Adequate Quantification of Project Cost Risks: 
Introduction of Non-Linear Probabilistic (Monte Carlo) Technique

Yuri Raydugin, Risk Services & Solutions Inc., Calgary, Canada

ABSTRACT

Literature on project management contains an abundancy of references to abnormally high project cost overruns as well as bitter complaints that modern risk quantification methods could not accurately predict project cost outcomes in many cases. This article provides a) an explanation of abnormally high project cost overruns, b) a link of risk quantification with ‘project team’s quality’ (team’s strengths and weaknesses) and bias, c) an explanation why all currently used risk quantification Monte Carlo methodologies are relevant to ‘strong teams’ only, d) introduction of a new non-linear probabilistic (Monte Carlo) methodology to define adequate cost contingencies for projects managed by ‘weak teams’, e) a practical case of the non-linear (Monte Carlo) probabilistic modeling, and f) rough calibration of non-linear probabilistic (Monte Carlo) models that could be practically used for rule-of-thumb estimating of project cost outcomes.

KEYWORDS
Bias, Bow-Tie Diagram, Impact, Non-Linear Probabilistic (Monte Carlo) Risk Analysis, Non-Linear Regression Analysis, Probability, Project Cost Overrun, Risk Addressing, Risk Causes, Team’s Strength

INTRODUCTION

Literature on project management contains an abundancy of references to abnormally high project cost overruns as well as complains by practitioners that modern risk quantification methods could not accurately predict project cost outcomes in many cases. Moreover, in some cases cost overruns might be counted by hundreds percentage points above approved project budgets.

A quick snapshot of available multiple citations on the topic looks as follows:

- According to Flyvbjerg (2017), 70% - 90% of megaprojects have cost overruns including infamous examples such as Sydney Opera House (1,400% overrun), Boston Central Artery Tunnel project (275% cost overrun), etc.
- According to Hollmann (2016a), 10% of all large projects overrun their estimated costs by 70%.

At the same time, it was pointed out by Raydugin (2016) that accuracy of risk quantification could be high enough in some particular cases (‘strong project team’ cases).

A development of a practically applicable and adequate risk quantification methodology that is based on robust theoretical foundation is long overdue. Risk quantification methods should be able
to predict project cost outcomes of any size even if cost overruns would be counted by hundreds percentage points.

Apparently, prediction of actual project costs upon their completion has two equally important aspects: base estimate and cost risk contingency development. These two contributions to total project costs are interdependent. If a base estimate is inflated through taking into account some project risks and uncertainties, the required risk contingency would be lower. At the same time, some legitimate allowances related to project scope uncertainties are usually included to base estimates, etc. For the purpose of this paper, standard definitions introduced and supported by Association for Advancement of Cost Engineering (2012) are presumed. However, any base estimate development aspects are left out of the scope of this paper as it is focused on cost contingency development only.

A major breakthrough to explain the low estimating accuracy was an introduction of special type of risks (‘systemic risks’) that were not properly taken into account previously when quantifying project contingencies (Hollmann, 2016a). As a result, a hybrid cost contingency development methodology was introduced (Association for Advancement of Cost Engineering [AACE], 2008). It combines standard probabilistic (Monte Carlo) methodology for project-specific risks with parametric methodology for systemic risks. All contemplated systemic risks of a project are represented in a project probabilistic cost risk model as a standalone systemic risk allowance of a predefined impact and 100% probability. The predetermined impact is derived from empirical data for previously completed comparable projects. In other words, the hybrid methodology treats all combined relevant systemic risks of a project as one summary systemic issue (given impact vs. certain occurrence).

The purpose of this paper is to make a next logical step through conversion of the parametric part of the hybrid methodology to probabilistic (Monte Carlo) modeling in a consistent manner.

This paper provides with

- Explanation and Monte Carlo modeling of abnormally high project cost overruns comparable with outcomes of Sydney Opera House or Boston Central Artery Tunnel projects including modeling of ‘tipping in blow-out’ and ‘mega blow-outs’ (Hollmann, 2016a)
- A direct link of systemic risks with a ‘project team’s quality’ concept based on team’s strengths and weaknesses relevant to development and execution of a particular project
- An explanation why all currently used standard probabilistic (Monte Carlo) methodologies are relevant to ‘strong teams’ only (no systemic risks)
- A mechanism of coupling of project-specific risks and systemic risks when even low-severity project-specific risks could be elevated to critical-severity risk in case of ‘weak teams’
- A new non-linear probabilistic (Monte Carlo) methodology to define adequate cost contingencies for projects managed by any type of project teams (both ‘weak’ and ‘strong’)
- A practical case of the non-linear probabilistic (Monte Carlo) modeling
- Rough calibration of non-linear probabilistic (Monte Carlo) models that could be practically used for rule-of-thumb estimating of project cost outcomes
- A justification for and a scope of an additional academic calibration study which requires access to databases of completed projects

Simply speaking, this paper accentuates the fact that cost risk probabilistic models for a given project should clearly differ for cases when the project is developed by a ‘strong’ team and when it is developed by a ‘weak’ team. For example, if all ‘strong’ project teams of an organization are not available to work on a particular project, assignment of a ‘weak’ team should be factored into the project contingency in a consistent way.

Results of this paper explain previously experienced project cost overruns including most notorious ones pointed to by Flyvbjerg (2017). They could be practically used for realistic estimating of project cost contingencies even before detailed academic calibration study is undertaken. This should help avoid embarrassing cases of unexpected and notorious project cost overruns through development
Survey on Risk-Based Decision-Making Models for Trust Management in VANETs
www.igi-global.com/chapter/survey-on-risk-based-decision-making-models-for-trust-management-in-vanets/227770?camid=4v1a

Empirical Analysis of Software Piracy in Asia (Japan VS. Vietnam): An Exploratory Study
www.igi-global.com/article/empirical-analysis-of-software-piracy-in-asia-japan-vs-vietnam/130654?camid=4v1a

Perceptions and Framing of Risk, Uncertainty, Loss, and Failure in Entrepreneurship