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Development of target cost – By the owner or together with Contractors - Target Value Design

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Abstract

Cost growth and cost overrun of projects is a well-researched topic, but still a recurring problem. Some of the problems may be attributed to the difficulties of setting a realistic cost estimate in the early phase of the project. This paper aims to give insight into the challenge of setting realistic cost targets. We particularly focus on large and complex infrastructure projects in the context of the Norwegian construction industry. Four large infrastructure projects have been examined, all used a variation of target cost and were more or less successful in their implementation of this approach. Through interviews and document study we identified that when setting cost targets for projects, both allowable cost and target cost should be considered. Allowable cost should be defined by the project owner, implying that the allowable cost should be set before the start of design. Furthermore, the target cost should either be set by the project owner or in dialogue with the design and contractor team. The study concludes that it is important that the target cost is set 12 – 20 % below allowable cost so that it is possible both to drive innovations through the design process and to be able to handle risks during construction.

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1. Introduction

Cost growth and cost overrun of projects have been researched by scholars all over the world (Flyvbjerg 2003, Odeck 2004, Merrow 2011, Klakegg, Lichtenberg 2015, Torp et al. 2016, Bakke et al. 2019). Their result shows the same pattern, both small and large projects had cost overruns, generally of significant size. Flyvbjerg (2003) analyses many international large projects and shows that 90% of the projects in the study had significant cost overruns. Flyvbjerg also found a significant overestimation of project benefit. Odeck (2004) analyzes a complete sample of all public road projects in Norway for a 3-year period (1992-1995) – a total of 620 projects. The study indicates that small projects have even worse results than large projects – the cost overrun was even more frequent and relatively larger in small projects. Merrow (2011) documents that the situation is not much better in the private sector, stating that as much as 65-75% of industrial megaprojects fail on business. Torp et al (2016) studied 11 large and 34 medium to large-sized projects in Norway, concluding that most of the projects registered cost growth during the planning phase. The projects registered about 50% cost increase from the first estimate established in the pre-study to the estimate made at the end of the design phase, before the final decision to start detail design and construction. Scope and design change, project complexity, site and location constraint, and the need for special facilities were the most important factors that contribute to cost escalation in the planning phase. Bakke et al (2019) investigated 19 Norwegian governmental construction projects and analyze the correlation between the relative strength or weakness of the Project Mandate and the development of cost estimates through all project's phases. All the projects in this study underestimated the cost in the earlier phases. The main reasons for the underestimating were found to be lack of project goals, the future needs are not properly identified and the client demands increased during the planning phase. A key challenge is to create good cost estimates at an early stage in the design process. Early prediction of project costs is fundamental to setting targets, making informed decisions, project evaluation, engineering design, cost budgeting, and cost management (Dang and Le-Hoai 2018). Underestimation in a project's initial phase may be significant and pose a serious problem regarding the selection of a project and its relevance to societal needs and market demands (Andersen et al. 2016). Danielsen et al. 2017 claim that all project proposal needs realistic cost estimates, and that this is important to the client to ensure those right decisions about the size of the investment, and whether to realize the identified project. Similarly, every project manager needs a realistic cost estimate to allow for successful cost management during the project. At a certain point in the project life cycle, usually, right before the final decision to fund the project, a cost target is set. The cost target is based on an updated cost estimate. The target cost is the amount of money the project manager has available for the project.

Do, Ballard and Tommelein (2015) argue that there is a close connection between Integrated Project Delivery (IPD) and the Target Value Design (TVD) concept which was introduced in 2004 by Ballard and Reiser. The American Institute of Architects (2007) describes TVD as a unique way of creating value within budgeted constraints. This is done by designing to a financial target, using several iterations, rather than estimating the cost based on a pre-decided detailed design. TVD allows changes to occur, that normally would be regarded as an extra cost. Through combining IPD and TVD the commercial incentives are aligned towards the project's goals which are reflected in achieving customer value. It is no longer about completing unilateral contributions at the least cost. Thus, the commercial incentives move to re-aligning the thinking of participants from short term objectives to optimization and improvement of the whole product. Tillmann et al. (2017) report that factors that influence the ability to deliver a project to target costs are 1) how cost targets are set and the market price is estimated 2) how shared profit is agreed upon and made transparent and 3) how production costs are steered towards the target cost and tracked, so risks can be identified and mitigated. To summarize; it is well-proven that projects have a strong tendency for cost overrun- – large or small, private or public – and over time. Projects still struggle to find the right realistic cost estimate in the early phase of the project life cycle and steer to that cost during design and construction.

This study aims to address the challenge of setting realistic cost targets in complex projects. The International Centre for Complex Project management (2012:22) defines complexity to be characterized by a “degree of disorder, instability, emergence, non-linearity, recursiveness, uncertainty, irregularity and randomness, and dynamic complexity where the parts in a system can react/interact with each other in different ways”. The project size adds to

the complexity. Naturally, complex projects are more challenging to manage than simpler ones. The following Research Questions are set for the research:

- RQ1: How should target cost in large complex projects be decided?
- RQ2: When is the “best” time to decide the target cost in large complex projects?

2. Theory - From project delivery to value creation

Every project is undertaken for a specific purpose. Typically, the project owner has a goal that should be satisfied through the results of the project. This is the business objective that the project should fulfil. A standard project model consists of the phases Concept, Design, Construction and Operation/use. In the classic project delivery process, the owner identifies the business need and develop it to a level of detail in the concept phase. Then a separate organization can be contracted for the design and execution phase in a design-build model. Then the owner takes over the result and gets the value in the operation phase. Value is an assessment made relative to a set of concerns that someone wants to be addressed, according to Macomber and Barberio (2007:1-2), and there is nothing of value independent of a person saying (assessing) it is valued. The authors argue that client concerns – interests, not worries, and as design proceeds new concerns arise while others fade away. A contract between the owner and the project delivery organization will, as precisely as possible, define what to deliver within an agreed deadline and cost constraints. The project organization executes the project and delivers the results to the owner. This delivery process includes a clear distinction between the owner and the project organization, where the contract is the link. Today, a more integrated approach is followed where the owner is more directly involved in the total life cycle of the project as this is sought to be a more efficient way to maximize value creation. The project organization must take the business goals into account, in addition to the project goals, understand the rationale for the project and act in the best interest of the owner. The owner, on the other hand, must closely monitor the project and understand the business interest of the project-executing organization. According to Johansen et al. (2019), the project owner is responsible for finding the right project to develop. In the concept phase, before the start-up of design, the owner decides which project is the best. As a basis for the decision, a cost estimate is typically developed. The project owner decides which of the concepts will be the best project for the company. In the early stage of the process, all the concepts are immature, with their advantages and disadvantages. Thus, it is not an easy task to select which concept to develop into a project and which to forego. The project that represents the best business case must be identified. Which of the concepts seems to obtain the highest return on investment over the project life cycle? Some of the concepts may apply proven technology, while others require a breakthrough in technology. Some will have a substantial negative environmental impact; others may have less. Some will require a large investment with low risk of cost overrun; others may seem to cost less but involve a larger risk of cost overrun. A cost estimate is a prediction of the quantities, cost and/or price of resources required by the scope of an asset investment option, activity, or project. An estimate must include a prediction of the risks and uncertainties. Estimates are among other things used to set cost targets for the project – the for the design and execution phase of the project life cycle. Cost estimates are determined using experience, calculating and forecasting the future cost of resources, methods and management within a scheduled timeframe (Johansen et al. 2019). Project budgets normally include a contingency for handling the uncertainty. Zhao (2006) found that most practitioners (77%) use a deterministic percentage approach for estimating project cost contingency. An alternative way of adding contingency as a deterministic percentage is to do stochastic estimation, adding the uncertainty through the stochastic estimates of each cost item (Lichtenberg 2000). The successive principle has been used as a cost estimation method in the Nordic countries since 1990 (Klakegg et al. 2015). This method combined with Monte Carlo simulation has proven to be simple and under the right condition a fairly accurately way to make a cost estimate in the early stage based on limited information. The cost estimate is presented by a probability distribution, where the cost budget could be defined by deciding at which level of uncertainty you accept for your budget. Norwegian Ministry of Finance has decided to set the budget at P85, meaning that it is an 85 % probability of ending up below the budget. We will argue that the main challenge is not how to estimate costs, we know how to do the estimation. The challenge is rather that many project owners make too certain estimates, too early in the process. A main challenge in the early phase is that the scope is normally not finalized at this stage (Sonmez 2011). It makes no sense to make an accurate estimate on a bridge or a tunnel if the project owner hasn't decided on the scope. Target Value Design is based on conceptual cost estimates to before design, based on programmatic data (Ballard and Pennanen 2013). Programmatic data includes what is

wanted (functionalities, capacities, and features of the desired asset), where the asset is to be located and when it is to be produced. Target Value Design (TVD) is a management practice in which the design and construction are steered towards the project constraints while maximizing customer value (Ballard, 2011). In TVD, the Allowable Cost is cost the customer finds acceptable; i.e., they are willing and able to pay that amount and are assured that they will receive in return what they want. The customer sets Allowable Cost before the start of design, based on the project business case. The project team defines the Expected Cost for each design solution. It would be the cost of the facility with determining performance that was provided at current best practice. The target cost is set when the client decides to fund the project (Ballard 2011) and thereafter the design phase is launched. Macomber and Barberio (2007) argue that Target-Value Design (TVD) turns the current design practice upside-down. They identify five principles:

- Rather than an estimate based on a detailed design, design based on a detailed estimate.
- Rather than evaluate the constructability of design, design for what is constructible.
- Rather than design alone and then come together for group reviews and decisions, work together to define the issues and produce decisions then design to those decisions.
- Rather than narrow choices to proceed with the design, carry solution sets far into the design process.
- Rather than work alone in separate rooms, work in pairs or a larger group face-to-face.

Macomber and Barberio (op cit.) moreover introduce nine practices, which they denote foundationally. The first is to engage deeply with the client to establish the target-value, because both designers and clients share the responsibility for revealing and refining concerns, for making new assessments of what is value, and for selecting how that value is produced. Secondly, lead the design effort for learning and innovation. It is to be expected that the team will learn and produce something surprising. Hence, it is central to establish routines to reveal what is learned and innovated in real-time. That includes expecting a surprise, which will upset the current plan and require more re-planning. Thirdly, design to a detailed estimate, and use a mechanism for evaluating design against the budget and the target values of the client. Fourthly, collaboratively plan and re-plan the project, which has the potential to avoid delay, rework, and out of sequence design. Fifthly, concurrently design the product and the process in design sets. Develop details in small batches (lot size of one) in tandem with the customers (engineer, builders, owner, users, architect) of the design detail. Adopt a practice of accepting (approving) completed work as you design. Sixthly, design and detail in the sequence of the customer who will use it, to reduce the number of negative iterations. Seventhly, work in small and diverse groups to encourage learning and innovation. Eighthly, work in a Big Room as the design is messy, and impromptu sessions among design team members are a necessary part of the process. Ninthly, make a habit of finishing each design cycle with a conversation for reflection and learning.

3. Method and research design

To answer the research questions, this research was designed and based on the examination of several road construction cases conducted within the Norwegian construction industry. The case study method was chosen as it represented a sound empirical approach to study the Target Value Design phenomena. As prescribed by Yin (2014), a case study approach is beneficial when one seeks to conduct an in-depth examination of a contemporary phenomenon where the investigator has little control over the events. The four infrastructure cases are all public-initiatives, thus subject to public procurement rules, and administrated by the two Norwegian public projects owners Norwegian Public Roads Administration (NPRA) and Nye Veier AS. Two of the cases are managed by the NPRA, and two by the “rival” Nye Veier AS. The cases (measured in monetary size) ranged from NOK 750Millions to NOK 5500Millions.

The data collection involved a qualitative research approach using semi-structured interviews as a means of collecting primary data. Also, a document study was conducted to collect secondary data and to verify data from the interviews. The choice of using semi-structured interviews is attributed to the flexibility provided by this method. Since the study draws evidence from several unique cases, flexibility in approach was needed. All interviews followed an interview guide with pre-defined questions, but the interviewee was encouraged to elaborate and talk about subjects beyond the predefined questions. The questions were formulated to be open-ended with emphasis on collecting responses on particular issues. To gather the perspectives from a cross-section of actors involved all the cases, some specific roles and professions were targeted in the sampling. This included the project owner's project manager, managers from the advisory groups, the contractors' project manager/project managers and the Public, Privat Partnership (PPP) company manager (the predominant target group). 4-6 interviews were conducted in all the cases

and the duration of the interviews varied between 1-2 hours. All the interviews were recorded and later transcribed to ensure accuracy in the data. The secondary data was collected from all four projects, this included contracts, plans, summaries of the projects and various presentations that the projects themselves have developed and which they have shared with the researchers. Lastly, the results from all the cases were shared between the researchers, and the data were analyzed using a qualitative approach.

4. Case study findings and discussion

Table 1 summaries the case study of the four large and complex infrastructure projects with 2 different approaches on developing target cost.

Table 1: Description of the four large and complex cases under scrutiny

Project	Development of target cost	Short description of the project
E6 Helgeland nord Client: NPRA	Target cost developed before involving contractors – at the end design phase	Operation phase 62-kilometer new road 2 lines. Construction period app. 4 years, open for traffic October 31st, 2019 Final cost 2,7 billion Norwegian kroner.
Rv. 3/25 Løten-Elverum Client: NPRA	Target cost developed before involving contractors – at the end design phase	Construction phase 16-kilometer 4 lines road, additional 9-kilometre 2-line road – Opens for traffic November 2020 Estimated cost ca. 5,5 billion Norwegian kroner.
E18 Rugtvedt-Dordal Client: Nye Veier	Use of Best value procurement- cost developed together with contractors – Contractor/design team involved from the middle of the design phase	Operation phase 16,3-kilometer 4-line road. Construction period 2,5 years (May 2017-December 2019). Cost 1,8 billion Norwegian kroner.
E6 Kvål-Melhus Client: Nye Veier	BVP and Integrated Project delivery Contractor/designer involved from the start of the design phase Target cost developed in a joined process	Construction phase Around 7-kilometer 4-line road, Construction period 2- 2½ years June 2019 - December 2022. Cost 0,75 billion Norwegian kroner.

The case study findings are based on a comparison among four case projects. The case projects used two different approaches to develop the target cost. In both approaches, the client wants to enter into a contract with cost slightly below allowable cost so that risks and changes can be handled. In the following, we explain the differences among the cases and thereby set the basis for answering RQ1 (How should the target cost in large complex projects be decided?) and RQ2 (When is the “best” time to decide the target cost in large complex projects?). The maximum price (allowable cost) and target cost are set at a relatively early stage in the process for most of the projects included in the study, implying that the target cost is set before many of the projects key solutions are selected and before the complete design is decided. This results in the projects being rather immature at the time of setting targets. The maximum price (or the client’s budget and maximum price) and the target cost (project organization’s steering target) are established before the project moves on to detailed design. This is challenging in many ways if:

- the owner asked for a greater degree of innovation,
- the owner asked for more optimization of the project based on the contractor's and consultant's expertise,
- and the project is open for re-adjustments and change of road line choices after the contract has been signed.

In all the cases this proved to be elements that were difficult to combine, and at least one of the parties will get a bad deal with such a solution. The outcome is, thereby, that one of the contracting parties will not achieve their intention – or aim – of the contract. From the contractor's point of view, they can potentially lose money or at least not achieve the defined bonuses. The client, on the other hand, will potentially not achieve the intention of a higher degree of innovation. Figure 1 shows the two alternative strategies for the time of setting allowable cost and target cost, identified through the case studies. With alternative 1, allowable cost and target cost are set before entering the design phase. This is in line with principles of TVD discussed in the theoretical section above. In alternative 2, allowable cost and target cost are set at the end of the design phase, before detail design and execution. In both alternatives, the project owner wants to sign a contract below allowable cost, to be able to handle risks and changes during detail design and construction.

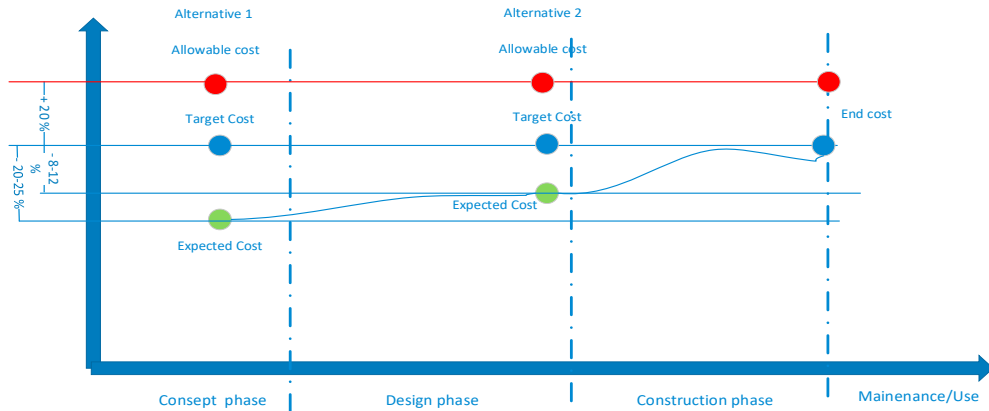


Figure 1 When should target cost be developed? (based on Malvik, Johansen 2020)

At what time in the project process should maximum price (allowable cost) and the target cost be set and frozen? If you choose an approach to freeze maximum price before design and choose to stick to it through the whole process, you need a mature concept before the start of design. Most often the scope is not defined this early (Sonmez 2011, Johansen et al 2019). A mature concept will be based on a defined scope, the project is approved by the municipality, land acquisition is done, and geotechnical and geological investigations are performed. Also, the parties should agree on the location of the road in the terrain. The route should not be adjusted or deviate from the agreed, and the scope of heavy constructions like bridges and tunnels should be defined. If one or more of these things are not in place, it would be better to sign the contract at a later stage in the design, when more details are defined and decided upon. Alternative 2 from figure 2 is preferred when the project scope is immature when entering design, or when project owner wants to involve designer's and contractor's knowledge to improve the concept and explore flexibility with innovative solutions. The purpose of the development process in the procurement stage, from project owner's side, is a target cost 8 to 10 % below allowable cost, in high-risk projects up to 20 %. So that can deliver maximum value within the target cost. 3 out of the 4 cases has been successful in terms of delivering the project within the established target Cost. – the fourth case (The IPD project – is not finished with the construction phase and its therefor too early to conclude on that case on this matter in this study. The reason is to secure realistic level of contingency for the next phase and to be sure it is possible to end up below allowable cost. This will give stretch target to drive innovation beyond current best practice (Pennanen and Ballard 2008). The project owner can start with target cost intentionally to low as a starting point, and thereafter work together with the designers and contractors towards a common agreed-upon target cost. This strategy is shown as starting point 1 in Figure 2. Another strategy for the project owner is to start with what they think is a realistic target cost, and then negotiate or start a dialogue with the market, bringing the target cost down below target cost – contingency (20 %). Then the contract is signed for detail design and construction. In both cases, the project owner must have an early estimate that allows them to give and “fair” starting point of the target cost when the design or detail design is started up Starting point 1 seems to be the intended situation when a Best Value Procurement process is run for the case projects in this study. The argument for deliberately starting at a lower cost than the target cost– starting point 1- seen from the owners perspective, is that the target cost and design should be developed step by step so that maximum value for the money that is available will be the result of the design phase– the cost and the value should be evaluated in each of the steps so that project has a realistic possibility to be delivered within the target cost and so that project team can handle the risks and opportunities in the construction phase. Ideally, the project parties should agree on this situation from the start, and commonly agree that the best concept will be developed through the procurement process, with the right target cost. Such a target cost process or value-based design process will develop through design iterations, where we evaluate the result from each round against the targets. Design solutions are improved through the iterations together with the chosen contractor and designers. For each new iteration, the parties evaluate the most effective solution and agree about what to optimize in the next round of design iteration. The process should ideally use open-book and design criteria should be agreed

upon. A common agreement on target cost is a prerequisite for the start of construction. All parties are eager to find a solution that is sustainable for everyone. Without a common agreement, the process might be stopped, and the project owner can start iterations with a new contractor and designer team.

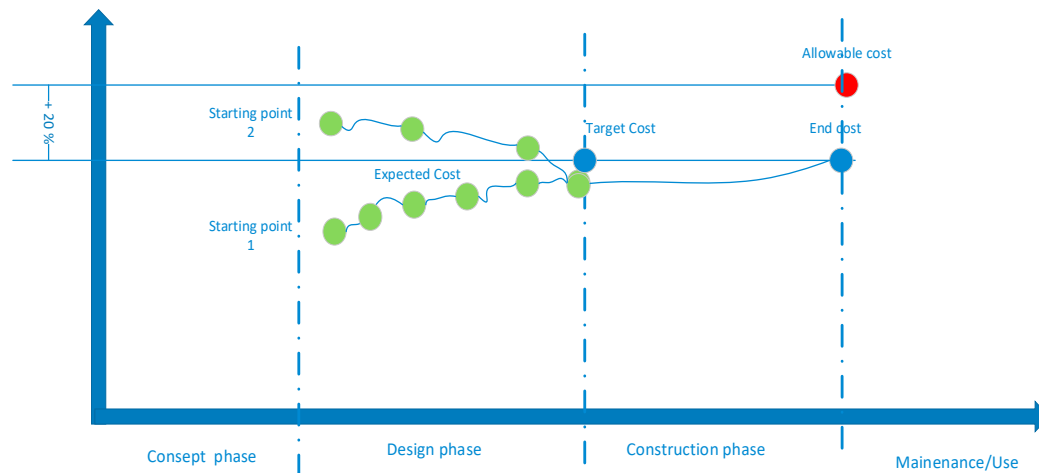


Figure 2 Alternative starting point for establishing target cost (based on Malvik, Johansen 2020)

The chosen contractor and designer team is dependent on a realistic starting point from the project owner's side. If the owner believes that the starting point of the design phase is on 1 and at the contractor/designer is disagreeing on and suggest that what the owner asks for, in fact, will cost more – starting point 2 – is what the contractor and designers believe is the cost for the scope that owner suggests should be delivered as part of the project. An unrealistic starting point may result in a demanding process through the whole design phase, as the second iteration will show that that the price of the contractor and design team is far higher than project owner expects. This will potentially lead to the search for cuts and simplifications instead of improvements. Such negative dynamic easily end up with a product less than optimal, or a road with unnecessary expensive maintenance and a road below today's expectations. A process as described in the previous paragraph will not bear changes in design solutions for heavy constructions like bridges and tunnels. The project will also be sensitive for impact from identified risks in the concept. A possible drawback is that to agree upon a target cost for the next phase, contingencies necessary to control risks during construction will be reduced. Also, with this starting point, you start with know-how that even how hard the contractor and designer work, they will not achieve the bonus that normally is part of the IPD agreement. With starting point 2, the project owner uses negotiation or dialogue with the market before setting allowable cost and target cost in the procurement stage. The dialogue or negotiation is run in two or three iterations with three or four contractor and design teams. Design solutions are developed during the iterations and in parallel separate processes with the different teams. The procurement phase concludes with the team with the highest overall score. The project owner will during the whole process keep a certain distance to the teams, and without sharing solutions, ideas and prices developed. The project owner aims to sign a contract for the remaining design and construction with the team with the best solution within the maximum price (allowable cost).

5. Discussion and conclusion

This paper aim to answer how the target cost should be decided in large complex projects be decided, and the "best" time to decide the target cost in large complex projects? Four large Norwegian road construction projects are studied to answer these questions through case study research. When setting cost targets, both the allowable cost and target cost should be considered. Allowable cost should be defined by the project owner, based on the business case before contractors and designers are involving in the process. This implies that allowable cost should be set before the start of design, and the estimates should be an early estimate that allows the owner to give and "fair" starting point of

the target cost when the design or detail design is started up. This is in line with the addressed state of the art thinking in TVD. Ballard (2011) states that target cost should be set before launching design. Target cost could either be set by the project owner before procurement of a design and contractor team, or in a dialogue or negotiation with the market through the procurement process. Setting target cost before and without dialogue with the market on large complex projects, increased the probability that the target cost will not be possible to validate. The implications for the proceeding process will be that the target cost must be adjusted during the procurement process, or after procurement. Therefore, we conclude that it is a better idea to set the target cost later in the procurement process, not before the start of procurement. When it comes to how to decide the cost targets, allowable cost should be set by the project owner. It is the amount the project owner is able and willing to pay to get what he wants. Target cost could either be set by the project owner or in dialogue with the design and contractor team. We will recommend the target cost to be set in dialogue with the chosen team. In both cases, a realistic starting point from the project owner when setting target cost is important. The target cost must be 12 – 20 % below the allowable cost so that it is possible both to drive innovations through the design process and to be able to handle risks during construction.

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