

IMPLEMENTATION STRATEGIES IN LARGE INFRASTRUCTURE PROJECTS

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ABSTRACT

Clients want to improve the innovation and efficiency in infrastructure projects, and thereby reduce time and money spent on construction and maintenance. The purpose of this paper is to present and compare experiences with new implementation strategies in infrastructure projects, and to identify how the different strategies contribute to innovation and efficiency. As the complexity of infrastructure projects are increasing along with their magnitude, there is a need to gather international and national experiences with untraditional implementation strategies. This will result in a recommendation to which strategies that best fit a complex, large-scale project.

The results are based on a literature review and case studies, hereunder document studies and interviews with key personnel from the cases. Investigated implementation strategies and types of contract involve use of competitive dialogue, public private partnership-arrangements, design and build with maintenance responsibility and partnering.

Strengths and weaknesses of the investigated implementation strategies have been charted based on experiences from large-scale projects. The paper concludes that the investigated strategies fall short of providing the desired focus on innovation.

KEYWORDS

Implementation strategies, complexity, waste, infrastructure, value

INTRODUCTION

According to Rizk and Fouad (2007), infrastructure projects are traditionally implemented as Design-Bid-Build contracts where the contractor holds little or no responsibility for the planning and design. The complexity of the projects as well as the clients' desire to influence decisions has led to a shift in strategy (Herbsman, Tong and Epstein, 1995). According to Molenaar, Songer and Barash (1999) the public sector has moved away from the traditional design/bid/build strategy towards a design/build. As this strategy has become one of the favourable methods, the timesaving is seen as the greatest advantage (Ibbs et al., 2003). There is a general need to improve the quality of infrastructure, the speed of the implementation and

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also reduce time and money spent on maintenance. Innovation is thus needed in all stages of the implementation process.

The purpose of this paper is to present and compare experiences with new implementation strategies in infrastructure projects, and to identify how the different strategies contribute to innovation and efficiency. This will result in a recommendation to which strategies that best fit a large-scale project of great complexity. Norwegian experiences with implementation strategies are collected through five case studies, while international experiences are gathered through a literature review. Types of strategies include partnering, competitive dialogue, design and build with maintenance responsibility and public private partnership-arrangements.

The Norwegian Public Roads Administration (NPRA) plans to replace seven different ferry services with fjord crossings along the highway route E39. The route runs along the western coast of Norway, a distance of almost 1100 km, and the total costs are estimated to be around 268 billion NOK. NPRA want innovation and increased focus on efficiency in the project. The research question is:

- How do the investigated implementation strategies contribute to innovation and efficiency in complex, large-scale projects?

RESEARCH METHOD

The research was carried out as five case studies, to see events in the context of the real world, but with the lack of clear boundaries between them (Yin, 2014). A project organization gives concrete boundaries for the case studies. The selection of cases was based on what implementation strategy was used, and can be seen in the following table.

Table 1: Selected Cases

Project name	Implementation strategy	Informants	Cost
E6 Trondheim – Stjørdal	Competitive dialogue	NPRA: project manager Contractor: project manager	750 mill NOK
E6 Helgeland Nord	DBOM and competitive dialogue	NPRA: project manager Contractor: costing manager	1630 mill NOK
E18 Grimstad – Kristiansand	PPP	NPRA: project manager Contractor: project manager	3300 mill NOK
E39 Lyngdal – Flekkefjord	PPP	NPRA: project manager Contractor: project manager	1200 Mill NOK
E39 Klett – Bårdshaug	PPP	NPRA: project manager Contractor: costing manager	1450 mill NOK

The strength of the case study method is the use of several types of data (Yin, 2014). Leading up to this article, a literature review, document studies and interviews were conducted. The literature review focused on the international experiences, and what advantages or disadvantages have been reported. The approach was to search for

keywords (see table 2) in databases including Google Scholar, Compendex and Bibsys ASK.

Table 2: Keywords and combinations

Keyword	In combination with
Implementation strategy	Infrastructure
Contract types	Innovation
Contract strategies	waste and/or efficiency

A project document study was performed, supporting subsequent interview findings of national relevance. Yin (2014) argues that the most important use of documents is to corroborate and argument evidence from other sources. Two reports from NPRA⁶ on experiences from the new implementation strategies were found relevant in the document study, and four previous Norwegian master thesis's on the subject.

Ten interviews with project managers and project owners on the selected cases were conducted, as described in table 1. The interviews were conducted with the intention to provide a better understanding of the literature, and thus provide debt to the analysis (Yin, 2014). Depending on the implementation strategy used on the projects, different questions were asked. The interview guide containing the interview questions is found as an attachment in Opsahl (2015). A common denominator was how the informants experienced the implementation strategy along with any negative/positive aspects. The interviews were semi-structured, enabling the conversation to run more freely. In retrospect, to validate the information from the literature and reveal new aspects of the strategies more interviews could have been conducted. The intention was for the informant to give his or her own reflections on the subject matter, as these are not always displayed in a formal report (Yin, 2014).

THEORETICAL FRAMEWORK

The principle of Lean thinking is strongly connected to the reduction of waste, or more specifically the reduction of activities that use resources without creating value for the project (Womack and Jones, 2003). The idea is to do more with less. Shah and Ward (2007) propose that the main objective of Lean production is to eliminate waste through the reduction of variability. In the following, the term “innovation” describes development and use of new technical solutions.

Value for the customer in infrastructure projects is linked to the lifecycle of the project. To see design and construction in relation to operations and maintenance allows the contractors to take the Lifecycle Costing (LCC) into consideration. Lifecycle Costing is defined by the standard ISO15686 as a technique to make cost

⁶ “Vegutbygging i Offentlig Privat Samarbeid. (Road construction with PPP).” 2012. (Available at <http://www.vegvesen.no/Vegprosjekter/Om+vegprosjekter/OPS-PPP>)
 “Kostnadsreduksjon i byggeprosjekter. (Cost reduction in construction projects).” Letter to Ministry of Transport and Communication 24.11.2014

assessments over a specific period of time, taking all economic factors into consideration.

This paper uses “implementation strategy” as a term describing how the project shall be implemented, and it involves procurement, construction, operation and maintenance. Here, the actual issue is how innovation and efficiency is facilitated for in these processes.

The term “megaproject” originates from the large-scale, complex projects with a typically cost frame of 1 billion USD (Flyvbjerg, 2014). Fiori and Kovaka (2005) use the term megaproject when a project is of magnified cost, extreme complexity and has a high visibility. Flyvbjerg (2014) highlights the advantage of the large-scale construction sites on megaprojects. This enables the contractor to work simultaneously at several project sites, taking advantage of equipment surplus and unoccupied work force. Hence, the contractor reduces waste.

Early contractor involvement is part of the Lean Project Delivery (Jørgensen and Emmitt, 2009). The integrated project organization is responsible for design as well as construction. Through early involvement of the contractor the design can be influenced, improving the overall performance of the project in terms of implementation time and cost (The AIA, 2007). Kadefors (2004) states that an early development of project-wide communication and relations will facilitate a better collaboration.

Competitive dialogue aims to align the demands from the customers with the solutions chosen by the use of the contractor’s knowledge and innovation (Hoezen et al., 2010). It is a flexible procedure that allows for the client to discuss all aspects of the project with the contractor (Hoezen and Dorée, 2008). In complex projects this is an advantage for both parties, as it can facilitate innovation through interaction and cooperation. After the dialogue is closed and the preferred bidder chosen, no substantial modifications should be made. This paper defines competitive dialogue as the procurement form where a dialogue is initiated before the preferred bidder is chosen, according to Hoezen and Dorée (2008).

The chances of discovering future problems in the projects are enhanced by the dialogue phase (Hoezen et. al., 2010). This reduces the risk and uncertainty for both the client and the contractor. However, the risk is increased for both parties compared to the traditional Design-Bid-Build, as more contractors negotiate before the preferred bidder is chosen. Hoezen and Dorée (2008) state that trust-based collaboration is important in execution of competitive dialogue. The dialogue is conducted with each contractor individually, and the client must be careful to maintain confidentiality of the tenders.

Public private partnership-arrangement (PPP) is a contractual relationship between government and industry, in this case a contractor, to deliver a public facility (Papajohn, Cui and Bayraktar, 2011). The private company makes the capital investment, and the public authority will reimburse this investment throughout the contract period (most commonly 20 to 30 years). During the operational phase, revenues are intended to cover the financial investments as well as costs of construction and operation, but not the maintenance. A fee will apply if the finished project does not deliver in accordance to expected performance standards. The aim of PPP is to see the cost of construction in relation to the quality and lifecycle costs of the project (Papajohn, Cui and Bayraktar, 2011). The public sector is still responsible

for the availability of the service or facility, but the operational responsibility lies with the private company. As the Norwegian definition is similar to the definition of Papajohn, Cui and Bayraktar, (2011), this paper uses their definition of PPP.

The most important part of a PPP contract is how the risk is split between the parties (Iseki and Houtman, 2012). In general, the public authority carries the risk related to overall planning and the users' need for the project. The private company holds the risk related to the design, operation and maintenance, as well as the financial and technological risk. As the private company carries the full responsibility for design, implementation and operation, the PPP contract implies increased focus on cost efficiency and innovation (Resor and Tuszynski, 2012).

In the Design Build Operate Maintain contract (DBOM) one contractor is responsible for design, construction, operation as well as the maintenance for a set period of time while the ownership remains with the public authority (Dahl et al., 2005). The focus lies on the project to meet the set performance standards, by reducing the gap between design and construction (Priemus, 2009). The project is seen as a whole, and this implies a reduction in number of contracts between the client and different contractors. To help design keep focus on the operation and maintenance, contract structures and design strategies should be applied with great consideration (Dahl et al., 2005). This paper uses the definition of Dahl et al. (2005).

In many ways this implementation strategy is similar to PPP, but they differ in the way the project is being financed (Dahl et al., 2005). The contractor still carries the risk for the condition of assets, but the client pays revenue to the contractor to cover the cost of development and construction during the implementation phase.

If the conditions are right for a DBOM project, Priemus (2009) says the price can be improved, and more innovation can be brought to the table. Preconditions would be professional behaviour from the involved parties, a culture for innovation and a complex project with little interaction with the environment. Lee, Tommelein and Ballard (2010) link the use of a set of lean practices to the success of the application of this implementation strategy, and thus the reduction of waste.

Partnering consists of collaboration on commercial terms between participants from the client and the contractor to continuously improve the performance (Bennett and Jayes, 1998), and this definition will be used in the following. According to Thomas and Thomas (2005) a higher value can be achieved by using an integrated team approach to reduce waste of resources.

The intention is that early involvement of the contractors and consultants shall improve the cooperation within the project organisation. Thompson and Sanders (1998) claims the benefits of partnering increase along with the development of the relationship between the parties. Partnering thus depends on "the right combination" of participants in the project group (Thomas and Thomas, 2005).

FINDINGS

Findings from the literature review, document studies and the interviews for each implementation strategy are presented separately.

The literature review confirms the benefits from using competitive dialogue when there is a lack of a clear project description or the project is particularly complex. The client can utilize the expertise set in the contractor's organisation to improve the outcome of the design process. Formulation of the functional descriptions should not

restrict the solutions in order to allow for innovation to evolve. The risk of not winning the procurement is significant for the contractor, but the document study reveals a reduction in the number of tenderers as a possibility.

The document studies show that it is beneficial to use the contractor's expertise in complex projects. The innovation in the industry seems to be greatest when using competitive dialogue. However, regulations imposed by the client, in these cases the NPRA, will still limit the innovation. All the informants pointed out that better solutions make up for the extra time spent in the dialogue phase. According to the informants, there is little focus on operation and maintenance when developing solutions. This needs to be cared for in the contractual terms.

There was unanimous consent amongst the informants about the high value of the early initiation of the communication flow as a result of the early contractor involvement. Informants from both parties highlight the forming of communication patterns and development of trust. Faster communication implies less waste in the implementation phase. Further on, the informants from the contractors stated that the preapproval of solutions presented through the dialogue phase reduced the need of amendments during construction.

All the informants brought up the high cost related to the dialogue phase of the project. Giving the contractors a compensation for their time and resources spent might solve this problem. According to the document studies, the compensation should as a minimum cover the cost of external advisors as well as to some extent the internal resources spent.

The document studies pointed to the biggest potential for increased value in PPP being the shift of responsibility⁷. As the contractor holds full responsibility for both the design and the construction, the possibility arises for a speed-up of the construction. This possibility might contribute to a faster completion of the construction phase, but the document studies showed it can also turn out to be counterproductive in terms of late preapproval of solutions by the client⁸. In a report⁹ on the Norwegian experiences, it is pointed out that the most positive effects from PPP are the expected increase in efficiency and a shortening of the construction time.

Informants from the contractors claim that standard solutions often are chosen over innovation in order to reduce the contractor's risk. Solutions are often chosen based on the total cost. The question remains why innovation is avoided, as risk alone cannot be the only factor. Avoiding cost associated with developing new solutions might be an underlying factor, but the informants refused to confirm this statement, nor deny it.

The interviews show that early involvement of the contractor is believed to reduce waste in the construction phase. Due to the responsibility for the project from design and through operation, the informants from NPRA highlight that changes in scope are fewer and of lesser impact.

⁷ "Offentlig Privat Samarbeid (OPS) og innovasjonspolitik. (PPP and innovation politics)." Vista Analyse AS, 2008

⁸ "Kartlegging og utredning av former for offentlig privat samarbeid (OPS). (Investigation of forms of PPP)." Ministry of Trade, Industry and Fisheries, 2003

⁹ "Evaluering av OPS i vegsektoren. (Evaluation of PPP in the NPRA)." Dovre International AS and Transportøkonomisk Institutt, 2007

A Norwegian report¹⁰ states that the enhanced risk taken by the contractor in DBOM concerns the industry. As this is part of the incentive to keep operational costs low, informants from NPRA does not share this concern with the contractors. The allocation of risk for operation to the contractor should imply a reduction of scope changes during the operational phase.

The reduction in the number of contracts to only one large contract proves by the literature review and the document studies to be one of the biggest advantages for the client. An incentive is given to the contractor to see the design and operations in connection. The contractor assumes a high risk in terms of the need for maintenance and poor construction works when holding responsibility for the operational phase.

One can assume that innovation is being facilitated by the need for maintaining a high quality and designing for low maintenance costs. Interviews conducted with informants from the contractor states the opposite, as standard solutions are more often chosen to avoid the risk of untested solutions. The limitations imposed by the client are pointed out as an obstacle for innovation, as new solutions would have to be preapproved and thus extends the design phase. This again limits the contractor's possible profit, and is seen as a huge downside.

As an implementation strategy, partnering involves an increased collaboration between the parties. According to literature, the benefits of this are how the project owner can utilize the knowledge of the contractor to find the best solutions.

Previous student work¹¹ states that the model is seen as more demanding in terms of involvement, but the gain is a more efficient building process. Early contractor involvement will be beneficial for complex projects, and thereby partnering can be useful.

Several factors need to be present in order to generate a well-functioning partnering process, according to the document studies. The right mind-set of the participants is a key to ensure full commitment. A translucent economy, or open book economy, is important to enhance the trust between the client and the contractor.

Interviews conducted show that there is an overall consensus that partnering provides an increased value for the project. In terms of innovation, the opinions are divided. Some informants claim that even though the early involvement implies that innovation should occur to a large extent, the reality is the opposite. Partnering becomes a way of developing efficient communication patterns and thus facilitates for innovation.

DISCUSSION

The early contractor involvement is of essence in the use of competitive dialogue if the project is to create the innovative solutions desired in complex projects. This interaction leads to a common objective for the project and an early initiation of communication. Hence the project can experience a reduction of duplicated work and design errors, consistent with the principles of Lean. Cohesive staffing will be an advantage to ensure the up-keep of the communication flow from the dialogue phase.

¹⁰ "E6 Helgeland, Korgen – Bolna (KS2)." Dovre International AS og Transportøkonomisk Institutt, 2013

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The dialogue phase seems to provide a better economical control, based on the joint development of solutions. The latter will be a huge positive effect for the client, as cost overrun tends to be an issue with infrastructure projects.

On the negative side no reduction of operational costs is seen, as the contractor claims to have no knowledge of the lifecycle costs of the new solutions. As these costs should be easy to estimate, unwillingness to adopt new solutions is more likely to be the underlying issue. To make the strategy more profitable and thus more attractive for the contractors, the compensation should be of such size that participation in the dialogue leads to economical gains for the contractor.

In terms of PPP and DBOM, one can state the following positive experiences: The construction time can be expected to be shortened due to parallel design and construction, private financing (in PPP) and the possibility to better make use of the resources. Quality is still expected to remain high due to the contractors' responsibility for operation. In megaprojects this will contribute to lower the lifecycle costs, as maintenance costs will be reduced. Waste is assumed to be reduced as the number of interfaces is less, but this is just an assumption based on the literature review, and is not confirmed in any of the conducted interviews.

Of the negative experiences the findings show that innovation is not increased in these strategies, it is rather the opposite that happens as the contractors choose standard solutions to avoid risk. The limitations imposed by the client in terms of preapproval of solutions are connected to this challenge. The intention to lower the maintenance cost and increase quality, depends on design freedom. Innovation is not increased until a solution is found to this contradiction.

From the findings we have that all projects can benefit from using partnering, but especially projects where the project scope is hard to define. For a megaproject, one can assume that the complexity is not merely of technical difficulty, but also depends the magnitude of the project. Hence, partnering would be highly profitable in megaprojects. Furthermore, when the client sees it as beneficial to develop the project together with the contractor in terms of innovation, partnering should be considered.

CONCLUSION

This article seeks to give a recommendation in terms of how to implement megaprojects. Together with efficiency, innovation is an important issue in these projects, as there are few similar projects to gather experiences from. In terms of the highway route E39 with the seven fjord crossings, an underlying issue is how to achieve the desired innovation in the project.

As a summary, it can be stated that the new implementation strategies contributes to the reduction of waste during design, construction and operation. Designs are conducted to improve constructability through an early involvement of the contractor as well as better communication between the parties in accordance to the principles of Lean. This improvement of efficiency is an expected result. On the opposite side, the common denominator of the negative experiences seems to be the lack of facilitating for innovative solutions. The contractors lack the freedom to come up with new solutions and fear the attached risk, and thus the industry is merely moving sideways as opposed to forward in terms of innovation. As this is one of the main objectives of the investigated implementation strategies, it is a rather important issue to address in further research.

For the fjord crossings along the E39 highway route, the desired innovation in the project needs to be addressed. Partnering might be seen as the obvious choice, but according to the interviews conducted in this article, innovation is not really present in this strategy, nor is it in PPP or DBOM. By early contractor involvement, the possibility for innovation as a result of the contractor's competence and experience arises. A better way to ensure innovation in the solutions is thus by the use of competitive dialogue.

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