RISK ANALYSIS AND CONTINGENCY DETERMINATION USING PARAMETRIC ESTIMATING
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RISK ANALYSIS AND CONTINGENCY DETERMINATION USING PARAMETRIC ESTIMATING

TCM Framework: 1.6 – Risk Management

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INTRODUCTION

Scope

This recommended practice (RP) of AACE International (AACE) defines general practices and considerations for risk analysis and estimating cost and schedule contingency using parametric methods. Parametric methods are commonly associated with estimating cost based on design parameters (e.g., capacity, weight, etc.) or time duration based on costs; in this case, the method is used to estimate contingency based on risk parameters (e.g., level of scope definition, process complexity, etc.). This RP includes practices for developing the parametric methods and models (generally empirically-based). Recommended practice 43R-08 provides example process industry parametric models (including software)\textsuperscript{(16)}.

Purpose

This RP is intended to provide guidelines (i.e., not a standard) for contingency estimating 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 quantification methods for their situation. This RP does not address management of contingency once it is determined.

While this RP is relatively short, it incorporates a lot of information by reference and it addresses a complex research and empirically based methodology. It is highly recommended that the reader understands the research behind this method to avoid significant misunderstanding of risks and misstatements of contingency.

Background

This RP is based on over 40 years of research, development, and practice. The development and use of parametric risk analysis and contingency estimating methods evolved in parallel with industry’s recognition that poor project scope definition was often the greatest project cost and schedule risk driver. This recognition led to the development of project scope development processes (e.g., phase-gate processes) and scope definition maturity matrices such as those included in AACE’s recommended practice for cost estimate and schedule classification\textsuperscript{(1,2)}.

Before the above were accepted as best practices, experts first had to prove their value to project outcomes. They did this by studying actual projects and developing empirically-based parametric models that showed how poor scope definition resulted in greater cost growth and wider accuracy ranges. A paper by Hollmann surveys these parametric developments\textsuperscript{(4)} regarding costs and highlights the pioneering work of the late John Hackney, followed by Edward Merrow, \textit{et al.} at the RAND Institute, and Steven Trost, \textit{et al.} for the Construction Industry Institute (CII)\textsuperscript{(7,9,11)}. A paper by Baccarini also provides an extensive survey of these methods\textsuperscript{(4)}. Work by Myers, \textit{et al.} at RAND and Lee \textit{et al.} at CII extent the research to schedule\textsuperscript{(8,10)}. These and the other sources referenced in this RP are recommended reading for parametric method practitioners.

It is AACE’s recommended practice that whenever the term “\textit{risk}” is used, that the term’s meaning be clearly defined for the purposes at hand. The method in this RP quantifies the impact of \textit{uncertainty}, i.e. "\textit{risks + opportunities}".
Background – Parametric Estimating

This is not an RP on parametric estimating, but a basic understanding of it is required. AACE’s *Cost Engineering Terminology* defines a parametric estimate as one that has “…estimating algorithms or cost estimating relationships that are highly probabilistic in nature”[12]. Generally, the relationships of the outcome (e.g., cost growth) and the inputs (e.g., risk drivers) are determined by studying empirical data using methods such as multi-variable regression analysis, neural networks, or even trial and error. The following illustrates the typical form of a simple parametric estimating algorithm:

\[ \text{Outcome} = \text{Constant} + \text{Coefficient 1} \times (\text{Parameter A}) + \text{Coefficient 2} \times (\text{Parameter B}) + \ldots \]

The “outcome” in this case may be a measure of cost growth (e.g., contingency percent of base cost) or schedule slip (e.g., contingency percent of base duration), and the parameters are various quantified risk drivers such as a measure of the level of scope definition upon which the estimate or schedule was based. The algorithm can be much more complex employing logarithmic, exponential, and power series.

Advantages of parametric estimating for risk analysis and contingency determination are that it is inherently empirical in nature (based on actual measured experience) and it can directly provide probabilistic information about the distribution of possible outcomes. It is also very quick and simple to apply.

A disadvantage is that parametric estimating is based on empirical methods such as regression analysis and these require that the parameters actually have more or less predictable relationships with the outcomes. This is more important for some risk types than for others. Another disadvantage is that obtaining empirical data and creating models is a challenging effort; increasingly so as one attempts to model cost growth and risk drivers at more detail levels. Therefore, the method is typically limited in use to estimating overall project contingency that results from selected risk types. As will be explained in the next section, this is not a problem for early estimates (i.e., AACE Class 5), but for later estimates (i.e., Class 4 or better) the method is best used in combination with range estimating, expected value analysis or other more definitive methods.

Background – Risk Types

In respect to parametric methods, risk types fall into one of two categories; risks that have systematically predictable relationships to overall project cost and schedule growth outcome and those that don’t. These categories have been labeled as “systemic” and “project-specific” risks for contingency estimating purposes (i.e., there will be other ways to categorize risk types for other purposes).[4] In order to use the methods properly, it is important to understand the distinctions of these types.

The term *systemic* implies that the risk is an artifact of the project “system”, culture, business strategy, process system complexity, technology, and so on. Research by Hackney and others has shown that the impacts of some of these risks are measurable and predictable between projects within a system, and to some extent within an industry as a whole. Measures of these risks are generally known even at the earliest stages of project definition, and furthermore, the impacts of these risks tend to be highly dominant for early estimates. Also, the link between systemic risks and cost impacts is stochastic in nature; this means it is very difficult for individuals or teams to understand and to directly estimate the impact of these risks on particular items or activities (for example, the risks of process technology on something like site preparation or concrete foundations may be dramatic, but is not readily apparent). Finally, systemic risks tend to be “owner” risks; i.e., the owner is responsible for early definition, planning, technology, and decisions so these risks cannot be readily transferred to execution contractors. The following are typical systemic risks dealt with using parametric methods:

- Process Definition
  - Basic Design