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The Importance of Doing a Risk Assessment in Every Project, Early and Often

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Abstract–Is there a benefit to executing a project risk assessment early and repeating it often? The definitive answer is yes! Developing and executing a risk assessment early in a project reduces the risk of dealing with project threats and opportunities in an unprepared and chaotic fashion when they do occur. Awareness of time, cost, and/or scope risk impacts on a project is crucial. Understanding the extent to which risk affects a project in a planned and coordinated effort improves the probability of successfully completing a project on time and within budget.

It comes as no surprise that the majority of projects fail their estimates to complete as most projects do not execute risk assessments early and often. While other issues may impact a project and lead to failure in addition to omitting proper risk assessments, the inability to manage risk through constant risk assessments is a pivotal reason for failure.

This paper will focus on a process that assists the project team in avoiding the continuous failure of completing a project on time, on budget, and within scope because of a lack of proper risk management. If will also provide suggestions to help avoid risk pitfalls by executing risk assessments in a continuous and consistent pace, not only when the risk arises, but from the beginning of the project through closeout.

The objective of this paper is to encourage project teams to take the appropriate time and effort to assess project risks with the goal of providing an organized and practical approach to project risks and opportunities.

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Introduction

The ability to manage risk is of high importance in the project controls field. Clients, whether owners or contractors, expect risk to be managed on their projects. Individuals in charge of developing, tracking, and managing risk have the responsibility to build and maintain a comprehensive risk register. It goes without saying that managing risk is a key task for the project team and, without clear understanding of the process, the project or program has a high probability of failure. It is therefore imperative that risk is well defined and understood by all project stakeholders.

Project risk can be defined as an uncertain event or condition that, if it occurs, has a positive or negative effect on a project objective. [1]. The positive effects are considered opportunities; events with negative effects are called threats. There are also two dimensions of risk: 1) risk probability, which is the likelihood that each risk will occur; and 2) risk impact, which identifies the possible effect of risk on the schedule, cost, quality, safety, or performance.

Purpose

While risk is discussed at some point on most projects, many owners seldom revisit these discussions consistently nor is a risk analysis performed as a standard. Like cost and schedule, risk should be managed every day and have standard policies, procedures, and guidelines to manage risk properly.

The fundamental message of this paper proffers that without detailed, comprehensive, and well-managed risk management tools, techniques, and guidelines, the project or program is bound to fail. It will focus on the needed process to ascertain a well-managed risk assessment, when these risk assessments should occur, who should be involved, where risk should be managed, and why it is so important to complete a risk assessment early and often.

Long-Range Planning (Class 10) and Risk Management

In theory, a project can be risk assessed at a very early stage. While results from the assessment may not be conclusive (i.e., unable to capture all possible risks of a project), its creation develops a foundation for project insight in the long run.

To establish a strong risk assessment foundation, it is recommended that some level of estimate be available as input for the assessment. The stronger the estimate, the better the possibility of developing a useful risk assessment. Thus, having a Class 5 estimate (i.e., primarily an estimate with a maturity level of project definition deliverables up to 2%) may be useful. [2]. But what about a less mature project?

In recent years, a fairly new concept for estimating has been developed. Since more projects are starting earlier with the need of better studies – whether cost, schedule, or risk driven – the concept of a Class 10, or long-range planning estimate, has resulted. The Class 10 estimate addresses the challenges of developing and communicating long-term system planning. This type of estimate is highly conceptual, with limited scope definition, and is often based on parametric or analogous assumptions. [3]. While this level of estimate is very unpredictable due to its lack of detail, it may still be used for a risk assessment, thereby giving stakeholders an idea early on in a project of the various threats and opportunities a young project might encounter.

The use of a Class 10 estimate opens the possibilities of developing a risk assessment with some foundation in the early planning stages of a project. Additionally, this type of risk assessment can be developed using reference class forecasting and/or parametric modeling, which are discussed in the following paragraphs.

Reference Class Forecasting

Reference class forecasting (RCF) is a method that aims to remove strategic representation and optimism bias in cost and schedule completion targets. It was first introduced by Bent Flyvbjerg, and it is based on theories developed by Daniel Kahneman and Amos Tversky [4]. RCF relies on historical cost and schedule data from completed projects to build a probability distribution; the goal is to identify desired contingency amounts based on the risk appetite of the organization (e.g., funding to P80 levels).

The authors recommend using the RCF method early in the project planning and approval process for Class 10 and Class 5 estimates. At this stage, there is a high level of uncertainty given the level of scope definition and the minimum details available. A main point to consider when using RCF is that it will not give stakeholders a list of prime risks that may affect the project. RCF only assists team members in allocating a level of cost and schedule contingency based on past performance. Another key point is that contingency amounts will need to be removed from the historical project data; risk analysts may need to make assumptions about the contingency levels of completed projects since that type of data is rarely available or known.

Risk analysts will have to evaluate the historical project data, normalize it, identify specific reference classes from similar projects, remove contingency amounts so that bare cost estimates and durations are assessed, develop a probability distribution for either cost and schedule, and use price deflator indices to account for inflation and market conditions.

Parametric Modeling

When historical project data is available to create the RCF model, creating a parametric model is recommended to validate contingency allocation. Risk analysts can create a parametric model for Class 5 estimates that can also be used for Class 4 and Class 3 estimates [5]. The parametric model can be combined with other risk analysis methods and with the project schedule to assess uncertainty, project risks, and systemic risks. A key suggestion when creating the parametric model include diagnosing and validating the different regression assumptions, which include the lack of autocorrelation, that the error term is normally distributed, that the mean of the error term is zero, and the absence of perfect multicollinearity.

As with the RCF, risk analysts must evaluate historical project data, normalize it, identify similar projects, remove contingency amounts so that bare cost estimates and durations are assessed, use price deflator indices to account for inflation and market conditions, and perform a statistical analysis using multiple linear regression.

The development of the parametric model and the RCF model involves a level of subjectivity and bias that will come into play when normalizing and cleaning the data and when project team members are asked about the parameters and coefficients they want to use. Risk analysts are also affected by bias, so the recommendation is to ask other risk analysts to review and validate the assumptions and then come to an agreement on using specific parameters in the model. Additionally, parametric modeling will not reveal risks that are driving potential impacts to the project. It will only provide an overall contingency recommendation based on the desired P-value, typically between P70 and P90.

Applying Risk Management Across Life Cycle of Project

After determining the risk assessment development approach, the team needs to put the process into action.

A Project Cycle Approach

A risk project cycle approach could be defined as a circular process whereby the risk is reviewed, planned, identified, assessed, mitigated, and responded to. All steps need to be recorded in a risk register from which the team can manage project risks and opportunities. Figure 1 shows a cyclical approach.

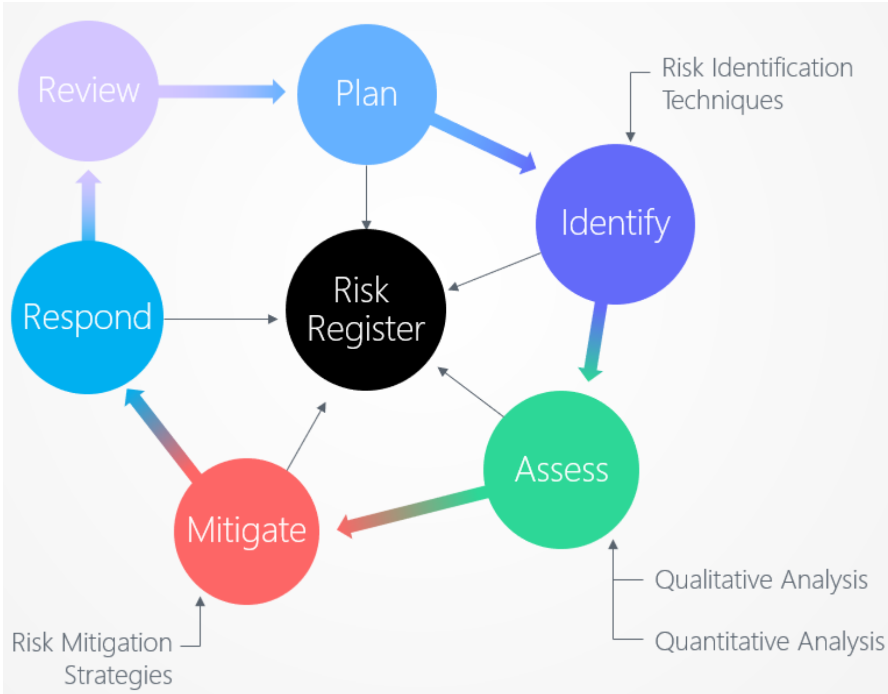

Figure 1–Risk Management Process in Action

Project Life Cycle & Risks

Throughout the different phases of a project, the amount at stake and the total project risk deviates from one another. The further along the project, the less the total project risk, but the amount at stake for the remaining risk increases. Figure 2 explains this scenario graphically.

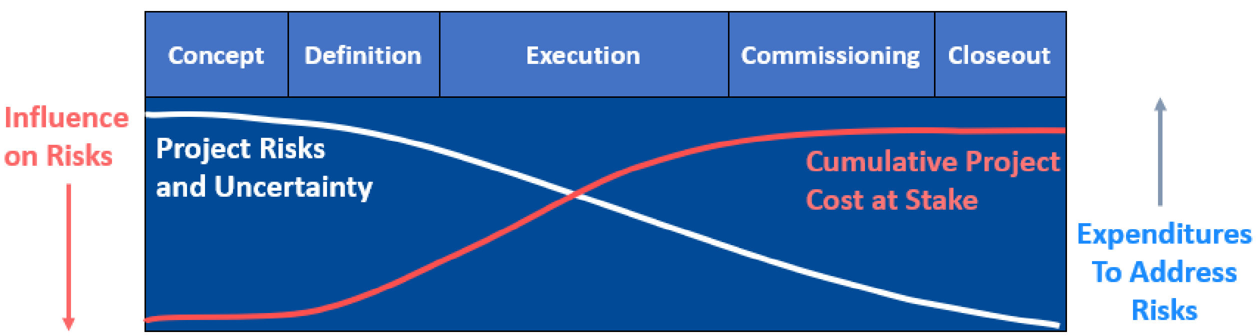

Figure 2–Project Life Cycle & Risks

Cost & Schedule Risk Analyses

The following are descriptions of the commonly used six-step process for cost and schedule risk analyses.

1. Review: Ensure starting point – either the estimate or schedule – is suitable to use as a basis for the analysis.
2. Identify: Identify and prioritize risks that can affect the project's cost and schedule outcome.

3. Model: Create the model and set up inputs to use for a Monte Carlo simulation.
4. Range: Determine probabilistic characteristics of model inputs (e.g., probability distributions, ranges, etc.).
5. Simulate: Perform a Monte Carlo simulation.
6. Report: Interpret simulation results for project team use.

Process Details for Cost vs. Schedule Analyses

The details on how to approach a cost risk analysis (CRA) versus a schedule risk analysis (SRA) vary. The following describes a detailed process for each.

Cost Risk Analysis

- Review estimate and estimate basis document to ensure they are credible and reflect the project execution plan.
- Interact with project team to identify and prioritize risks that could affect the project cost outcome.
- Develop a cost model. Usually, the model is a summarization of the estimate with cost variables added to simulate effects of risks.
- Determine probabilistic distribution for cost risk variables; determine “range” inputs to the variables.
- Use a simulation tool, such as @RISK™, to perform a Monte Carlo risk simulation.
- Interpret the results of the simulation for the project team’s use. Key item: Probability distribution of overall cost.

Schedule Risk Analysis

- Review project schedule and schedule basis document to ensure they are comprehensive, have CPM integrity, and reflect the project execution plan.
- Interact with the project team to identify and prioritize risks that could affect the project schedule outcome.
- Develop a critical path method (CPM) schedule model (i.e., typically a summary schedule of 75–250 activities containing the project’s critical, near-critical, or risk-sensitive sequences.
- Develop the probabilistic parameters (i.e., ranges to activity durations, use of risk events, and use of risk factors) for the CPM model.
- Use a simulation tool, such as Oracle Primavera Risk Analysis, to perform a Monte Carlo risk simulation.
- Interpret the results of the simulation for the project team’s use. Key items: Probability distribution of key project milestone events and probabilistic critical path.

Desired Timetable

The preparation for a risk analysis can be broken down in three stages.

1. Pre-Workshop (1-2 weeks prior to workshop)

    - Become familiar with the project.
    - Engage in pre-workshop interaction with project team participants.
    - Prepare the risk register.

2. Risk Workshop (1-3 days)

    - Conduct the workshop. (Duration will vary depending on project scale and the extent of project risks that need to be identified and evaluated.)
    - Identify the tasks that need to be completed during the workshop.

3. Post-Workshop (<1 week)

    - Develop final deliverables from workshop.

Team Engagement

When a project includes risk management, it is important to know the team's maturity regarding experience and attitude. An inexperienced group will require more time to process the concept while a team that with previous experience completing a risk analysis will be more adept. The next section discusses key aspects for a successful team engagement experience.

Understanding Team (or Client) Experience

When it comes to risk, consideration needs to be given to the client's experience. Understanding an internal risk management guide, risk management planning deliverables, and risk attitudes is essential.

If a robust or sophisticated internal risk management guide exists, it is usually "battle tested," and emphasis should be placed on the risk team familiarizing themselves with it. Also, while risk management planning deliverables may exist and expectations and templates may already be defined in a risk management guide, the team will still need to understand and identify how to adjust/tailor these items for the project being assessed. Finally, understanding any established attitude regarding a client's risk appetite, risk tolerance, and risk thresholds is important.

Inexperienced teams often do not have an internal risk management guide. When risk results differ greatly from a client's anticipated assumptions, existing approaches manifest as ineffective, and emphasis should be placed on creating and applying a better approach. When risk management deliverables are vague, the team will need to carefully define them. Lastly, a client's risk attitude, when unknown, also needs to be clearly defined in regard to risk appetite, tolerance, and thresholds.

Organizations & Risk

Organizations perceive risks as part of project uncertainty and organizational objectives. Some clients may even be willing to accept risks based on their own risk attitudes, which are defined as follows:

Risk *A*ppetite: The degree of uncertainty an organization is willing to accept in anticipation of a reward.

Risk Tolerance: The degree, amount, or volume of risk that an organization or individual will withstand.

Risk Threshold: The level of uncertainty or impact at which the organization will accept risk. A color-coded probability and impact matrix provides thresholds examples (see Table 1). [1].

Recognizing Critical Success Factors

Risk Management = Project Management
- All stakeholders, including an organization's upper management, are responsible for the project and recognize and accept the benefits for managing risks.
- Risk management activities need to be integrated into the overall project plan.

Project Objectives Defined
- Clear definition of project objectives is in place and a high-level understanding of the environment in which the project will be developed and executed is known.

Level of Risk Management Sophistication
- An inexperienced organization will need time to develop a project-specific approach. Alternatively, this organization may want to borrow from another entity. Note: This will still require familiarization and significant tailoring.
- Lessons learned from previous projects, where available, should be incorporated into the approach.

Involvement of Project Stakeholders in Planning
- The project manager needs to involve project stakeholders in risk management planning. This creates awareness, shared understanding, and an opportunity to address varying interests early on.
- Disagreements between stakeholders on risk tolerance and evaluation measures need to be immediately addressed and resolved.

Compatibility with Organization Objectives, Policies & Practices

- The risk management plan should identify (reference) and take into account all relevant organizational procedures, policies, and practices.
- The risk management plan should be consistent with the organization's strategic risk management or corporate governance processes.

Risk Analysis

Cost and schedule risk analyses are mainly performed to support major decisions at different stages of the project lifecycle. As a project moves through the early phases, an organization needs to assess project alternatives along with project risk profiles. Depending on the organization's risk maturity level, risk assessments can become time-consuming if project information – such as scope, assumptions, constraints, budgets, schedules, and expert judgments – needs to be collected.

The earlier the risk management process begins, the more time project team members will have to properly identify and manage risks. Two common processes that project teams follow to identify, qualify, and quantify risks include the qualitative risk analysis (QLRA) and the quantitative risk analysis (QRA). The authors have found that organizations that are starting their own risk management practice are better off implementing QLRA as a standalone process, and then move to QRA once their risk maturity level has improved.

Qualitative Risk Assessment (QLRA)

Qualitative risk assessment is the process of prioritizing risks to define the efforts related to risk responses, treatment, and strategies that address the most significant risks. In the early project phases, especially when project information is limited and when dealing with Class 5 estimates and schedules, risk collection and elicitation strategies should be defined and should include historical experiences and risk data, checklists, requirements and technical documentation, and expected deliverables.

As a first step in performing a QLRA on a project, risks need to be identified. There are several effective risk elicitation tools and methods as noted in Recommended Practice 62R-11 [6]. These tools and methods should take into consideration the organization's culture, risk maturity level, project objectives, and relevant procedures. In the authors' experience, using a minimum of three different risk identification strategies to pinpoint not only risks but also to detect potential issues and constraints is a helpful approach to collecting risk data. While it is recommended that risk practitioners facilitating the elicitation of risks bring their own list of risks after evaluating the project documentation, project team members should also be encouraged to identify risks that correspond to their disciplines or trades to elicit ownership of these risks.

Below is a list of the risk identification tools and methods used by the authors:

- Risk registers from past and similar projects

- Technical documentation (e.g., scope documents, business case, capital appropriation requests, drawings, specifications)
- Checklists of risks and issues
- Individual interviews
- Group interviews
- Brainstorming
- Lessons learned
- Procurement evaluations and vendor performance evaluations

There are usually two school of thoughts when project teams identify the number of risks. One camp aims to collect as many risks as possible early in the project, irrespective of the quantity. The other camp focuses on a limited number of risks that they consider to be prime and that, according to these practitioners, need to be assessed with a goal of bringing better quality and focus to the risk assessment. It is important to note that risks need to be described by the project team in a manner that is not ambiguous, meaning that when risks are read two to three weeks after they have been initially identified, all involved on the team should be able to accurately understand the causes of a given risk and its potential impacts. A structured risk statement should follow a cause-risk-impact description; an example of a structured risk statement is as follows:

"Due to incomplete information from the pipe fabricator, pipe spools may be fabricated to wrong revision, thereby creating pipe installation rework in the field when the spools do not fit properly."

Additionally, project team members should focus on identifying systemic risks that will most likely affect the project during the early definition stages. These systemic risks include scope definition, new technology, project controls capabilities, complexity, and the basis of the schedule and cost estimate. Systemic risks have 100 percent probability of occurrence.

Once risks are identified and included in a risk register, the risks must be qualified. To accomplish this, risk practitioners commonly use a method that identifies the probability of occurrence and the potential impacts should the risk occur. Ideally, project team participants who identified the initial project risks will also provide their input to qualify the risks. Whenever possible, the QLRA should be performed using a formal risk workshop. The workshop should be planned at least one month in advance to allow participants sufficient time to gather key project information and to give them opportunity to brainstorm risks that correspond to their trade or work.

The QLRA relies on a risk matrix to qualify and rank the risks. The matrix is based on probability and impact scales and should be developed in collaboration with the risk workshop attendees. The scales are usually tailored for each project and typically contain either a 3 x 3 or 5 x 5 probability along with impact score levels. These levels help qualify the threats and opportunities based on their potential impacts on project objectives (e.g., cost, schedule, quality, safety).

The risk matrix example below represents the basis for the scoring scale used on project risks. A risk rating value threshold is developed to identify risks that are defined as low, medium, or high within the objectives of cost and schedule; these objectives are assessed separately to identify their individual ratings. Typically, risks deemed as either medium or high would be quantified by the project team during the QRA.

Defined Conditions for Probability Scales of a Risk					
	Very Low	**Low**	**Medium**	**High**	**Very High**
Probability	0 - 0.1	.11 - 0.30	.31 - 0.50	.51 - 0.89	>0.90
Defined Conditions for Impact Scales of a Risk on Major Project Objectives					
Project Objective	**Very Low**	**Low**	**Medium**	**High**	**Very High**
Cost	< $10k Thousand	$(10K – 50K) Thousand Cost Increase	$(51K – 250K) Thousand Cost Increase	$(251K – 500K) Thousand Cost Increase	> $ 500 Thousand Cost Increase
Schedule	< 1 Month Time Increase	(1 - 3) Month Time Increase	(3 - 4) Month Time Increase	(4 - 6) Month Time Increase	> 6 Months Time Increase

Probability					
VH	0.9	1.8	2.7	3.6	4.5
H	0.7	1.4	2.1	2.8	3.5
M	0.5	1	1.5	2	2.5
L	0.3	0.6	0.9	1.2	1.5
VL	0.1	0.2	0.3	0.4	0.5
	VL	**L**	**M**	**H**	**VH**
	Impact				

Risk Rating Value		
<1	Green	**Low Risk**
1-1.99	Yellow	**Medium Risk**
>2.0	Red	**High Risk**

Table 1–Probability and Impact Matrix with Risk Thresholds

However, there are many limitations and inconsistencies when using the risk matrix, such as ambiguous inputs and outputs of probability and impacts, suboptimal resource allocation, range compression, and subjective thresholds [7]. Risk practitioners should be aware of the implications. Alternatives that the authors have used early during the project life cycle are the bow-tie method and the failure mode and effects analysis. The main goal when using these alternatives is to categorize risks by their causes. Identifying common root causes among several risks may assist in developing risk responses. Another alternative method to performing a QLRA is to ask subject matter experts (SMEs) for their expert judgment as to the prime risks that need to be addressed based on the project's current phase.

Risks are prioritized and ranked based on the product of their probabilities of occurrence times their impacts, and where the risk rating falls within the risk thresholds of the defined risk appetite. Usually, risks that are deemed medium or high are used as part of the QRA, though some practitioners use only high rated risks in the QRA.

Quantitative Risk Analysis (QRA)

There are multiple risk quantification methods that risk analysts can use throughout the project life cycle. Reference class forecasting and parametric modeling are recommended for Class 10 and Class 5 estimates, respectively. For Class 4 to Class 1 estimates, the recommendation is to use hybrid models based on parametric models and a Monte Carlo simulation for expected value and CPM-based methods. AACE International lists several recommended practices that detail the process to perform each risk quantification method. These include RP 42R-08: parametric modeling [8]; RP 57R-09: integrated cost and schedule risk analysis using risk drivers [9]; and RP 113R-20: hybrid cost and schedule using combined parametric and expected value [10].

Risk analysts should have a good understanding of the following areas before starting any risk quantification effort:

- Organization's stage-gate process
- Organization's methodologies to develop the cost estimate and schedule
- Types of risks assessed at the portfolio, program, and project-type levels (e.g., tactical, strategic, systemic, project risks, and uncertainties)
- Escalation and currency exchange protocols
- Economic indices to adjust for inflation
- Local market conditions and their impact on capital and business planning
- Use of historical data and how it was normalized and validated
- Calibration of historical data and expert judgement
- Linear and nonlinear probabilistic methods
- Organization's change and contingency management policies

Risk analysts should be available to perform quantitative risk analyses not only at the stage-gate point but at any time the project team is ready to make a major decision about the project; these decisions usually occur between stage-gates. The project team may also ask risk analysts to perform probabilistic scenario analyses given the dynamic nature of the market landscape.

Calibration Assessments

One of the most neglected tools to assess the degree of subjectivity in risk inputs provided by the SMEs is the use of calibration assessments. The authors have incorporated the classical method [11] to collect, assess, and combine expert judgments for risk inputs related to their probability of occurrence and cost and schedule impacts. The goal of this step is to ensure that risk analysts use the most accurate input information to improve the results of the QRA and increase the level of objectivity. Calibration assessments should be used at any point during the asset's life cycle to assess subjective expert judgments and risk data.

Calibration assessments use a series of predetermined seed questions where the risk analyst, acting as facilitator, already knows the answers. These baseline questions are distributed to the SMEs who, in turn, provide responses based on their judgments. The risk facilitators compare the responses with the known value and determine whether the SMEs were accurate. Usually, the risk analyst will assess the responses and use risk input data from the respondents who were calibrated. An example of an assessment of a seed question and responses is provided in Figure 3.

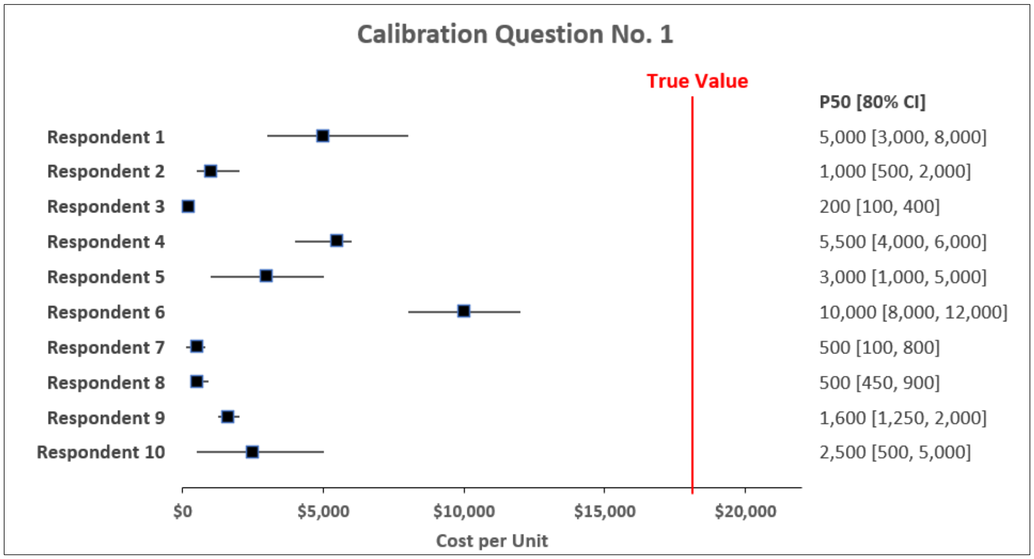

Figure 3–Sample of Calibration Assessment Seed Questions and Results

Figure 3 shows the results a sample seed question that was asked to 10 team members to assess how well they responded and if they were calibrated. The red line indicates the true value; the P50 value is depicted as a box in each respondent response, and the whiskers represent the ranges based on an 80% confidence interval (i.e., P10 through P90). The sample shows that all respondents to this question show overconfidence.

Trending Chart of Risk Analysis Results

Since the premise of this paper is a recommendation to perform risk analyses early and often on a project, it is recommended that a chart be developed that shows when a risk analysis was initially performed to track the accuracy of the analysis and the performance of the project. Figure 4 provides an example of a trending chart that shows the timing of the expected project completion on the Y axis and the timing of the schedule risk analysis reviews on the X axis. The comparison shows at what gate the schedule risk analysis was performed, the deterministic completion date of the project, and the results of the risk analysis depicted by the mean value and the 80% confidence interval.

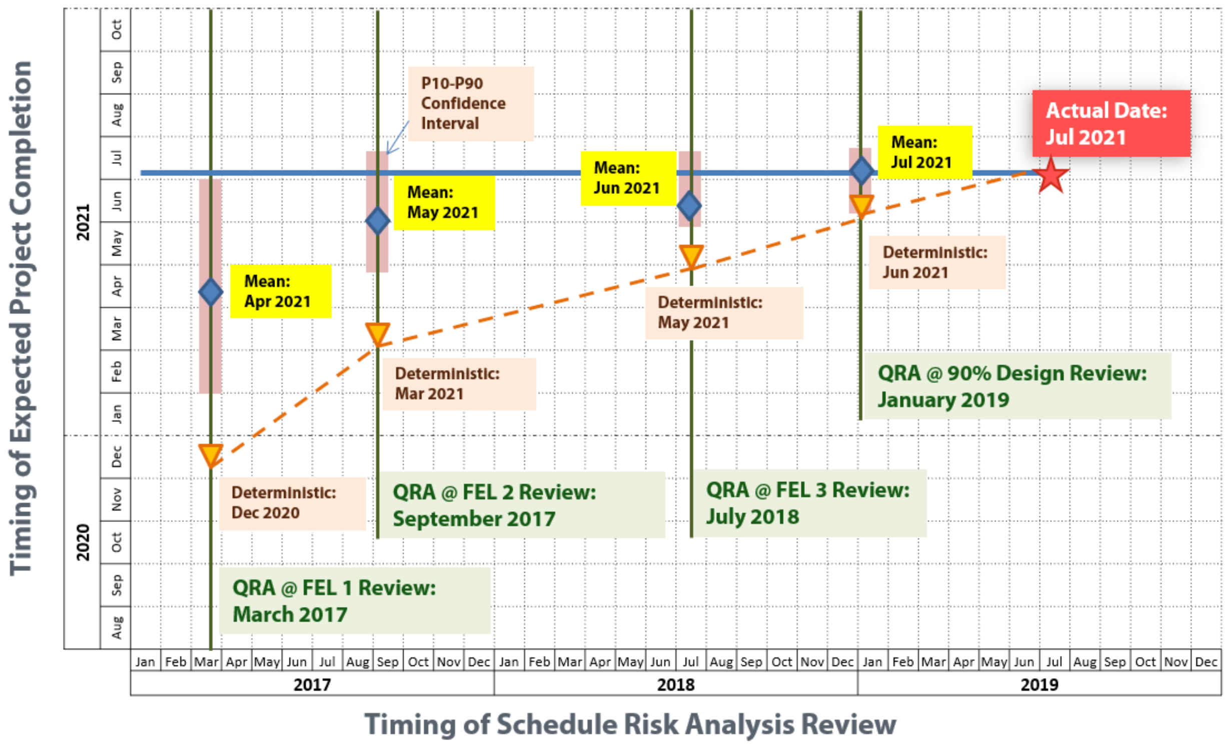

Figure 4–Comparison of Schedule Risk Analysis against Actual Final Result

Conclusion

The goal of every project is to finish on time and on budget. Without appropriate risk management, this pursuit becomes almost impossible. The ability to manage risk in every phase of the project improves project results. The focus of this paper emphasizes the need for early, consistent, and recurring risk assessments with the objective of finishing a project successfully. Project teams can address risk quantification early during the project development phases by implementing reference class forecasting and parametric modeling, using several tools and methods to complete QRA as the project progresses.

As projects move through the stage-gate approval process, risk analysts must be aware of the potential bias that they will encounter as they elicit risk information. Several common challenges that risk analysts will encounter include creating affective stakeholder engagement, working with poor quality cost estimates and schedules, and dealing with bias. Research has shown that using historical data minimizes bias and models based on empirical data have higher probability of being more predictive. However, this paper recommends that risk analysts use calibration assessments to ensure that the risk inputs provided by SMEs are reliable and closer to the true forecasted cost or schedule values, whether the data comes from historical projects or expert judgement.

While there is an established process to perform QRA, risk analysts must understand the limitations and implications of using risk matrices during QLRA. The authors present a typical timeline in which to hold a risk workshop, show several risk identification tools and methods to elicit risks, and provide a recommended risk description.

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