AACE INTERNATIONAL RECOMMENDED PRACTICE

65R-11

INTEGRATED COST AND SCHEDULE RISK ANALYSIS AND CONTINGENCY DETERMINATION USING EXPECTED VALUE

AACE INTERNATIONAL

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TCM Framework: 7.6 – Risk Management

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TABLE OF CONTENTS

May 2, 2012

INTRODUCTION

Scope

This recommended practice (RP) of AACE International (AACE) defines general practices and considerations for integrated cost and schedule risk analysis and estimating contingency using expected value methods.

Purpose

This RP is intended to provide guidelines, not standards, for contingency estimating that most practitioners would consider to be good practices that can be relied upon and that would be recommend for use where applicable. There is a range of useful risk analysis and contingency estimating methodologies; this RP will help guide practitioners in developing or selecting appropriate methods for their situation.

This RP is an extension of 44R-08, *Risk Analysis and Contingency Determination Using Expected Value,* that addresses using expected value methods only for cost. However, integrated cost and schedule methods are generally recommended; this RP for expected value methods, or 57R-09, *Integrated Cost and Schedule Risk Analysis Using Monte Carlo Simulation of a CPM Model,* for CPM-based methods.

Background

This RP is an extension of 44R-08 which covers cost contingency only; both RPs are intended to be used together. As described in 44R-08, expected value has been in common use for both decision and risk management. Expected value in its most basic form can be expressed as follows:

Expected Value = Probability of Risk Occurring x Impact If It Occurs

This calculation has long been a fundamental method used in decision tree analysis and risk screening. Its use is common because it is qualitative, simple to understand, simple to calculate, and it explicitly links risk drivers with their impacts so that the risks can be managed. However, its use for integrated cost and schedule risk analysis and contingency estimating has been minimal, largely because of the popularity of Monte Carlo simulation software using CPM schedules (see 57R-09).

Expected value method has advantages and disadvantages that are described in 44R-08. However, *integrated* expected value has additional advantages over CPM-based methods for specific situations. First, a precondition of CPM-based methods as described in 57R-09 is having a "high quality CPM" schedule. Unfortunately, empirical research indicates that high quality CPM schedules at the time of project authorization are the exception in industry [3] (further, the study showed that high quality schedules correlate with 23% less schedule slip; i.e., poor schedule quality is a systemic risk in itself.) However, high quality CPM schedules are not necessary for expected value methods. Second, AACE's 27R-03, *Schedule Classification System* establishes that a *critical path* is not usually available for Class 5 or 4 schedules that are developed using methods such as bar charts. Hence, expected value methods can be considered more versatile in that they can be applied to any project plan of any Class or quality (albeit, the lower the quality of the base plan, the lower the quality of the risk analysis and contingency estimate). AACE is not recommending toleration of poor practices, but practitioners must often work within less than ideal circumstances.

Also, the effects of compounding, cascading, and/or dynamic logic risks are very difficult to model in deterministic CPM schedules (which are typically based on fixed logic). These aggravating risk effects can be conceptually

identified by elicitation or through experience and applied in expected value (the method tends to force this consideration). Also, expected value can be used for bounds testing of deterministic CPM models to factor in the presence of strategic or chaos-threatening risks.

The traditional expected value method (probability x impact) with Monte Carlo can be applied to both costs and durations. However, unlike costs for which risk impacts are essentially cumulative, the time impacts to schedule activities are not if there are multiple "paths" and the impact is to a non-critical path. Also, a risk time impact to one path can offset another risk that impacts a separate path providing that these impacts are also not cumulative. The CPM method deals with these complications directly; the expected value method does not, and hence requires more subjective schedule analysis and intuitive understanding than CPM-based methods. Therefore, this RP highlights the importance of strong planning/scheduling knowledge and risk analysis facilitation.

The method in this RP integrates cost and schedule by using explicit assessment of combined cost-schedule impacts of a risk in consideration of potential *risk responses* (and their cost-schedule tradeoffs in respect to project objectives). This provides up-front understanding, or at least consideration of possible future project team behavior, as opposed to just simple mathematical derivations of schedule impacts. An additional outcome of this practice is therefore a *contingent response plan*.

It is recommended that users consider application of both CPM and expected value methods where possible in order to gain the benefits of both. For example, apply the expected value method to every project in a portfolio, large and small, regardless of the quality of base plan. This gives some insight into potential project "system behavior" including human factors, feedback loops, potential chaos, etc. Then, for major or strategic projects where quality schedules are more typical, apply the CPM-based methods for its insight into mechanical aspects of schedule behavior.

Background – Risk Types

As discussed in 44R-08, the expected value method of contingency estimating explicitly links risk drivers with their impacts. This requires explicit understanding and treatment of the risk types. Risks fall into one of two categories; risks that have systematically predictable relationships to overall project cost and schedule growth outcomes and those that don't. These categories have been labeled as *systemic* and *project-specific* risks for contingency estimating purposes. Parametric risk analysis methods are generally recommended for systemic risks such as the impact of poor quality planning (see 42R-08, *Risk Analysis and Contingency Determination Using Parametric Estimating*). This RP explains how parametric and expected value contingency estimating methods can be used together in a way that best addresses both systemic and project-specific risks.

RECOMMENDED PRACTICE

The following steps assume that a formal risk management process is being followed and that risks have already been mitigated in the project plans to some extent. This recommended practice then addresses the *residual risks* that need to be funded, incorporated into plans, controlled and managed. Teams that skip the risk mitigation effort, in the interest of saving time, and go directly to contingency estimating may miss many of the benefits of risk management.