. 2013. Determining `the most economically advantageous tender´ based on capability and fee-percentage criteria. *Journal of Public Procurement,* 13(4)**,** 409.

LAHDENPERÄ, P. 2016. Preparing a framework for two-stage target-cost arrangement formulation. *International Journal of Managing Projects in Business,* 9(1)**,** 123-146.

LENFERINK, S., ARTS, J., TILLEMA, T., VANVALKENBURG, M. & NIJSTEN, R. 2012. Early Contractor Involvement in Dutch Infrastructure Development: Initial Experiences with Parallel Procedures for Planning and Procurement. *Journal of Public Procurement,* 12(1)**,** 1-42.

LENFERINK, S., TILLEMA, T. & ARTS, J. 2013. Public-private interaction in contracting: Governance strategies in the competitive dialogue of Dutch infrastructure projects. *Public Administration,* 91(4)**,** 928-946.

LÆDRE, O. 2006. *Valg av kontraktsstrategi i bygg-og anleggsprosjekt*.

LÖWIT, H. & DOSTÁLOVÁ, M. Defining of decision-making criteria for optimum construction procurement system selection for public works. Creative Construction Conference, 2014.

MARIQUE, Y. 2013. Cooperation and competition in complex construction projects: Implementation of EU procurement rules in England and Belgium. *International journal of law in the built environment,* 5(1)**,** 53-70.

MOLENAAR, K., TRIPLETT, J., PORTER, J., DEWITT, S. & YAKOWENKO, G. 2007. Early contractor involvement and target pricing in US and UK highways. *Transportation Research Record: Journal of the Transportation Research Board,* 2040(01)**,** 3-10.

MOSEY, D. 2009. *Early contractor involvement in building procurement: contracts, partnering and project management,* John Wiley & Sons.

NAOUM, S. G. & EGBU, C. 2016. Modern selection criteria for procurement methods in construction: A state-of-the-art literature review and a survey. *International Journal of Managing Projects in Business,* 9(2)**,** 309-336.

NTP 2016. National Transportplan 2018-2029. *In:* PLAN, T. N. N. T. (ed.).

RAHMAN, M. & ALHASSAN, A. 2012. A contractor's perception on early contractor involvement. *Built Environment Project and Asset Management,* 2(2)**,** 217-233.

RAHMANI, F., KHALFAN, M. & MAQSOOD, T. The use of early contractor involvement in different countries. AUBEA 2013, 2013. University of Auckland, 1-10.

RAHMANI, F., KHALFAN, M. & MAQSOOD, T. The application of Early Contractor Involvement (ECI) in different delivery systems in Australia. International Conference on Construction in a Changing World, 2014. University of Salford, 1-12.

REKONEN, S. & BJÖRKLUND, T. A. 2016. Perceived managerial functions in the front-end phase of innovation. *International Journal of Managing Projects in Business,* 9(2)**,** 414-432.

RIEMANN, S. & SPANG, K. 2014. Application of Contractor's Knowledge in Public Financed Infrastructure Projects in Germany. *Procedia-Social and Behavioral Sciences,* 119(2014)**,** 202-209.

SCHEEPBOUWER, E. & HUMPHRIES, A. 2011. Transition in adopting project delivery method with early contractor involvement. *Transportation Research Record: Journal of the Transportation Research Board,* 2228(06)**,** 44-50.

SCHNITZER, J. S. 2010. Regulating Public Procurement Law at Supranational Level:The example of EU agreements on public procurement. *Journal of Public Procurement,* 10(3)**,** 301-334.

SONG, L., MOHAMED, Y. & ABOURIZK, S. M. 2009. Early Contractor Involvement in Design and Its Impact on Construction Schedule Performance. *J. Manage. Eng.,* 25(1)**,** 12.

SØDAL, A. H., LÆDRE, O., SVALESTUEN, F. & LOHNE, J. Early Contractor Involvement-: Advantages and Disadvantages for the Design Team. 22nd Annual Conference of the International Group for Lean Construction, 25-27 2014 Oslo, Norway. 519-531.

TORP, O., AUSTENG, K. & WUBISHET, J. M. 2004. Critical success factors for project performance: A study from front-end assessments of large public projects in Norway.

TORP, O., MAGNUSSEN, O. M., OLSSON, N. & KLAKEGG, O. J. 2006. Cost uncertainty in large public investment projects. *Concept-report no 15.*

TURNER, N. & RIDING, M. 2015. Early contractor involvement in Australia: Learnings from Transfield Services projects. *Small Enterprise Research,* 22(2/3)**,** 173-184.

VAN VALKENBURG, M., LENFERINK, S., NIJSTEN, R. & ARTS, J. Early contractor involvement: a new strategy for "buying the best" in infrastructure development in the Netherlands. Third International Public Procurement Conference (IPPC), 2008.

VEGVESEN, S. 2012. Delprosjekt gjennomføringsstrategier og kontraktstyper.

WALKER, D. H. & LLOYD-WALKER, B. Understanding early contractor involvement (ECI) procurement forms. Procs 28th Annual ARCOM Conference, 3-5 September 2012 Edinburgh, UK. Association of Researchers in Construction Management, 877-887.

WALKER, D. H. & LLOYD-WALKER, B. M. 2015. *Collaborative project procurement arrangements,* PMI.

WILLIAMS, T., WILLIAMS, M. & RYALL, P. Target cost contracts: adopting innovative incentive mechanisms to improve the project delivery process. Procs 29th Annual ARCOM Conference, 2013 Reading, UK. Association of Researchers in Construction Management, 759-768.

YIN, R. K. 2013. *Case study research: Design and methods,* Sage publications.

APPENDIX: INTERVIEW GUIDE

1. Introduction
    - Can you tell me about your background?
    - Information about the case project (a separate cheek list was used to gather information about the case projects).
2. How can public owners integrate contractors' knowledge and experience in project planning/project design (general questions)?
    - In your opinion, what kind of implementation strategies and contract forms can public owners use to integrate contractor knowledge and experience in project planning/project design?
    - How can these implementation strategies and contract forms help to integrate contractors' knowledge and experience in project planning/project design?
    - What are the advantages and disadvantages of these implementation strategies and contract forms?
    - What could government owners achieved by integrating contractors' knowledge and experience in project planning/project design?
3. What did NPRA to integrate contractors' knowledge and experience in project planning/project design (project specific questions)?

    <u>Previous project specific experience</u>

    - What is your prior experience with integrating contractors' knowledge and experience in project planning/project design?
    - Based on your prior experience, what are the advantages and disadvantages of integrating contractor knowledge in project planning/project engineering? Can you give me some specific examples?

    <u>Specifically on the case project</u>

    - Can you tell me about what you have done / will you do differently to integrate contractors' knowledge in project planning/project design in this specific project?

- Why do you want to integrate the entrepreneurs' knowledge in project planning/project design?
- Why were this specific contract strategy, contract form, and procurement procedure chosen?
- What did/will NPRA achieve by integrating contractors' knowledge in project planning/project design in this specific project?
- Which challenges bring this contracting strategy? Why?
- What can be done to improve this strategy for future use? Or what should be done differently?
- Do you have experience from other projects with similar or other contractual strategies that are used to integrate contractors' knowledge and experience in project planning/project design?

4. What are the success factors for integration of entrepreneur knowledge in project planning/project engineering (project specific questions)?
    - In your opinion, what were the success factors of integrating contractor knowledge and experience in project planning/project design in this specific project?
    - In your opinion, what were the challenges for NPRA by integrating constrictions` knowledge in project planning/project design? Why?
5. How can NPRA integrate contractor knowledge and experience in project planning/project engineering in future projects (general questions)?
    - Do you think that there is a need to integrate contractors' knowledge in project planning/project design in NPRA's future projects?
    - When shall the contractor's knowledge integrate into project planning/project design?
    - In general, what are the success factors of integration contractors' experience or knowledge and experience in project planning/project design in NPRA's future projects?