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Overview of the Methods for Determining Project Contingency and What are their Advantages and Drawbacks

We are often asked to provide an overview of all the different methods to derive project risk contingency. In this White Paper, which is a summary extract from new content in the Second Edition of our Industrial Project Risk Handbook for Project Managers, we list available methods, their advantages and drawbacks.

Preamble note – In this White Paper the term 'contingency' is defined as: 'single reserve that is budgeted so as to cover up to reasonable level, risks related to a project (Known- Unknowns)' and depending on the terminology used by organisations, can cover 'Management Reserves' as well.

Introduction

The main categories of quantitative risk methods used to derive contingency values are:

- Parametric Methods
- Upcoming (Parametric) Artificial Intelligence Methods
- Statistical Modelling Methods
- Scenario Analysis Methods
- Combining Several Methods

Parametric Methods

Parametric methods are based on the availability of a wide historical database of similar projects, for which the final performance outcome is known. By regression analysis, the parameters driving performance emerge and it is possible to correlate the value of those parameters for the current project to a statistically expected outcome.

Those methods emerged in the 1980s from Rand Corporation studies , which has given way to the foundation by the lead Rand researcher, Edward Merrow, of the Independent Project Analysis, Inc (IPA) company that continues to grow a very large dataset of industrial projects and provide studies and analysis showing the effect of certain parameters on project outcome. The most famous is the Front-End Loading method, as statistics have shown that the best predictor of industrial project performance is its level of definition at final investment decision. There are quite a lot of other parameters which can be correlated to project outcome, and such studies are published regularly. However, the dataset and the actual quantitative correlations are not readily available except by being a client of this particular company.

There are many methods for contingency calculation and none is entirely satisfying.

The Association for the Advancement of Cost Engineering International (AACEI) has published a number of standards addressing parametric methods, which can be used. They are unfortunately based on older 1950s-1980s datasets, as they mostly derive from the Rand Corporation work. They are to be found in the Recommended Practice 43R-08 which is accompanied by an Excel Spreadsheet for practical usage. This allows to enter a certain number of key parameters of the project under consideration, and an evaluation of the cost and schedule contingency is provided on the basis of the historical dataset correlations.

Large companies that have executed a number of projects can compile its own project dataset and derive correlations, which is also made easier by artificial intelligence. However, such an investment is still quite rare, as it is costly to recover properly calibrated data from past projects, and in particular for projects completed a long time ago. Still, at the time of writing this paper, a number of startups are trying to gather meaningful data to build more elaborate artificial intelligence models.

Discussion on Advantages and Drawbacks of Parametric Methods

The advantage of parametric methods is that they are based on actual, real-life performance of projects and therefore capture all possible real-life inadequacies and systematic bias that may affect project estimating and budgeting.

The observational, historical grounding of the method is often mentioned by promoters of the method as a key advantage against all other methods that involve some sort of modelling of the project without challenging implied assumptions.

In general, the level of contingency derived from this method may be significantly higher than from modelling methods. This does not contribute to its popularity amongst project sponsors and project managers trying to promote their projects, while it may be arguably more realistic, being based on past project experiences.

Methodological drawbacks include:

- Prediction is based on the analysis of historical projects, which implies the assumption that future project performance be correlated with past project performance. While this seems to have proven empirically valid until now, a change of paradigm or technology may challenge this assumption,
- Development of a suitable database of representative projects, which characteristics are sufficiently detailed and objectively measured, is a very significant investment. This explains that they are not made available without substantial fees, or require substantial upfront investment,
- The outcome of the method is a statistical expectation from similar projects and does not account for the specific circumstances of the project under consideration except for the parameters input into the method. This may for example, create a systematic bias in the result of the outcome for a particular organisation or situation.

Upcoming (Parametric) Artificial Intelligence Methods

With the development of Artificial Intelligence (AI), practitioners have started to implement new approaches to predict project outcomes. Of course, AI needs to be trained on

a historical dataset. Therefore, these approaches are more similar to parametric methods than project modelling methods such as statistical and scenario approaches.

We observe two categories of AI approaches:

- Extensions of parametric methods, where artificial intelligence models are fed databases of project outcomes and then used to predict the outcome of future projects based on a wider set of parameters,
- Training of artificial intelligence models on much wider datasets including ongoing monthly project performance reports, up to, for the most ambitious, the entire content of internal electronic correspondence exchange within the project, with the aim to detect weak signals that could be the onset of a variation (opportunity & risk). At the date of writing, this area is still very much experimental, but some practitioners report satisfying ability to estimate the project completion cost based on relatively limited amount of monthly project performance historical data.

Discussion on Advantages and Drawbacks of Artificial Intelligence Methods

AI methods are not yet mainstream for project contingency calculation. Their full benefit is not to be expected before a few years. Yet, this is an area worth watching, in particular in the scheduling space.

Proper operation of artificial intelligence requires a sufficient cleanliness of the set of data used for training. This initial effort may be consequential and is akin to the initial investment that has to be consented for parametric methods. At the same time, larger datasets can be used than for conventional statistical correlation-based methods which use – and measure – only a limited number of parameters. It also appears experimentally that good enough results may be obtained on smaller datasets than conventional parametric methods, and this may be an argument for more widespread organisation-level usage of such methods.

Statistical Modelling Methods

Statistical modelling methods are based on the modelling of the project through a decomposition of the project in elements or activities. Probabilities are associated to each cost or schedule element. In addition, discrete opportunities and risks are added in the model, associated with probabilities and impact. Depending on the method, linkages or correlations can be applied between elements. Statistical methods will then re-calculate the statistical spread of the outcome of the project, seen as the sum of individual elements. The method will allow to attribute a contingency value based on the risk appetence of the organisation - the risk appetence expressed as a given probability to exceed this protection.

The most well-known statistical method is the Monte Carlo method. Because of their popularity and prevalence and the need to fully understand their benefits and limitations, those methods are detailed in our Risk Handbook.

It should be noted however, that the drawbacks on the realism of the method have led some leading writers on the topic of project risk to dismiss those methods as excessively unrealistic and optimistic. As the outcome of the method is generally a lower contingency value than with parametric methods, they may create excessive confidence in project managers and sponsors.

It should always be remembered that the most useful aspect of quantitative cost risk analysis is to have a good team discussion of the impact of risks

Discussion on Advantages and Drawbacks of Statistical Methods

Advantages include:

- The method provides a statistical spread of outcomes, that allow to account for various risk appetences, contrary to other methods providing generally only a single value point,
- Since the method is based on a model of the project, it is possible to easily simulate different project configurations and circumstances by adapting the model,
- Schedule statistical analysis can allow the identification of unexpected alternate critical paths for the project - due to statistical variation - that become the actual drivers of the project and increase the importance of certain aspects of the project previously thought to be secondary.

Drawbacks include:

- The method is not fully mathematically consistent, requiring experience and care in building the underlying project models – increasing the number of line items in a model reduces the standard deviation and thereby the amount of contingency,
- The method does not properly account for shared resources between model elements, and thus cannot simulate indirect consequences of the statistical condition of a model element on another; this impedes simulation of scenarios of snow-ball effects throughout the project,
- Statistical distributions used in the model are limited to conventional statistical distributions. The method does not work with 'long tail' statistical distributions while those are actually more representative of complex systems. It is also quite impossible to include low probability, high consequence risks or opportunity and keeping the model mathematically stable.

Scenario Analysis Methods

Scenario analysis consists of modelling the project by defining a limited number of scenarios, each combining a number of events. The events need to remain compatible between each other within a single scenario, to ensure that the scenarios are indeed physically possible. Several scenarios of various probability can thus be built, each corresponding to a compatible combination of events. Ideally, at least 2 quite different scenarios for each class of probability should be built to provide diversity in the scenario analysis.

Project models for scenario analysis should generally remain of a limited complication: it is better to spend effort building multiple models based on major effects rather than trying to fiddle into building a too complicated model. Scenario analysis is often used as a complement to statistical methods to challenge and check consistency in the outcomes.

Discussion on Advantages and Drawbacks of Scenario Analysis Methods

The main benefit of this approach is that interdependencies can be factored in each scenario, contrary to the statistical approach. Non-linear effects such as 'cliff effects' (small variations of parameters leading to substantial changes of the outcome in terms of cost or schedule) or an accumulation of consequential impacts can be much easier identified and modelled. They will generally not be identified in statistical analysis, possibly leading to a greater spread of outcomes for the scenarios.

The benefit of setting up a model of the project that can then be updated or used to analyse alternative scenarios is also retained in this method.
The main drawback is that the choice of scenarios is deeply subjective and based on experience. It is limited to a couple of scenarios and the assessment of their probability remains quite subjective and can be challenged. Scenario probability is hence generally limited to subjective categories such as 'possible, probable, remotely probable' and is often a matter of judgment.

Combining Several Methods

Since each method has its advantages and drawbacks, and looks at projects in a different manner, it is useful to apply different methods to a single project to check for potential weaknesses or issues that may only come up in one of the methods. At the same time, it is important to limit the effort spent with respect to the expected benefits for the organisation.

Most organisations do request the use of more than one method, with the aim to check a wider range of occurrences. Statistical approaches are often combined with scenario analysis.

Summary

There are many methods for contingency calculation and none is entirely satisfying. Modelling methods such as statistical approach and scenario analysis allow a number of scenario and sensitivity analysis that are more difficult to obtain from parametric methods. Because of the cost and effort involved, and because results are sometimes discouraging, parametric methods are less used while their usage should probably be enhanced.

In any case, in order to have consistency and be able to compare between projects in a portfolio, organisations should define a standard way of calculating contingency applicable to all projects, and improve continuously on this method based on actual project performance observations.

It should always be remembered that the most useful aspect of quantitative cost risk analysis is to have a good team discussion of the impact of risks and their relative importance which contributes to risk awareness, anticipation and proactive decision making. With regards to schedule risk analysis, the main benefit is to enable the identification of potential critical paths which again helps anticipation and proactive decision making. There can be limited practical value in the actual numbers apart from providing an insight in the level of residual risk at any point in time (based on known-unknowns), and as conventional methods for justifying financial risk provisions. Working with risk identification and quantification reduces the scope for unknown-unknowns and increases the time available to manage them when they actually occur.

For the interested reader, the AACEI has a full range of standards addressing most methods of contingency calculation.