Effectivity of Risk Management for Design & Construct Projects of Large Contractors

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Abstract

This paper presents an evaluation on the risk analysis and risk management of a contractor for large Design and Construct projects. Risk management and risk analysis are vital tools to secure project profitability. The evaluation of individual projects brings to surface some discrepancies that obstruct the learning-cycle for today's projects. Therefore recommendations are made to increase effectiveness of risk management for Design and Construct projects.

1 Introduction

For a contractor the (financial) result of a project is highly influenced by risk. To assure project profitability the price is based on a cost estimation. This estimation is based on cost accounts (fixed and variable) and a projection of a risk analysis. In past years efforts have been made to produce estimations that are statistically controlled. This means that for a great number of projects the cost realisations all fall within statistical boundaries of the cost estimation, with just few exceptions.
Especially estimations for Design and Construct projects are sensitive to risk [1]. Risk control is merely concentrated in early project stages, though full implication is only known in later stages [2]. The responsibility for design implies more risk allocated at the contractor's account. In this paper, first the probabilistic approach to project cost estimation will be reviewed, followed by the factors which blur a proper evaluation of cost estimation in Design and Construct projects. One of these factors, namely the uncertainty in claims, will be studied in more detail, followed by a recommendation how to improve the evaluation method for probabilistic cost estimation.

2 The probabilistic approach to project cost estimation.

At the start of a project a cost estimation sums up all fixed and variable cost items (Fig. 1). A probabilistic cost estimation then starts with making an inventory of project risks throughout the project. This inventory has to be as complete as possible, identifying all relevant risk items. These risk items will be the input in the risk model, for which a Monte Carlo simulation is often used. For this purpose the risk items are modelled as either normal events or special events [3, 4, 5], characterised by their probability distribution. This distribution can be displayed in a density curve or in a cumulative distribution curve.

Using a Monte Carlo simulation the individual risk items can be combined to a cost probability distribution. When displayed in a density curve one can clearly show the distinction between fixed cost, variable costs and the reserve for risk. This reserve is set at an acceptable probability of exceedance, determined in the distribution curve [6].

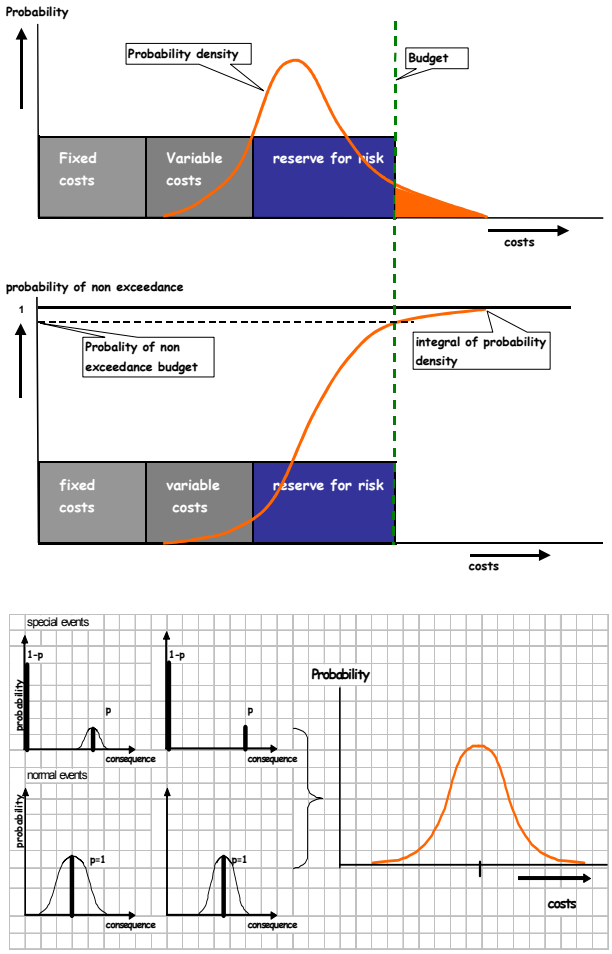
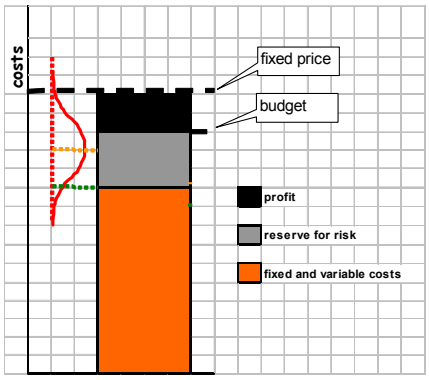


Figure 1 Probabilistic cost estimation



In a full probabilistic approach the project budget is fully determined by this cost estimation, its total budget following from the chosen acceptable probability of exceedance (Fig. 2). When applied in a transparent manner each project calculated in this way can be evaluated and used to build a database to refine this method.

Figure 2 Principle of probabilistic budgeting

3 Three factors that obfuscate the evaluation of probabilistic estimation for Design and Construct projects.

In practice risk management is a continuous process. At several stages in the project the risk analysis provides a momentary value (Fig. 3). The risk analysis thus delivers the information for the decision making in the process. To evaluate effectivity of risk management we concentrate on the quality of risk analysis and its role in the decision-making. To do so we will evaluate the cost specification known at the end of a Design & Construct project and compare it to the cost estimation as it is used to determine the project budget.

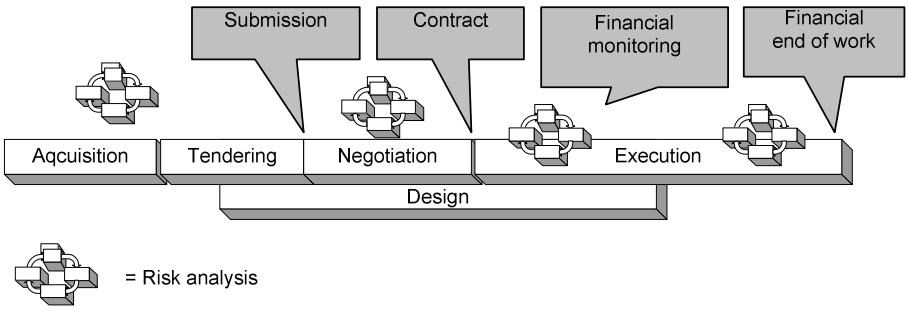


Figure 3 Risk analysis process during all stages of the project

The comparison shows the sufficiency of the budget, the reserve for risk, for the total costs due to risks during the project. In [7] two large Design & Construct projects have been examined. The projects were both part of the alignment of a new railroad through the Netherlands, both included a large tunnel and were characterised by their substantial contract price and construction time. During the evaluation of two large infrastructural projects it appeared, according to [7], that

three factors obfuscated the evaluation of probabilistic estimation for Design and Construct projects:

- The reserve for risk in the cost estimation is not only determined by the output of the risk analysis. This decision is a management decision and often influenced by commercial considerations. Therefore the cost estimation is not a full rational probabilistic method.

- Design & Construct contracts are sensitive to changes of the actual work scope as defined in the contract. During the realisation work-tasks are added and deleted. In the account of the project costs, the implication of these changes is included. The work scope used to set the budget can differ substantially from the actual scope of the realised project.

- During a Design & Construct project claim situations can occur. Claims mostly handle about a dispute between contractor and initiator concerning the account responsibility of a cost overrun that has occurred. The uncertainty around these claims is not accounted for in the risk analysis. Furthermore the costs and income of these claims are often separately accounted for in time. This blurs the overview during the project.

5 Claims and work outside the contract scope.

A Design & Construct project can be defined as the process that handles creating a solution for a complex problem. The goal is to solve this problem effectively and efficiently. Risk in Design & Construct projects can be divided into two kinds [1].

Process risk: Risk concerning the efficiency of the solution. This risk is principally allocated with the contractor

Perception risk: Risk concerning the perception of the problem and the effectivity of the solution. This risk is principally located with the initiator.

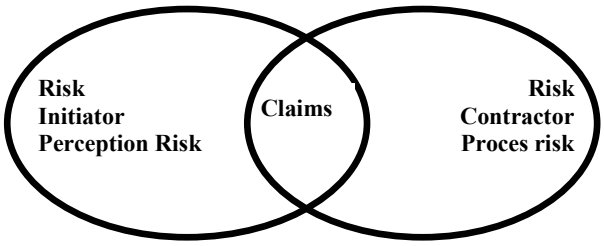


Figure 4 Schematic overview of claim risks

In practice it is not clear for every risk that leads to cost overrun whether initiator or contractor is responsible. In fact it is not clear if these risk are process risks or perception risks. Most claim situations handle these disputes (Fig. 4). Since cost overrun mostly occurs when extra work is done these costs are initially accounted for by the contractor who will then claim these costs at the initiator.

The problem therefore occurs that during the different stages of construction costs and possible income are separately accounted for in time. Even when construction is finished the financial result is still very uncertain because claims are often exceeding construction time.

Furthermore common risk analysis for the contractor is based on process risk. The inventory contains risk items with uncertainty in occurrence and consequence. There are no risk items with uncertainty in allocation. In the evaluation of two large infrastructure projects the exposure to uncertainty in claims was dominant to process risk exposure. The financial evaluation of the risk analysis is therefore blurred because the financial consequences of claim risk and process risk are not separately accounted for.

The most important control measure available for the contractor for risk due to claim situations is two folded:

- Screen the contract on deficiencies and possible interpretation differences.
- Appoint a contract manager to the work to concentrate all juridical work.

It is not very suitable to control the risk from claim situations statistically in the risk analysis.

The key question that now arises is how to evaluate the risk analysis at the start of the project to the financial result without the financial repercussions of claims. Only then will it be possible to acquire statistical material that can be used to refine the risk analysis for process risk.

6 Recommendations for an improvement of probabilistic cost estimation and its evaluation.

The solution for the problem of a clear evaluation of reserve for risk consists of the distinction of process risk as identified in the risk analysis and the exposure to risk due to claims. For a contractor claim risk mainly consists of the uncertainty of compensation for costs made with work supposedly outside the contract scope.
If we want a full oversight during work to effectively manage the exposure, the risk analysis will also have to provide information on claim risk. Furthermore the evaluation of process and claim risk for many projects will give the contractor a statistical tool.

This can be achieved with the following adjustment to the risk analysis. In every momentary value presented in the risk analysis exposure on process risk and claim risk have to be separated. The probability function of the total cost is shifted along the x-axis if a new claim risk has led to costs and if that risk was not accounted for in the risk analysis. The exposure to the claim risk is separately displayed in a new budget function with the probability on compensation for the extra cost. If we account for every claim risk separately we can at any time calculate the most

probable value of total profit or loss by combining the probability distribution of cost and budget.

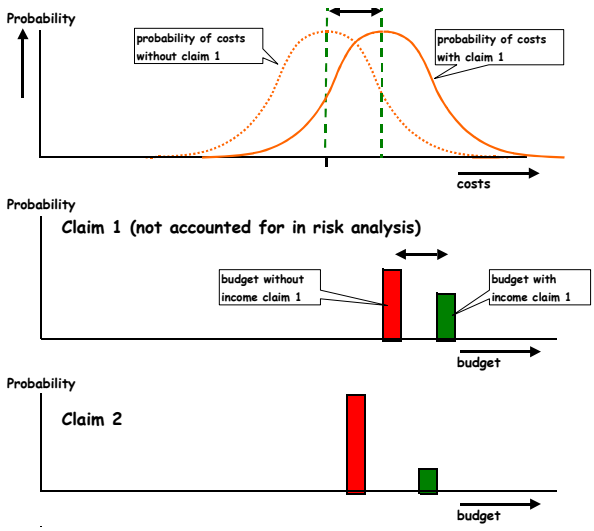


Figure 5 Output Risk Analysis claims

To do so we consider all claims independent of each other. Then a Markov chain can simulate all possible outcomes of the claims together:

$$B_{tot} = \sum_{i=1}^{n} q_i * \overline{B}_i$$

For which i=1,...,n represent all claims, $\overline{B}_i$ *are all possible combinations of claims,* q_i *is the probability on a combination by multiplying the probabilities on claim i.*

This provides a probability function of the total budget. Together with the cost probability from the risk analysis we can now at any time see and calculate the exposure. Furthermore the financial outcome can be evaluated separately for cost and budget, and for process risk (risk analysis) and risk due to claims. This way each project provides clear and useful information to answer the question if the reserve for risk is sufficient. Furthermore the outcome can be statistically useful when gathered in separate databases.

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