Safran Risk

Why Conduct Cost and Schedule Risk Analysis?

with David T. Hulett, Ph.D., FAACE, Author of Integrated Cost-Schedule Risk Analysis

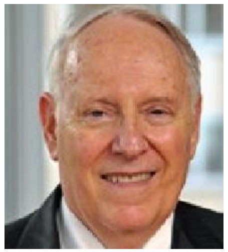
Safran Risk

Foreword

The mitigation of cost and schedule overrun is crucial to any successful project. It's something project managers are all too aware of, yet many large-scale projects overrun both the planned costs and schedule. Often, overrun can be attributed to a lack of in-depth analysis at the planning stage and failure to investigate and test initial estimates further.

Cost and schedule risk analysis helps project managers assess likely impact of uncertainty and individual risks on overall project costs and time to completion. As a result it's a key weapon in any project manager's arsenal.

Here, we look at what cost and schedule risk analysis is, the common causes of cost and schedule overrun, and how conducting in-depth analysis can mitigate them, before demonstrating the benefits in practice.



Risk Analyis Expert
David T. Hulett, Ph.D., FAACE

Author of Integrated Cost-Schedule Risk

Analysis Hulett & Associates, LLC

(310) 476-7699 (o)
(310) 283-3527 (m)
David.Hulett@projectrisk.c
om www.projectrisk.com

Contents

Safran Risk

CHAPTER 1

What is Cost and Schedule Risk Analysis?

Put simply, project cost estimates and schedules are statements made by experts such as engineers or estimators about how much a completed project will cost and how long the work will take.

However, because events in the future are never fully known, it is wise to investigate the assumptions behind the statements and any future conditions that may make these projects cost more (or less) than their estimate or differ in time from their scheduled duration.

Sometimes this is an exercise in validating or re-sizing the contingency added by the estimators. Schedules typically do not have a contingency in time, so this may be the first- time schedule contingency is discussed.

Cost and schedule risk analysis uses quantitative project risk methods of integrated project cost and schedule models to evaluate the likely impact of uncertainty and individual risks on overall project costs and time to completion.

These analyses not only determine the likelihood of finishing the project on time and budget, they can also be used to estimate the contingency needed to provide the desired level of certainty in achieving the planned cost and finish date.

Modern approaches to risk analysis identify risk drivers and use them to drive the Monte Carlo simulation of cost and schedule, and these can be used also to identify the most important risks to project schedule and cost, enabling project planners effectively to mitigate risk.

Why is Cost and Schedule Risk Analysis Needed and How Does It Work?

Research and experience shows us that cost and schedule estimating on projects is often unsuccessful because cost overruns routinely occur. A few real-world examples include:

- A study of public transportation infrastructure projects (Flyvbjerg 2002) found that 9 out of 10 projects had overrun their initial estimates and that overruns of 50 to 100 percent were common.

  The study also found that costs are underestimated in almost 9 out of 10 projects. Furthermore, for a randomly selected project, the likelihood of actual costs being larger than estimated costs is 86% and likelihood of actual costs being lower than or equal to estimated costs just 14%.

- For IT projects, an industry study by the Standish Group found that average cost overrun was 43 percent, and that 71 percent of projects were over budget, over time and under scope.

  Edward Yourdon reported that it is generally accepted that the average IT project is likely to be 6 to 12 months late and 50% to 100% over budget (Yourdon 1997).

There are plenty of high-profile examples of spectacular cost overrun, but some of the most infamous include (Flyvbjerg 2014):

Scottish Parliament Building

+1,600%

original cost estimate

% cost overrun

Sydney Opera House

+1,400%

original cost estimate

%cost overrun

Concorde

+1,100%

original cost estimate

%cost overrun

Bank of Norway Headquarters

BANK

+400%

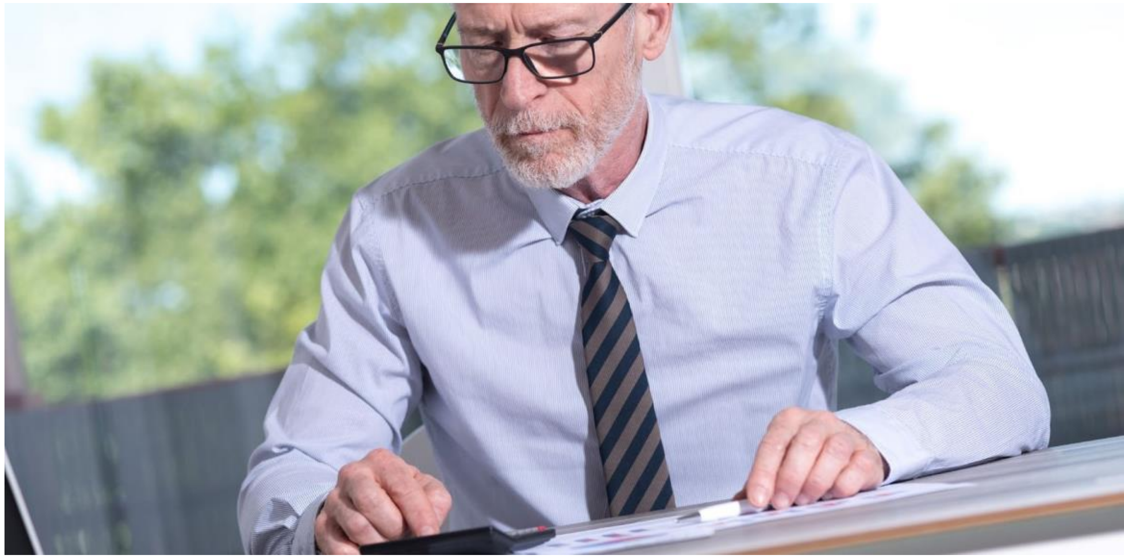
original cost estimate

%cost overrun

Safran Risk

CHAPTER 2.1

Why do so Many Projects Overrun Their Cost Estimates?



The principal reasons for costs and schedules to overrun estimates (assuming that the cost estimators are competent) often relate to corporate culture and to the risk inherent in the project itself. According to research conducted by Flyvbjerg and Associates and DeMarco and Lister, the following are the most common reasons for cost overrun:

1

Corporate management, including those responsible for selling the project to the customer, contributes to schedule and cost overruns by causing project cost estimates and activity durations to be optimistically estimated.

2

Customers like to have certainty about time and cost objectives and can be impatient at being told of uncertainty in achieving key objectives, often leading to pressure from owners and resulting in estimates and schedules that are optimistic.

3

Risk in the project, including estimating uncertainty, is often more likely to push the costs higher than lower, since in practice most of the risks identified are threats rather than opportunities. Add to this the systemic risks such as incomplete SOW, weak project team.

4

Technical issues such as imperfect techniques, inadequate data, honest mistakes, inherent problems in predicting the future, lack of experience on the part of forecasters.

5

Deliberate under-estimation (on the part of project sponsors) designed to make projects more appealing to stakeholders or the public.

Each of these factors can lead to estimates and schedules that are not, and maybe never were, achievable. To put it bluntly, whatever the project plans produce on paper will not shorten the real schedule or lower the cost. Often optimistic estimates and schedules do little more than provide the appearance of success and get the project sanctioned.

Safran Risk

CHAPTER 2.2

How are Project Uncertainty and Risk Defined?

Uncertainty

Uncertainty is akin to "common cause" variability in Six Sigma methodology: Common cause variation is fluctuation caused by unknown factors resulting in a steady but random distribution of output around the average of the data. It is a measure of the process potential, or how well the process can perform when special cause variation is removed. It is not likely to be reduced since it is caused by many small but unknown factors. (iSixSigma 2017a)

Risk

There are several definitions of project risk, but one of the most widely-used comes from the Project Management Institute: Project risk is an uncertain event or condition that, if it occurs, has a positive or a negative effect on one or more project objectives. (PMI 2017)

Project risk is similar in nature to the "special cause" variation in Six Sigma: unlike common cause variation, special cause variation is caused by known factors that result in a non-random distribution of output. Special cause variation is a shift in output caused by a specific factor such as environmental conditions or process input parameters. It can be accounted for directly and potentially removed and is a measure of process control. (iSixSIgma (2017b)

Most risks, whether highly likely or less so, are thought of as making the project activities take longer or cost more than planned if they occur. Some examples of these risks might be:

- Difficulty in attracting or retaining good engineers.
- Equipment suppliers may be busier than usual and may take longer than the contract to deliver sufficient materials.
- The project is large so there may be fewer bidders, reducing competition and increasing the bid prices.

In addition to these project-specific risks there are systemic risks— so called since they arise from at least a partial breakdown of the project delivery system [Hulett-Whitehead 2017 and AACE International 2011a]. A few of these systemic risks include:

- The project concept, strategy or plan may not be sufficiently worked out to be starting execution.
- The project is complex so we may not have in place a strong-enough process and staff to handle the interdependencies.
- The project contains a high level of new or specialized technology, so there are engineering questions and perhaps even scientific questions to be resolved.

Safran Risk

CHAPTER 2.3

How Does It Work?

Analysis of risk can begin in the project's development phase, as soon as there is a notional schedule and budget, and should be continued periodically as estimates are refined and more risks are identified and quantified. The process of quantitative cost risk analysis is as follows (AACE International 2011b) (Hulett 2011):

CREATION OF AN ANALYSIS SCHEDULE

Develop a summary analysis schedule that complies with scheduling best practices and represents all the work (GAO 2016)

ADOPTION OF A BUDGET

The estimation of project costs enables management or other stakeholders to adopt a realistic budget without padding for risk.

MEASUREMENT OF IMPACT ON COST AND SCHEDULE

In integrating the costs and schedule risk analyses using resource- loaded CPM schedules we capture the impact on costs from both direct cost risks and indirectly from schedule risks.

MONTE CARLO

A Monte Carlo simulation approach is used to develop the possible finish dates and costs of the project plan under consideration.

QUANTIFICATION AND PRIORITIZATION OF RISKS

The risks that contribute to the contingency can be identified and prioritized using an iterative simulation approach. In this way, the quantitative risk analysis leads to a better project plan because it drives toward early mitigation of the important risks.

THE BENEFITS OF ANALYSIS CAN BE DIVIDED INTO TWO STAGES:

- The first stage addresses the two main causes of unrealistic plans: (1) random variability or unrealistic optimism or actual bias of the schedule and estimates and (2) project specific and systemic risks. This stage can develop estimates of cost and schedule that include establishment of contingencies of money and time and hence the adoption and communication of more achievable targets.
- In the second stage, quantitative risk analysis results can prioritize the risks to inform a strategy that is used to guide proactive risk management actions (Hulett 2017).

Safran Risk

CHAPTER 3

The Benefits Explained

The essence of integrated cost and schedule risk analysis is that "time is money." In simple terms, the cost of resources is likely to increase if the task they are engaged in takes longer than planned.

Time dependent resource costs include labor and rented equipment such as cranes and drilling rigs. Taking labor as an example, if an activity is originally scheduled to take 20 days and takes 40, labor costs are likely to increase in line with the extra time.

Likewise, indirect costs such as the management of the project team will increase if the project takes longer than expected.

Some risks affect the "burn rate" of labor or the total cost of equipment such as concrete, rebar and equipment to be installed.

These typical "cost risks" can be included so that cost varies even if the schedule is followed successfully.

A Monte Carlo simulation cannot produce a single data point for finish date and total cost because there are too many uncertainties.

For example, if 5,000 iterations are calculated the risk analysis produces 5,000 pairs of finish dates and project cost, but cannot determine which one will occur.

However, what it can do is create a probabilistic statement based on the results, for example:

- The project is 80% (or some other desired level of certainty) likely to finish on or before some date or to cost a dollar amount or less, given the schedule and the uncertainty and risks identified.
- The project is X% likely to finish as scheduled and Y% likely to cost as estimated.
- Taking the two objectives together there is a Z% chance they will both be achieved (Joint Confidence level, NASA 2015) or better with an 80% likelihood.

To illustrate, think of the simple schedule for an offshore gas production platform without the pipeline to the shore shown in Figure 1.

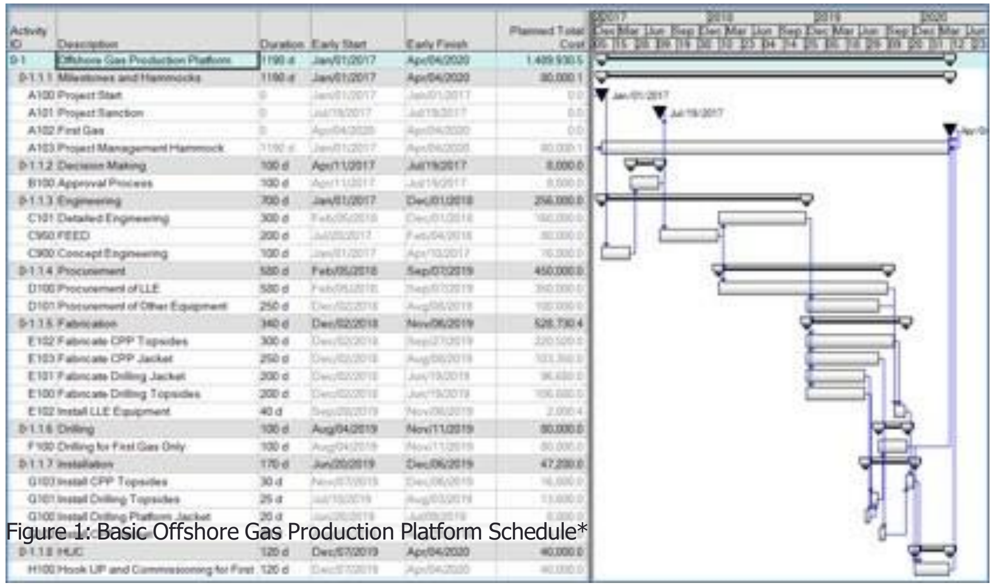


Figure 1: Basic Offshore Gas Production Platform Schedule*

Safran Risk

With a scheduled finish date of April 4, 2020 and an estimated cost of $1,499 billion (Fig. 1), add five risks and uncertainties on both cost and schedule.

With the uncertainty and risks added the statistical result for the schedule is found using the histogram and cumulative probability distribution shown in Figure 2 below.

The probability of completing on time is 5%, the P-80 is October 18, 2021 needing 562 calendar days of contingency beyond the scheduled date.

A similar histogram and cumulative distribution is calculated for the costs, which includes the effect of cost uncertainty, any risks applied directly to cost and the indirect effect of schedule variability on cost.

It is the indirect effect of schedule on cost that is the essence of the integrated cost- schedule risk analysis.

The findings are that there is an 8% probability of finishing on cost, that the P-80 cost is $1,834 billion, which is $344 million or 23% over the deterministic estimate of $1,489 billion.

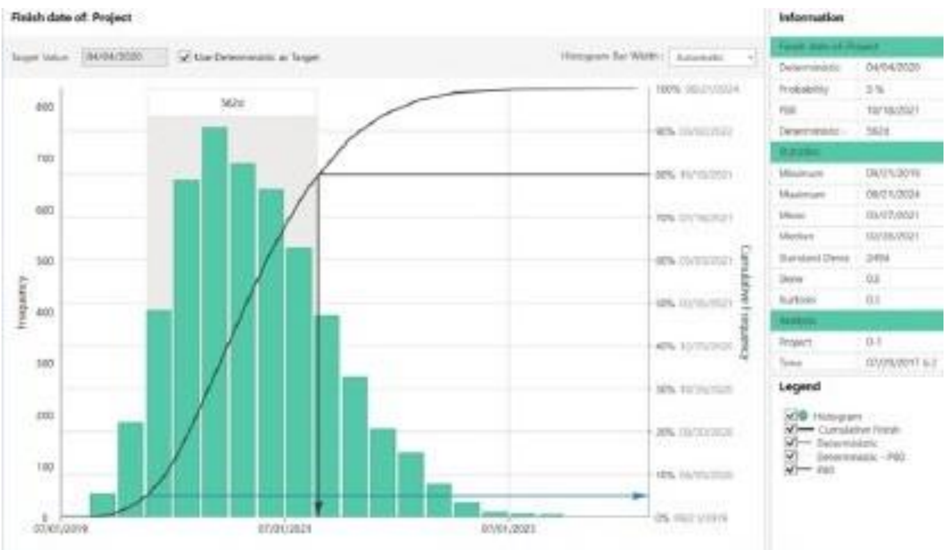


Figure 2: Histogram and Cumulative Distribution for Schedule using Monte Carlo Simulations with 5,000 iterations.*

Because both cost and schedule are solved in the same simulation the two objectives can be analysed together, as shown in the scatter plot in Figure 3.

The findings of the joint cost and schedule analysis in the scatter plot show that the combination of the finish date at December 8, 2021 and cost at $1.849 provides an 80 percent likelihood of succeeding on both time and cost. These values add some $16 million and 50 calendar days to the schedule from the P-80 results on cost and on schedule that did not take into account success for both targets.

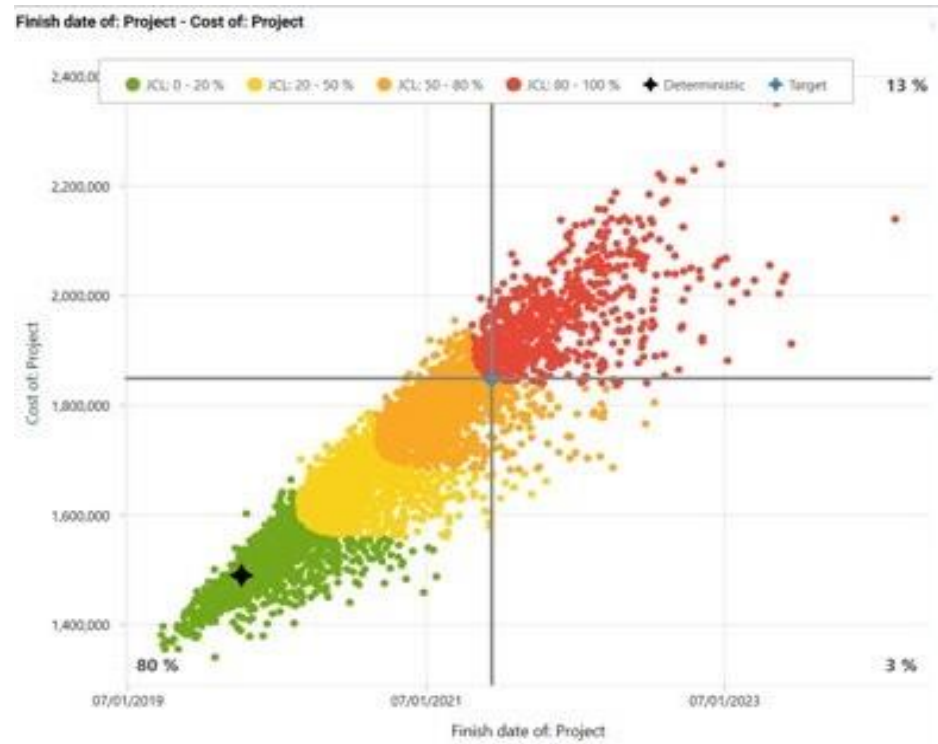


Figure 3: Joint Confidence Level (JCL) of 80 %for Both Cost and Finish Date compared with the Deterministic Plan.*

*The examples above were created using Safran Risk's user-friendly project scheduler, risk analysis, and risk reporting tools.

Safran Risk

CHAPTER 4

Summary

Applying quantitative risk analysis to the process of setting reasonable targets for project finish date and cost produces results that are not available from the schedule and the cost estimate themselves.

For example, quantitative risk analysis can provide accurate estimates to questions such as:

- How likely is the project to finish on time and budget?
- How much contingency is needed to provide a reasonable level of confidence of making cost, schedule and the two objectives combined?
- Which risks are the cause of overruns and the need for contingency of cost and schedule?

Performing quantitative risk analysis provides for uncertainty and risk where the project schedule and estimate just form the un-risked baseline. Estimate inaccuracy, bias, and risks' occurrence can be discovered through confidential interviews with the project participants including owner, contractor, designer, commissioning agent, etc., identified and provided for during the planning stage.

In addition, quantitative methods can be used to prioritize risk, making risk mitigation an available and practical tool
for project managers. If the mitigation plans arising from analysis are committed to and executed, then the project will perform better than predicted with unmitigated risks.

Of course, in conducting schedule and cost risk analysis, the right tools are essential.

Using software that allows for accurate scheduling, real-time analysis, and risk reporting will not only help you to identify and mitigate the risks likely to lead to overrun.

It will also provide a valuable tool for reporting to keystakeholders upon the likely risks.

Platforms such as Safran Risk simplify what would otherwise be an extremely complex procedure into a step by step process, allowing project managers to deploy quantitative risk analysis across their projects and empowering them to deliver better project outcomes.

Safran Risk

References

- **AACE International, (2011a),** Recommended Practice 43R-08: Risk Analysis and Contingency Determination Using Parametric Estimating – Example Models as Applied for the Process Industries, AACE International, Morgantown, WV
- **AACE International, (2011b),** Recommended Practice 57R-09 Integrated Cost and Schedule Risk Analysis using a Monte Carlo Simulation of a CPM Schedule, AACE International, Morgantown, WV
- **GAO (2015)** Schedule Assessment Guide, Government Accountability Office, GAO-16-2015
- **Hulett-Whitehead (2017),** "The Monte Carlo Method for Modeling and Mitigating Systemic Risk," Hulett, David T and Whitehead, Waylon, Cost Engineering, July/August 2017 AACE International
- **DeMarco, T. and T. Lister (2003).** Waltzing with Bears, Managing Risk on Software Projects, Dorset House Publishing.
- **Flyvbjerg, B. (2014),** "What You Should Know about Megaprojects and Why: An Overview," Project Management Journal, vol. 45, no. 2, April-May, pp. 6-19
- **Hulett, D. (2009).** Practical Project Schedule Risk Analysis, Dover Press.
- **Hulett, D. (2011)** Integrated Cost-Schedule Risk Analysis (Gower Publishers)
- **Hulett, D. (Forthcoming)** Quantitative Risk Analysis: Why Bother? Risk Doctor Briefing, The Risk Doctor Partnership.
- **iSixSigma (2017a),** "Common Cause," https://www.isixsigma.com/dictionary/common-cause-variation
- **iSixSigma (2017b),** "Variation: Special Cause," https://www.isixsigma.com/dictionary/variation-special-cause/
- **NASA (2015)** Cost Estimating Handbook Version 4.0 Appendix J JCL Analysis J-1 February 2015 Appendix J: Joint Cost and Schedule Confidence Level (JCL) Analysis
- **PMI (2017).** A Guide to the Project Management Body of Knowledge, 6th edition. Newtown Square, PA, Project Management Institute.
- **Yourdon, E. (1997).** Death March, The Complete Software Developer's Guide to Surviving "Mission Impossible" Projects, Prentice Hall PTR.

Safran Risk

David T. Hulett, Ph.D., FAACE

Dr. Hulett is recognized as a leader in developing and applying the concepts and methods for quantitative project cost and schedule risk analysis and applying them on large commercial and government projects.

He is a Fellow of the Association for the Advancement of Cost Engineering (AACE) International and heads leading project risk consultancy Hulett & Associates, LLC.

Find on LinkedIn

Safran

Safran is the preferred software provider for project control professionals around the world who need to manage complexities with ease.

Whether you run time-critical, asset-intensive, resource constrained capital projects, or high-risk research and development projects, Safran design smart solutions that enable you make the best decisions and ensure you deliver on time, and on budget.

www.safran.com