AACE INTERNATIONAL RECOMMENDED PRACTICE

44R-08

RISK ANALYSIS AND CONTINGENCY DETERMINATION USING EXPECTED VALUE

AACE INTERNATIONAL

AACE® International Recommended Practice No. 44R-08

RISK ANALYSIS AND CONTINGENCY DETERMINATION USING EXPECTED VALUE

TCM Framework: 7.6 – Risk Management

Rev. May 27, 2021

Note: As AACE International Recommended Practices evolve over time, please refer to web.aacei.org for the latest revisions.

Any terms found in AACE International Recommended Practice 10S-90, *Cost Engineering Terminology*, supersede terms defined in other AACE work products, including but not limited to, other recommended practices, the *Total Cost Management Framework* and *Skills & Knowledge of Cost Engineering*.

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1. INTRODUCTION

1.1. Scope

This recommended practice (RP) of AACE International (AACE) defines general practices and considerations for risk analysis and estimating cost contingency using expected value methods. This RP applies specifically to using the expected value (EV) method for quantitative risk analysis, not in the earlier qualitative risk assessment step. This RP is limited to estimating cost contingency; RP 65R-11*, Integrated Cost and Schedule Risk Analysis and Contingency Determination Using Expected Value* is an extension of this RP covering integrated cost and schedule risk analysis and contingency determination using expected value [1]. Note that RP 40R-08, *Contingency Estimating – General Principles* [2], calls for methods to "*clearly link risk drivers and cost/schedule outcomes*"; therefore, it is highly recommended that RPs 44R-08 and 65R-11 be used together to integrate cost and schedule risk analysis. Descriptions of other recommended risk quantification practices can be found in AACE Professional Guidance Document PGD-02, *Guide to Quantitative Risk Analysis* [3].

1.2. Purpose

This RP is intended to provide guidelines, not standards, for contingency estimation that most practitioners would consider to be good practices that can be relied on and that they would recommend be considered for use where applicable. There is a range of useful contingency estimating methodologies; this RP will help guide practitioners in developing or selecting appropriate methods for their situation. The expected value method is recommended for quantifying project-specific risks; i.e., events and conditions or contingent risks. While it can be used to quantify systemic risk, the parametric method is generally recommended for those risks as covered in RP 42R-08*, Risk Analysis and Contingency Determination Using Parametric Estimating* [4]. The hybrid approach to using expected value in combination with the parametric method is covered in RP 121R-20 [5].

1.3. Background

While the RP title mentions "contingency determination", the method produces a probabilistic cost distribution which can be used for determining both contingency and *management reserve*. For clarity, the operative definitions of these terms from RP 10S-90, *Cost Engineering Terminology*, are as follows (always confirm the latest version of 10S-90 for any changes) [6]:

- CONTINGENCY: An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs. Typically estimated using statistical analysis or judgment based on past asset or project experience. Contingency usually excludes: 1) Major scope changes in end product specification, capacities, building sizes, and location of the asset or project; 2) Extraordinary events such as major strikes and natural disasters; Management reserves; and 4) Escalation and currency effects. Some of the items, conditions, or events for which the state, occurrence, and/or effect is uncertain include, but are not limited to, planning and estimating errors and omissions, minor price fluctuations (other than general escalation), design developments and changes within the scope, and variations in market and environmental conditions. Contingency is generally included in most estimates and is expected to be expended.

- MANAGEMENT RESERVE: An amount added to an estimate to allow for discretionary management purposes outside of the defined scope of the project, as otherwise estimated. May include amounts that are within the defined scope, but for which management does not want to fund as contingency or that cannot be effectively managed using contingency.

This RP is based on a method that has been in common use for both decision and risk management for many decades. Expected value in its most basic form can be expressed as follows:

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

(Equation 1)

Figure 1 shows a more specific, simple example of the concept; in the example, $1,000 would be included in contingency as the contribution from a risk that would add $10,000 cost if it occurred [7]. It should be apparent that no particular risk is being funded; the method presumes that only some of the risks will occur, and the team does not know which ones. This analysis would be applied for each relevant risk and the total of their expected values summed. If there were ten risks of the same probability and impact as Figure 1, a contingency of $10,000 would be indicated (10 x $1000), which would be sufficient funds to cover the occurrence of only one of the ten risks[1]. If all that is desired is the contingency at the mean confidence level (i.e. expected value), no further analysis is required. However, best practice calls for probabilistic methods the produce a cost distribution; that involves the application of Monte-Carlo simulation (MCS) to the model.

As will be discussed later, the approach of using a bit of each risk (based on probability) suggests that a risk with extreme impact (or if it is the only risk) should perhaps be funded using a management reserve; i.e., the method works best for multiple risks (perhaps 5, 10 or more), each with a nominal impact that does not overwhelm the summation.

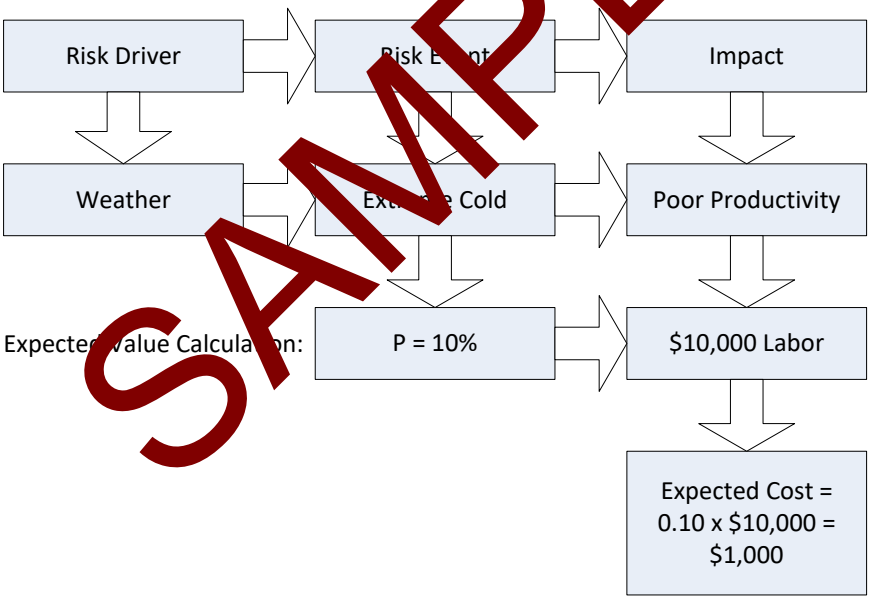

Figure 1 – Example of Expected Value Calculation [5]

This P x I calculation has long been a fundamental method used in decision tree analysis and risk screening. Its use is common because it is quantitative, 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 contingency estimating has not been as common as for decision making and screening. References by Hollmann, Dey and Mak *et al.[7,8,9,10]* report on applications employing expected value concepts including MCS. Also, the US Government Accountability Office's (GAO) Cost Estimating and Assessment Guide describes the method applied against a project's work breakdown structure (WBS) elements [11].

[1] This RP is not about contingency management; however, this example ("team does not know") shows why drawing down contingency funds as risks, of varied timings, are closed in a risk register is illogical.