

AACE
INTERNATIONAL
RECOMMENDED
PRACTICE

64R-11

**CPM SCHEDULE RISK MODELING
AND ANALYSIS: SPECIAL
CONSIDERATIONS**

SAMPLE

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AAACE International Recommended Practice No. 64R-11

CPM SCHEDULE RISK MODELING AND ANALYSIS:
SPECIAL CONSIDERATIONS
TCM Framework: 1.6 – Risk Management

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

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Disclaimer: The opinions expressed by the authors and contributors to this recommended practice are their own and do not necessarily reflect those of their employers, unless otherwise stated.

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INTRODUCTION

Scope

This recommended practice (RP) of AACE International defines general practices and considerations for the various aspects of conducting a project schedule risk analysis using a critical path method (CPM) network of activities and Monte Carlo methods to estimate contingency and/or to understand the project's behavior in consideration of risk. This RP does not present a standalone methodology, but is an extension of other RPs that present CPM-based approaches to schedule risk analysis and contingency estimating. This RP discusses key procedural, analytical and interpretive considerations in preparation and application of a CPM model; considerations that were not covered in the broader methodological RPs.

A quantitative schedule risk analysis is an important aspect of risk management on a project. It can help project teams understand how project risks and uncertainty may impact the project schedule and when key milestones will be achieved. The analysis should be conducted by a skilled risk analyst. This analysis is typically performed during project development prior to key approval points, but can also be used during project execution to assess the current status of the project schedule risks.

Most schedule risk analyses utilize a CPM network as the basis for conducting a Monte Carlo type simulation of project schedule variability. The CPM model for risk analysis must be properly constructed and realistically reflect how the identified risks may impact the project activities and overall duration. The identified schedule risks may be linked to the activities in the model in a variety of ways, depending on the software used and user preference. Regardless of how the risks are linked to activities by the software, the analysis needs to be based on a comprehensive list of schedule risks and an understanding of how they may impact the project. Understanding the compromises, assumptions and basis of the analytical methods and what the resulting schedule risk analysis means are key to developing appropriate risk treatment plans, contingency estimates, and making well supported value adding project decisions.

This RP is applicable to any industry or project where the CPM approach is used. It addresses considerations for risk analysis as they relate to the CPM model and not to any integration with cost risk analysis.

Outline

The following is an outline of this RP's content:

- Minimum Conditions of Satisfaction
- Schedule Model Building
 - Summary vs. Detailed CPM Models
 - What to Include in a Summary CPM Model
 - How to Summarize Schedule Activities
 - Logic Tie Considerations
 - Constraint Considerations
 - Schedule Work Calendars
 - Assignment of Resources and Costs
 - Probabilistic and Conditional Branching

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- Alternative Scenarios
- Associating Risks to Activities
 - Linking Risk Registers to Activities
 - Duration Ranges on Activities
 - Combination of Linked Risks and Duration Ranges
 - Establishing Correlations
- Interpreting Results
 - Typical Simulation Outputs
 - Merge Bias
 - Duration Cruciality vs. Schedule Sensitivity
- Conclusion

Background

The application of schedule risk analysis for projects is a growing practice. The practice is used at various stages of project development and execution. The practice serves multiple purposes, including:

- Assessing the potential variability in project duration (in individual activities, various sub-networks, or the overall completion milestone) resulting from identified project risks;
- Assessing how risks, including threats and opportunities, in the project schedule may influence project economics;
- Understanding which paths in the schedule have the highest probability of influencing the schedule completion or key milestones; and
- Understanding which risks have the most influence on overall schedule variability.

While multiple methods exist for conducting a schedule risk analysis, the most common method utilizes a CPM network model. There are multiple categories of schedule risks, from duration uncertainty to specific impact events to CPM network risks. The project risks with the potential distribution of impacts are either explicitly linked to the schedule activities or more subjectively reflected in duration variability that is assigned directly to each activity. Risks that are inherent in the network logic may show up as merge bias or as weaknesses in the CPM network. A Monte Carlo type simulation of the schedule model is then conducted, the results analyzed and feedback provided to the project team and/or management for further action/revision/acceptance. While there are other ways to handle the various categories of risks, the Monte Carlo simulation can be used for all types.

Without use of a Monte Carlo simulation, there are ways to provide schedule risk analysis. Specific impact event risks can be modeled directly in the CPM network by use of what-if scenarios, performed individually or progressively (by adding one event after another). Network risks may be evaluated through detailed and thorough review of the schedule from a technical network perspective. Duration uncertainties cannot easily be evaluated except through analysis such as three point duration estimates. Effective use of project controls practices will provide proactive engagement so that projects will not allow sequential activities to progress at their pessimistic durations.

What-if scenarios developed directly from the CPM model without use of a Monte Carlo simulation, are performed using the same process as described in AACE International Recommended Practice No. 52R-06 "Time Impact Analysis – As Applied in Construction".

Various software products are available which support Monte Carlo simulation and risk analysis using a CPM network model. Each product is different based on which scheduling programs they support, how risks are linked to activities, and how the results are presented. This recommended practice is not based on any specific software product but intended to support general practices with any available standard schedule risk analysis software.

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The key to deriving the best value from schedule risk analysis is to use a schedule risk model that correctly represents the project plan while also properly reflecting how the potential project risks may impact the schedule. Practicality requires tradeoffs that must be considered; these are covered in this RP.

This recommended practice should be considered complementary to RP 57R-09, “Integrated Cost and Schedule Risk Analysis Using Monte Carlo Simulation of a CPM Model”, which discusses how to conduct a combined cost and schedule risk assessment in a single CPM model. This recommended practice addresses considerations for conducting only a schedule risk analysis using the CPM model, not combining it with cost risk analysis.

RECOMMENDED PRACTICE

Minimum Conditions of Satisfaction

To properly conduct a schedule risk analysis and provide quality results, the project team needs to have developed the following items consistent with the current stage of project development:

- A development of scope of work, execution plan, cost estimate, and schedule that are consistent with each other;
- A quality schedule that includes activities for all project scope; has realistic durations for activities; has logic links that appropriately reflect the sequence of work and the dependences between activities; properly developed with full allowance for available, especially limited, resources and space for those resources to work; and realistic critical and near-critical paths;
- A team-approved schedule (where schedule realism is acknowledged only after project team buy-in around such factors that include, but are not limited to, the validity of precedence logic, extent of broken logic, missing logic or open-ends, logic density or logic to activity ratio, and the number or type of constraints);
- A risk register with a comprehensive list of all identified project-specific risks, an understanding of the likely impact of each of those risks, and risk response actions for each risk; and
- An understanding of the systemic risks, if not captured in the risk register, which may impact the project’s performance, including schedule completion.

If these items do not exist at the start of a schedule risk analysis, the team will need to address those issues and either resolve them as a part of the analysis, determine how the gaps should be reflected in the analysis, or defer the analysis until the items are satisfactorily modeled in the schedule.

Schedule Model Building

Summary versus Detailed CPM Models

Two basic approaches are used in formulating a CPM schedule model for risk analysis. One uses the detailed project schedule in its entirety, which may involve thousands of activities. The other uses a summary CPM model to represent the detailed project schedule, typically with only a few hundred activities or less. There are proponents to each approach. Risk analysis benefits from team input. Also, conducting a schedule risk analysis with a summary model is likely to be more understandable to the team while making better use of their time (and to take less time overall) than with a detailed project schedule. Summarized schedules are also useful for addressing more strategic risks and considerations. Use of a detailed project schedule may be more appropriate if it is expected to be incorporated into ongoing schedule management (i.e., a definitive diagnostic, tactical or control approach) for the project.