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Success factors for early contractor involvement (ECI) in public infrastructure projects

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Abstract

It is widely accepted that contractor involvement in the front end can influence the outcome of the project in a positive way. However, in the traditional project delivery method of construction projects, the design and construction process are separated and sequentially. As a consequence of this, it is difficult to integrate construction knowledge in the front-end of projects. The evolving project methods are designed to remove such typical challenges by involving contractors early in the process. The purpose of this paper is to explore the success factors for early contractor involvement (ECI) in public infrastructure projects. In addition, the paper aims to propose suitable approaches to implement ECI for public owners in future projects without violating the EU public procurement directives. In addition to a literature study, multiple case studies on eleven projects selected from the Norwegian public bridge projects were carried out. The majorly identified ECI success factors are timing of ECI application, proper compensation, trust, contractors` qualification, owners` competence, and risk distribution. The paper concludes that public owners can implement ECI by using various approaches without violating the EU public procurement directive. Furthermore, based on the identified success factors, effective practical strategies for the successful implementation of ECI may be generated.

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1. Introduction

Various strategies can integrate knowledge from construction into design [1]. One of the evolving strategies is early contractor involvement (ECI) [1, 2]. ECI offers improvement in value for money and project delivery time [3]. By applying ECI, an owner can have more control over the project cost as the prices of the bids are made clear earlier in the process [4]. In addition, the client makes sure on the implementation of environmental and social measures that are decided in the planning process. These will benefit not only the client but also other stakeholders and shareholders [4, 5].

According to previous research, ECI seem to be most beneficial when it is introduced in the early phases of the project. These phases of projects are typically characterized by having the largest potential to influence the design and where there is no significant project cost increase inflicted by changes [6]. The construction industry has also positive experiences of practicing it. However, ECI faces many barriers when it is implemented since it is different from the traditional business practices. Some of the common practical barriers areas are found in contracting practice, teamwork, and culture change. Predominantly, public owners face a major challenge if they want to implement ECI, due to the selection method defies established standards. It is a challenge for them to involve the construction team as early as found beneficial within ECI, since public regulations oblige them to use competitive, transparent team selection. Furthermore, they are obliged to make sure to consider both price and quality during the early team selection. That is in order to comply with EU public procurement directives [6]. A better understanding of ECI concept and its benefits for project success will improve its use to reach the full potential [1].

We have not found, however many literatures that discuss the success factors of ECI with an intention of increasing ECI concept understanding. Therefore, this paper set out to identify the success factors of ECI for public owners with an ambition of filling this knowledge gap. Moreover, this paper aims to propose various approaches to implement ECI for public owners on future projects.

The following research questions are addressed in this study.

- What are the success factors for early contractor involvement?
- How can public owners implement early contractor involvement on future projects?

2. Research method

The research was carried out based on case study approach. It was stared with literature study, followed by document study of chosen eleven cases and fourteen interviews with key actors from the selected cases.

To answer the research questions, the authors have started the research by studying relevant literature to gather background knowledge about ECI concepts and applications. The objective of the literature review was to identify relevant previous researches and thereafter establish a theoretical framework. The approach was to search for keywords in academic databases through search engines Google scholar and Oria. Oria is a Norwegian University library resource comprising academic journal papers, conference papers, reports, dissertations etc. Furthermore, references of articles were also studied.

Furthermore, the research has continued by multiple case studies. According to Yin (2013), choice of research methods in a large part is dependent on chosen research questions. The more the research questions seek to explain some present circumstances (e.g., how and why some social phenomenon works), the more that case study will be relevant [8]. We seek to explain how public owners can implement ECI and what the success factors for ECI are. Case studies hereby become relevant in our study. The cases or projects selection was conducted by exploring bridge projects that have used or `planning to use` various contract forms and implementation strategies, to facilitate integrating contractors` knowledge in the early phases of the projects. In this phase of the research, 20 key-professionals, that have several years of work experiences in Norwegian Public Roads Authority (NPRA), were contacted to find the appropriate projects to study. In addition, NPRA`s yearly internal projects reports from 2001-2013 were studied. The exploration has directed to the following eleven bridge projects that studied in-depth;

1) Lepsøybrua
2) Straumsbrua
3) Sykkylvsbrua
4) Tresfjordbrua
5) Paradisbrua
6) Linesøybrua
7) Gullibrua
8) E6*E16 Flyplasskrysset
9) Smålenenebrua
10) E39 Godsterminalenbrua and
11) Tjønnøybrua

Four of the projects are/will be announced for bid using turnkey contract and the remaining seven projects are/ will be announced for bid with alternative technical solutions.

In order to explore the responses of the interviewees and gather deeper information, in-depth interviewees were carried out by face-to-face and semi-structured interviews. With the aim of getting reliable information and genuine opinions to the research, key personnel of the target project with several years of experience in the construction sector and that held a senior position in their organization were the target respondents. In all, fourteen semi-structured in-depth interviews, thirteen with key client`s personnel and one with contractor`s personnel, on the eleven cases selected from the Norwegian bridge projects were conducted according to the methodological approach described by Yin (2013). The interviews were found valuable in obtaining a deep understanding of ECI practice in Norway as well as in identifying the success factors. The semi-structured interviews were conducted in-person based on interview guide and lasted between 1 -2 hours. Semi-structured interview was favored in order to collect comparable qualitative data and to identify new ways of seeing and understanding the topic. The nature of questions was open-ended with an intention to bring most out of the respondent`s own reflection. The professional role of most respondents was management. To specifically name the roles, three project managers, one assistant project manager, five construction managers, one control engineer, three design managers and one purchasing manager. The in-depth research has continued by studying documents provided by informants in addition to documents from NPRA`s internal database concerning the target projects (e.g. tender document).

This study involves some limitations since the research was based in only Norwegian public infrastructure projects and specifically in NPRA, which is governed by EU public procurement regulations, with a limited case study on bridge projects. Moreover, the scope of the study was restricted to NPRA`s bridge projects which were completed after 2001, as well as to bridge projects which are in planning and design phase under the course of this study. Furthermore, all interviewees, except one, are from the client side of the projects.

To increase the validity as well as the reliability of the study, the findings, and the data collection, various measures have been taken. Some of the measures are, most relevant literature from reliable database sources were identified and reviewed, only peer reviewed articles are used, the right interviewees were contacted, and all the interviews were recorded and transcribed.

3. Theoretical background

3.1. Early contractor involvement (ECI)

ECI is all about involving the contractor in the early stage of project development to get assistant in planning and buildability by working together as a team with owner and consultant [1, 9]. It also allows the contractor to engage in the front-end phase. Moreover, ECI gives contractors the possibility to contribute from the construction knowledge to the early process [1, 3]. In order to benefit fully from the ECI, both direct and early involvement of the contractor in the front-end phase is mandatory. Direct involvement facilitates for better cooperation while early involvement facilitates for better contribution [1]. According to literature, ECI has three major advantages. The first one is, it contributes for better relationships. The second one is, it increases understanding among parties. The last one and probably the most important one is, it decreases the potential of adversarial relationships since the approach demands

frequent interaction and communication. This close interaction and communication leads to developing a shared goals and objectives that in turn builds cooperative relationships [3, 9]. The main goals of ECI are better project control, time gains and innovation [4, 5, 10]. However, through the literature review it has been observed that there is an ambiguity about the definition of ECI.

Different terms have been used in different countries for the phenomena here called ECI. For example target pricing, integrated project delivery, early supplier involvement and interweaving [11]. Furthermore, different countries have adapted ECI based on their needs and situations. Some countries adopted relationship-based approach for the whole life cycle of the project. Other countries adopt a more hybrid model where the contract starts with a collaborative approach and moves to a conventional type of contract [12]. The contractor can be involved through various approaches to implement ECI [9]. The literature indicates various definitions of ECI and different approaches of implementation have been developed and practiced globally.

One of the approaches discussed by Song et al. (2009) is ECI in the design phase of a project. It is one of the strategies to integrate design and construction. It can be implemented by design-build (DB) contract instead of design-bid-build (DBB) and by procurement, engineering, procurement and construction (PEpC) instead of engineering, procurement and construction (EPC). The aim of ECI in design is to improve drawing, material supply, information flow and construction schedule performance through integration of construction knowledge into the design process [1].

The other approach described by Lenferink et al. (2012) and Valkenburg et al. (2008) is ECI in planning phase of a project. Based on their definition, the aim of this ECI approach is to involve the contractors in the procurement process before the decision to route determination is laid down. That is to get support from the contractors in the route decision-making. They further divide ECI in the planning phase in to different models depending on when the contractor gets involved in the planning phase. Parallelization and interweaving are the two extreme ends. There are, however, various intermediate models between these two extreme ends [4, 5].

Lahdenperä in several of his works associates ECI with alliancing, target costing and qualification-based selection of contractor, i.e. the most economical advantageous tender. According to him, the selection criteria in ECI cannot be based on only price. Instead, it is common to use various qualitative selection criteria [6, 13-16].

More specifically, Sceepbower and Humphries (2011) have identified the difference between ECI practice in the U.S. and Anglo-Saxon countries. The ECI approach in the U.S. resembles the contracting type with the construction manager and the owner holding two contracts, one with the designer and the other with the contractors. The use of ECI in Anglo-Saxon countries, however, the owner holds one contract with the contractor. This ECI resembles alliancing during the design phase and DB contracting during the execution phase [3].

Recently, Walker and Lloyd-Walker (2012) came up with a comprehensive description of ECI. According to them, ECI can take place in the internal phase, planning phase, design phase, as well as in the project execution phase. Literally, ECI can happen in all phases of project before operation phase. They further divide ECI in to five different models depending on in which phase of the project the contractors involved. Their conclusion is that ECI can be implemented by a range of procurement forms that could include traditional DBB, DB, management contracting, partnering and full alliancing [17]. In this paper, the comprehensive description of ECI by Walker and Lloyd-Walker (2012) is used as a base to explore and identify what kinds of approaches public owners in Norway use to implement ECI.

3.2. ECI and Public Procurement

Norwegian public owners are obliged to follow the international agreements including The European Economic Area (EEA) agreement and the World Trade Organization (WTO) agreement on public procurements [18]. The main purposes of this agreements are to achieve equal treatment of all bidders by obliging public owners to specify clearly what procurement procedures they intend to use before starting to procure [18, 19]. The different procurement procedures that are identified by EU-directive for public works, to supply and service contracts are; open procedure, restricted procedure, negotiated procedure and competitive dialog (CD) [4, 5, 20, 21].

ECI has been recommended to implement green public procurement. Green public procurement is a process whereby public owners aim to procure contractors that meet environmental requirements. It has been adopted by the construction sector in order to accomplish better environmental performance [22, 23]. Through ECI, green public

procurement requirements can form an essential element of the contractual framework to be met during project executions. It also enables the involvement of contractors in the preparation of contract specification related to green public procurements [23]. In order to promote the adoption of green public procurement, the EU has carried out remarkable efforts by including environmental consideration into purchasing policies. Specifically, the EU Directive 2004/18/EC states that environmental issues can be taken into account during the procurement process. Since public owners have high purchasing power, they can encourage the demand of environmentally friendly products and services. The use of green public procurement can be an effective way of stimulating the innovation capabilities of firms and the production of green products [22].

For public owners, however, it is a challenge to involve early the construction team since they are obliged to use competitive, transparent team selection. According to Lahdenpera (2013), they should use the `most economically advantageous` concept in which both price and quality viewpoints are taken into consideration. When `most economically advantageous` idea is used in early contractor involvement the price component obviously does not include the total price; instead, it may consist only the fee-percentages of competing service providers [6].

The `most economically advantageous` (price-inclusive multi-criteria selection) idea is challenging even in the late phases. Then, it is even more challenging to apply it in the early stage (ECI). The reason is projects at this phase has too much uncertainty, which makes a reliable cost estimate difficult. It is not practical to organize usual price-inclusive competition and fix the price in the early phase of the project because of causing risk premiums [6].

3.3. Success factors

Identifying the critical success factors is one of the tasks included in the quality assurance scheme initiated by the Norwegian Ministry of Finance in 2000 to ensure quality-at-entry of major public projects. Furthermore, early identification of critical success factors is vital in order to ensure successful project completions as well as to minimize surprising variations during project implementation [24]. The authors of this paper have found it essential to study the success factors of ECI in public projects.

The basic idea is that there are certain major factors whose impacts are substantial to project performances such that during front-end phase will enhance the successful completion of projects [24]. Regarding critical success factors, there is a shift in focus over time from mainly Technical issues towards Organizational and Management issues [24-26].

Identifying critical success factors is not to avoid of problems; instead, it is essential point be to knowing beforehand how to respond when problems develop. It typically found to help project teams to minimize firefighting spontaneous approach in managing uncertainties and changes encountered during project implementations [24].

4. Finding and discussion

4.1. What are the success factors of ECI?

The interviewees have discussed several success factors of ECI. The authors of this paper have compiled the findings and categorized them in to the following six major success factors based on their similarity. The success factors are sequenced based on alphabetical order.

4.1.1. Involve contractors early enough

When asked about the most important success factor of ECI, the majority of the respondent answered to involve contractors early enough, when they can make real influence and where they have real possibility to influence.

This is the for less complex and standard projects there may be less value that can be added by ECI as compared to more complex project. Furthermore, if the contractors are involved too early, then their contribution and influence on major decision-makings is very high. In the contrary, too early contractor involvement increases bureaucracy and expense. This is due to the procurement process. In the other hand, if the contractors get involved too late, then it is difficult to accept their contributions and implement it in the project. It is due to the time taking control and approval process of projects as well as due to the client resistance.

The finding from the case study proves ECI is not a "one size fits all quick fix" solution to all projects. Instead, it is important to develop different models of ECI, depending on the needs of contractor involvement. The consensus is that if the project is very complex, then it demands the involvement of contractors as early as possible.

4.1.2. Manageable risk transfer to the contractors (risk distribution)

To transfer manageable risk to the contractors has been discussed as a success factor for ECI by interviewees. In the early phases of a project, the risk level is high because of both lack of information and various uncertainties. A project owner should work to decrease the risk level both in order to be attractive for contractors and motivate them to participate in the early phases. Furthermore, fair risk distribution helps to avoid conflict afterward in the execution phases of a project. If the risk level is high, then it is difficult to find a contractor who is capable and willing to carry the risk. Likewise, if the project is very complex it may lead to conflict afterwards.

This illustrates that the risk should be carried by the party who can manage it well. Unfair transfer of risk to the contractor could make the project unnecessarily expensive for the owner. This is due to lack of enough participants in the tender accompanied by higher risk buffer set by the contractors. With regards to, this, there are different approaches of minimizing risk. The first approach is dividing one mega project in a manageable smaller contracts, this can contribute for significant risk reduction. The other approach is to have compensation format that suits the risk level. The third approach is to decrease the uncertainties by detail study before announcing the bid.

4.1.3. Project owners` competence

The interviewees described ECI procurement procedure as demanding. Therefore, the owner`s competence and previous experience with the ECI procurement procedures was raised as an important success factor by interviewees. If the owner makes a single minor mistake in the procurement procedure, then it may cause a major delay on the project. Furthermore, it may lead to laborious court proceedings and damages.

On the other hand, the interviewees have also discussed that regardless of what the client do to avoid disputes, there is all the time a certain level of risk if the owner involves some, not all, of the contractors in the early phases of projects. The contractors that are not involved can feel that they are discriminated or they do not have equal information like the one that are involved in the early phases of a project when open competition procurement is used.

The project owners` competence should not be limited to procurement procedures but also to technical knowledge is important. Even if in some of ECI models, owners transfer most of the risk and responsibility of the design to the contractor, the owners should still know what they have ordered and what shall they expect from the contractor. Furthermore, the owners should also be able to define properly the scope of the project. Therefore, in-house technical competence development is important success factor of ECI.

The finding shows the importance of using an appropriate procurement procedure that suits the project. Furthermore, it proves the need for the owner`s technical and public procurement competence. Likewise, transparency during the procurement process and making available all project information for all contractors afterwards are described as part of the important success factors.

4.1.4. Proper compensation for the contractors` contribution

The other success factor the informants identified during the interviews was proper compensation for the contractors` contribution. The major aim of contractors is to get profit out of the project. Therefore, the client should treat the contractors properly and compensate accordingly in order to the contractors can share their knowledge with the client. The experience of the interviewees is that, the interest to participate and the enthusiasm to contribute varies a lot based on the compensation format. In some cases, it could be sufficient by proper compensation. In other cases, the contractors can ask for patent for their idea. NPRA as a public owner has no possibility to use idea that the contractor has asked a patent on, in order not to give competition advantage to a specific contractor.

This confirms that the importance of developing a compensation format that suits the different ECI models. It also confirms the importance of trying to form a compensation form that enables to accomplish win-win for both the contractor and the client.

4.1.5. Qualification of the contractors

Several interviewees discussed the competence of the contractors that are involved in the early phases as another major success factor of ECI. When a client involves contractors at early phases of a project, then the aim of the client is to benefit from the experience that the contractors have from other similar projects. Consequently, the contractor should be qualified and be able to contribute. How can public owners be sure about the qualification of the contractors is the question that should be answered before the selection of one of the contractors. Therefore, the contractor`s previous experience in similar projects should be used as a selection and project awarding criterion and it is an important key success factor.

This verifies the importance of combining ECI with other selection criteria than just the lowest price, such as prequalification and the most economical advantageous tender. By doing this, the project owner can be sure about the qualification of the contractors that will be involved in the project.

4.1.6. Trust between the project owner and contractor

The trust between the client and the contractor is mentioned as another success factor of ECI by the interviewees. No contractor wants to share his knowledge, experience or ways of solving challenges of a project with competitors. Most of the interviewees experience shows that, if an owner gathers several contractors at one place then it is seldom that there will be constructive discussion in these meetings. Then, the client should first develop a proper plan to convince how to keep the contractors` confidential information before inviting for early involvement. A proper plan to have closed and one-to-one conversation increases the contractors trust level and at the same time the openness to share.

Contractors need to have protection and they want to feel safe before they start to share their knowledge with the client. Contractors demand also to be sure about how the information they will provide can be used by the client. Apparently, by the nature of business they want a benefit in return as well.

The finding indicates the importance of closed and one to one discussion between the contractor and the client in order to get most out of ECI. The higher the trust level between the client and the contractor leads to the more openness of the contractor and more contribution.

The interviewees also discuss the trust of the client on the contractor as important success factor of ECI. This explains that the owner trust level on the contractors is the decisive factor for how much responsibility the owner transfers to the private actors. Furthermore, it is also decisive how early the owner let the contractor be involved in the project. For example, when an owner prefers to use DB instead of DBB, then it means the owner has higher trust level to transfer responsibilities to the contractors and to involve them early. This is because in DBB contract, an owner does not exactly know what he will get at the end of the project before the project is completed.

4.2. How can public owners implement early contractor involvement on future projects?

Thirteen approaches to implement ECI were identified from the case studied projects and literature review. The identified approaches are; 1) Indirect approaches (consultant and in-house construction experience), 2) Information meeting with the contractors, 3) Partnering process phase, 4) Announcing the project with alternative technical solutions 5) Design build contract(DB) or turnkey contract and function description 6) Direct contract with specialist contractors in the front-end phase of projects 7) Idea competition 8) Contractors sell their idea to the owner in the early phase 9) Negotiated Bidding procedure 10) Opening the project for alternative offers 11) Competitive dialogue 12) Project partnering 13) Project alliancing.

It is clear that the contractor contribution varies a lot depending on which of the approaches are used. Some of the identified approaches are demanding for both the client and the contractors. Then, not all the approaches can be used in all types of projects. However, none of them were found inadvisable during this study.

Nine of the identified approaches, approach 1 to 9, have been implemented or will be implemented in the studied cases. Approaches 10 to 12 are, however, not implemented. However, the interviewees propose them as a potential approach for future projects. The last but not the least, approach 13, was identified from literature.

Table 1 presents matrix of (approaches X projects) to show the correlation among the approaches as well as which approaches are implemented in the case projects. It shows the thirteen possible approaches, identified by this study in the first columns and the elven target project in the first rows. The approaches are presented based on a sequence from

most implemented (1) to less implemented (13), in the eleven target projects; those are 1) Lepsøybrua, 2) Straumsbrua, 3) Sykkylvsbrua, 4) Tresfjordbrua, 5) Paradisbrua, 6) Linesøybrua, 7) Gullibrua, 8) E6*E16 Flyplasskryssetbrua, 9) Smålenenebrua, 10) E39 Godsterminalenbrua and 11) Tjønnøybrua.

Table 1: ECI implementation approaches (1-13) x projects (1-11) matrix

No	1	2	3	4	5	6	7	8	9	10	11	Total
1	X	X	X	X	X	X	X	X	X	X	X	11
2	X			X	X		X	X	X	X	X	8
3	X			X	X	X	X	X	X	X		8
4	X	X	X	X			X		X	X		7
5					X	X	X	X			X	5
6	X			X								2
7				X								1
8							X					1
9					X							1
10												0
11												0
12												0
13												0

5. Conclusion

This paper has addressed the following two research questions through multiple case studies

- What are the success factors for ECI?
- How can public owners implement ECI on future projects?

Six essential success factors for implementing ECI and thirteen approaches to implement ECI were identified. The findings might provide several useful insights into assisting public owners in determining important successful elements when attempting to implement ECI. Such an identification of success factors would be valuable in formulating effective practical strategies to improve the overall implementation of ECI. The paper also attempts to recommend various approaches for future implementation of ECI based on the lessons learned from previous projects and extensive review of contemporary literature. Based on these findings, effective practical strategies for the successful implementation of ECI may be generated.

In the following Table 2, all the success factors identified by this study, are presented.

Table 2. ECI success factors.

No.	Identified ECI Success factors
1	Involve contractors early enough
2	Manageable risk transfer to the contractors
3	Project owners` competence
4	Proper compensation for the contractors` contribution
5	Qualification of the contractors
6	Trust between the project owner and contractors

Table 3 shows all the possible approaches, which are identified in this study public owners can use to implement ECI. The approaches were identified from literature review and from the case studied projects. Even if the contractor contribution varies a lot depending on which of the approaches are used, none of them were found inadvisable during this study. Therefore, the conclusion is all of the identified approaches can be used on future projects. Since each of the identified approaches were not studied in detail to prioritize one over the other at this stage of the study, all the approaches are presented in alphabetic order in table 1.

Table 3. Approaches to implement ECI.

No.	Approaches
1	Announcing the project with alternative technical solutions
2	Competitive dialogue
3	Contractors sell their idea to the owner in the early phase
4	Design build contract (DB) or turnkey contract and function description
5	Direct contract with specialist contractors in the front-end phase of projects
6	Idea competition
7	Indirect approaches (consultant and in-house construction experience)
8	Information meeting with the contractors
9	Negotiated bidding procedure
10	Opening the project for alternative offers
11	Partnering process phase
12	Project alliancing
13	Project partnering

Although this research is based in Norwegian public infrastructure projects and specifically in NPRA with a limited case study on bridge projects, the study findings and practical experience of the important industrial practitioners may be cross-referenced to further similar investigations in other public owners in Norway or in other parts of the world for international comparisons.

With further research, more interviews with contractor and consultant participants would validate the findings better and even reveal new approaches. Likewise, more cases can also be investigated.

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