Chapter 2
Monte Carlo Simulation for Integrated Cost-Schedule Risk Analysis:
Concepts, Methods, and Tools for Risk Analysis and Mitigation

David Todd Hulett
Hulett and Associates, LLC, USA

ABSTRACT

Evidence shows that project costs and schedules often overrun their initial plans. The purpose of this chapter is to illustrate the most recent tools and methodologies available today in the application of Monte Carlo simulation techniques to quantify possible overruns in cost and schedule and to understand the sources of those overruns to facilitate risk mitigation actions. Notable methods described include the Risk Driver method, collecting risk data using individual confidential interviews, and use of iterative risk prioritization that facilitates risk focused risk mitigation. Emphasis is placed on the quality of the project schedule and on the quality of the risk data used. The use of prioritization of pre-mitigated for risk mitigation strategies shows how the methodology can be used as a dynamic tool of successful project management.

INTRODUCTION

Experience with projects large and small suggests that cost estimates, and by extension schedule estimates as well, have often been overrun, sometimes by significant amounts. Examples or project overruns, mainly of cost, cover public and commercial construction projects as well as IT projects. Some observers attribute this phenomenon to intentional underestimation at the outset of projects, particularly for government sponsored large infrastructure projects, to get the project started (Flyvbjerg, 2002). This phenomenon is also observed on commercial projects, whether underestimation is by the contractor or by the owner. Human optimism often cited as a contributing factor although people realize that commercial

DOI: 10.4018/978-1-5225-1790-0.ch002

projects might not be started if people knew more accurately what they might cost. Others suggest that projects, particularly megaprojects, are inherently risky and hard to control. Edward Merrow (2011) offers seven practices of management that contribute seriously to megaproject overruns of cost and schedule. Whatever the cause, there are forces that make the baseline estimate and schedule poor forecasts of the project's ultimate outcome. Clearly cost and schedule risk analysis is needed if we want to know when the project is likely to really finish and how much it is likely to cost. This chapter explains the leading approach to evaluate the impact of uncertainty and risk on project cost and schedule, emphasizing the integration of cost and schedule, and leading to risk mitigation.

BACKGROUND[1]

Experience shows us that cost estimating on projects is rarely successful because cost overruns frequently occur. One study of public transportation infrastructure projects found that 9 out of 10 projects had overrun their initial estimates and that overruns of 50 to 100 percent were common.

We make the following observations regarding the distribution of inaccuracies of construction cost estimates. Costs are underestimated in almost 9 out of 10 projects. For a randomly selected project, the likelihood of actual costs being larger than estimated costs is 86 percent. The likelihood of actual costs being lower than or equal to estimated costs is 14 percent. (Flyvbjerg et al., 2002)

Flyvbjerg also cites that cost estimating accuracy (overruns) averaged 44.7% for rail, 33.8% for bridges and tunnels and 20.4% for roads (Flyvbjerg, 2006). The reason cited was optimism connected with "strategic misrepresentation" of the costs by the owner and contractor, presumably to get the project approved.

Spectacular examples of cost overrun include the Sydney Opera House with 1,400 percent, and the Concorde supersonic airplane development with 1,100 percent. The cost overrun of Boston's Big Dig or Central Artery/Tunnel Project was 275 percent. The cost overrun for the Channel Tunnel between the UK and France was 80 percent for Construction costs alone. Each of these projects also experienced increases in financing costs (Wikipedia, 2016a).

Reporting from Edward Merrow, President of IPA, roughly two-thirds of the oil industry's megaprojects come in late, over-budget or fail on other key metrics. In addition some 64% of upstream megaprojects suffer from serious and enduring production attainment problems in the first two years (Energy Intelligence, 2014).

The Standish Group, which has a database of some 50,000 development projects, looked at the outcomes of multimillion dollar development projects and ran the numbers for Computerworld. Of 3,555 IT projects from 2003 to 2012 that had labor costs of at least $10 million, only 6.4% were successful (Thibodeau 2013). The Standish data showed that 52% of the large projects were "challenged," meaning they were over budget, behind schedule or didn't meet user expectations. Fully 41.4% were failures -- they were either abandoned or started anew from scratch. Edward Yourdon's book *Death March* cites the generally accepted assessment of IT projects' performance that the average IT project is likely to be 6 to 12 months late and 50 percent to 100 percent over budget (Yourdon, 1997).

Many large, complex construction projects have similar problems. Perhaps 40% to 60% of capital projects fail to meet schedules, budgets or both. Schedules are missed by an average of 55 percent and budgets by 33 percent (Bisaccia 2014). These are not two separate and unrelated results but are in fact