The Journeymap to Project Risk Analysis Maturity

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Context for Project Risk Analysis

Notorious project overrun experience

The need for quantitative risk analysis of project cost and schedule can be seen from three different perspectives: historical actual experience, identifying typical causes of project risk and viewing what is needed from the organization to address the problem.

Industrial projects consistently show mixed-to-disastrous cost and schedule results. Some of the individual project results for cost overrun as a percentage of initial estimates are well-known. These overrun percentages apply to cost only. There is less information about schedule overrun but they are related as we shall see:[1]

- Suez Canal, Egypt 1,900
- Scottish Parliament Building, Scotland 1,600
- Sydney Opera House, Australia 1,400
- Montreal Summer Olympics, Canada 1,300
- Concorde supersonic airplane, UK, France 1,100
- Troy and Greenfield railroad, USA 900
- Excalibur Smart Projectile, USA, Sweden 650
- Canadian Firearms Registry, Canada 590
- Lake Placid Winter Olympics, USA 560

Listed above are some examples of government-sponsored projects through the years.

The General project management Experience

What about the typical commercial / industrial project experience? In one recent study summarizing findings of twelve professional studies encompassing 1,000 large process-industry projects, the conclusion for the range of actual initial estimate accuracy based on a 10th percentile, 50th percentile (or mean) and 90th percentile, was as follows:[2]

- For P-10: the range was on average for a -9% (9% underrun) but the range of that value was wide, from -32% to + 8%
- For P-50 or Mean: the average was 21% but the range overrun was from 0% to 88%
- For P-90 the average range was 70% overrun with a range of 34% to 190%.

These findings indicate that initial cost estimates can be misleading when making major investment decisions.

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[1] Bent Flyvbjerg, "What You Should Know about Megaprojects and Why: An Overview," *Project Management Journal*, vol. 45, no. 2, April-May, 2014

[2] John Hollmann, “Estimate Accuracy: Dealing with Reality,” *Cost Engineering Journal*, *AACE International Transactions*, Nov/Dec 2012.

These findings of actual results are sobering when organizations are trying to pursue major projects, some of which might literally bring down the company if it goes badly.

Causes of Underestimation and Potential Overrun

Inside View, Outside View

One should ask how these discrepancies come to be and what can be done to avoid what seems to be a system-wide issue of project overruns. One explanation of this phenomenon is the difference between the "inside view" that characterizes the project estimates from the "outside view" that ignores the details of the project to look at actual results.[3]

- The Inside View: Initial estimates focus on the specific project and the issues / risks clearly addressed at that level. Those estimates represent solutions to engineering issues. Optimism is frequently practiced, whether on purpose or by accident. There may be conscious optimistic bias. This inward focus and solution is common and understandable. It often gives optimistic results, however.
- The Outside View: Actual results focus on empirically-derived data on overruns on similar projects and ignore the details of the project at hand. Human bias is bypassed in favor of empirical, relevant data. Reviewing actual projects, sometimes constructed recently by the same performer, will face the project management with inescapable facts. They may be asked why their project is viewed as much more successful than others in the database.

The project plan that arises from the inside view is often optimistic and ignores or downplays the existence and impact of those forces that could possibly cause schedule and cost overruns. In making estimates of cost or schedule the team makes assumptions that may be biased in an optimistic direction. In addition, they may not be challenged during the base estimating process.

Biases that Often Affect the Initial Schedule and Estimate

Two general types of bias are often present in the inside view approach:

- Motivational bias is practiced by people and groups who want the project to look better than it is. They are afraid of challenges, of "shoot the messenger" or of not being sure of their work. They consciously want the project to "go" so they will be willing to underestimate the cost and duration, over-promise results, and deny that any changes could occur on the project. Underestimating leads to better results but they are not real. Management often contributes by insisting on ignoring the

[3] Bent Flyvbjerg, "From Nobel Price to Project Management: Getting Risks Right," *Project Management Journal* August 2006, Project Management Institute

unknown knowns (problems we know but refuse to talk about) to make the project look better than it deserves.

- Cognitive bias is unintentional and based on human psychology. Project estimators and planners often underestimate the uncertainty in their estimates through lack of experience or availability of data. A common bias is the Anchoring and Adjusting bias by which an estimator or planner will focus on one estimate, perhaps an early estimate without much substance, and then adjust that estimate slightly as new information or demand for new estimate arises.[4] When this bias is working the possible minimum and maximum cases, and hence the estimate itself, will be underestimated even if the anchor has no inherent rationale.

Characteristics of a Successful Modern Project Risk Analysis

This white paper describes some of the most important developments in both methodology and tools that organizations can use to their advantage to both; (1) produce more realistic forecasts of when the project will really finish and with what cost, and (2) identify those risks that are important in driving their project to later and more costly results so those risks can be addressed in advance.

Estimating the amount of time and cost contingency to produce a desired level of certainty as well as identifying those risks that might be mitigated to make for better results takes discipline and commitment to identify and quantify probability and impact of the project risks honestly and realistically. There are several keys to successful risk analysis:

- Use a good-quality analysis platform. This is usually a project schedule that has been reviewed by the team for accuracy in portraying, at least at a summary analysis level, the project plan as it exists. The schedule also must comply with best practice scheduling principles.[5] Good practice scheduling is important since the schedule will be simulated using Monte Carlo simulation methods and specialized software. Simulation "computes" the project many times based on the occurrence of uncertainty and project risks as specified by the project team and others during risk data collection.
- Collect good-quality project risk and uncertainty data. Project risks represent an uncertain event or condition that, if it occurs, has a positive or negative (opportunity

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[4] A. Tversky and D. Kahneman, "Judgment under Uncertainty: Heuristics and Biases," *Science*, Sept. 26, 1974

[5] One source of scheduling best practices is the 10-step approach developed by the US Government Accountability Office (GAO) and can be downloaded at https://www.gao.gov/products/GAO-16-89G .

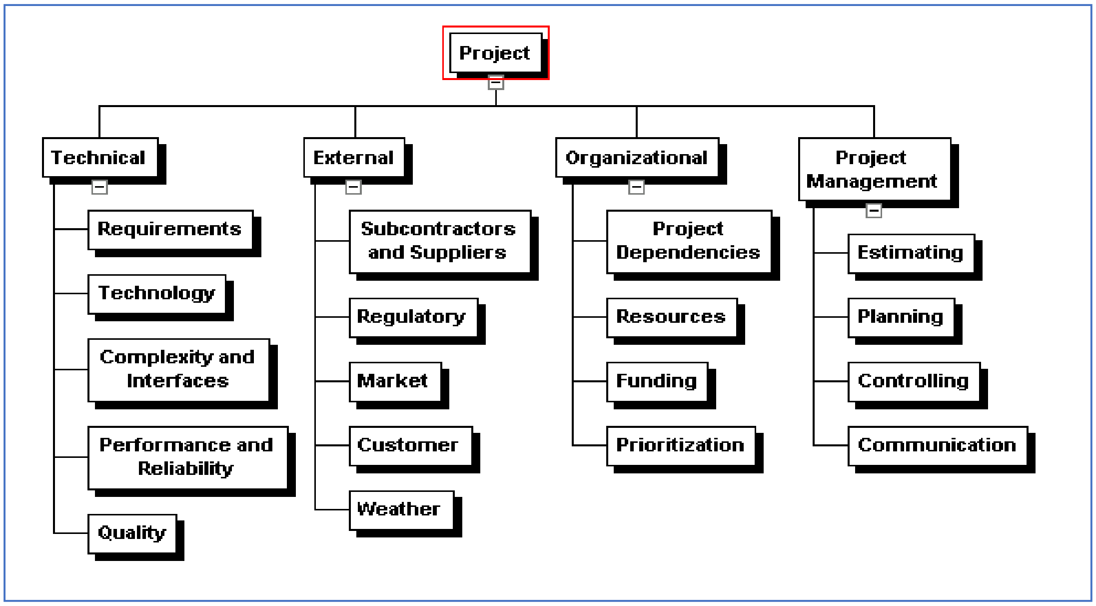
or threat) effect on the activities' duration and costs, leading to potentially a different finish date and total project cost.
Some analysts collect the risk data in workshops with many people in the room for a day or more. Workshops, they say, provide for good discussion and synergy and result in data to be used in the modeling of risks for simulation. There are some pressures characterizing the group risk culture that prevent open and honest discussion and expression of opinion. If present they jeopardize the quality of the risk data generated and decisions made group settings such as workshops.[6]

- "Groupthink" – members of a cohesive group prefer unanimity and suppress dissent
- "The Moses Factor" – an influential person's risk attitude is adopted against the personal preference of group members
- "Cultural conformity" – making decisions which match the perceived organizational or cultural norms

Because these pressures impede people's ability to express their true and honest opinions, an alternative data gathering method, the confidential risk interview, is often preferred. In this interview people can spend on average 2 hours with the risk interviewer talking in some detail about their views on risk identification and characterization of probability and impact. They do not fear that anything identifiable to them will be told to anyone else. Often new risks, risks that are not included in the Risk Register are identified even if they are the damaging or unpopular "unknown knowns." Data derived from these interviews is better quality where people can be free to express themselves, and they only have to commit 2 hours, not a full day or two, away from their project tasks.

An example of a Risk Breakdown Structure tool for identifying project risks at any level of maturity is shown below.

[6] David Hillson and Ruth Murray-Webster, *Understanding and Managing Risk Attitude*, 2005 Gower Publishing Ltd



- Organizational culture must be supportive of the effort. This is the most important pre-condition of all. With management's support success may be achieved in deriving information for decision makers. If management fails, is disengaged or is actively trying to manage the message, any risk analysis exercise will fail. Management must support and be seen to require the risk analysis to make its decisions. Management must insist on honesty and realism in the risk data, including requesting "the good, the bad and the ugly" so that all issues can and must be discussed honestly and realistically.
- Use modern software for Monte Carlo simulation. Since the platform for cost and schedule risk analysis is usually a resource-loaded project schedule, the software needs to be able to simulate schedules and costs simultaneously through the impact of variability in duration of activities with labor-type resources.
  Today we have software that handles both uncertainty and project risks. It treats the effect of risks on cost of labor and of materials differently, as it should. The software produces both cost and schedule risk histograms and scatter diagrams of cost and schedule simultaneously. Current software permits the use of risk drivers as well as discrete risks, and risks can be resolved in parallel or in series. Modern simulation software prioritizes risks using iterative simulations with progressive elimination of risks so management will know the possible days saved if the risk is mitigated.

Mechanics of Quantitative Risk Analysis

Uncertainty and Identified Risks as Sources of Variation

Uncertainty and risks are two main factors influencing variability of results for schedule and cost.

Uncertainty is defined as background variability, distinct from the variation caused by identifiable risks, that is caused by at least three commonly-found factors in projects;

(a) inherent variability of the work not caused by identified risks,
(b) estimating error or error of prediction, and
(c) bias in estimation or prediction if it exists

Uncertainty is always present at some level of impact so its probability is 100%. Since its specific source is not known uncertainty cannot be mitigated during the time of one project, although frequent repetition of the project may cause some reduction in uncertainty ranges in future projects.

The typical expression of uncertainty is in multiplicative terms such as 90%, 105% and 120%, where the most likely value is expressing a 5% underestimation bias in the durations of the schedule analyzed. The range of uncertainty might differ depending on the type of activity such as engineering, construction, procurement or commissioning. Uncertainty is similar to Common Cause in the Six Sigma world and is unlikely to be reduced.[7]

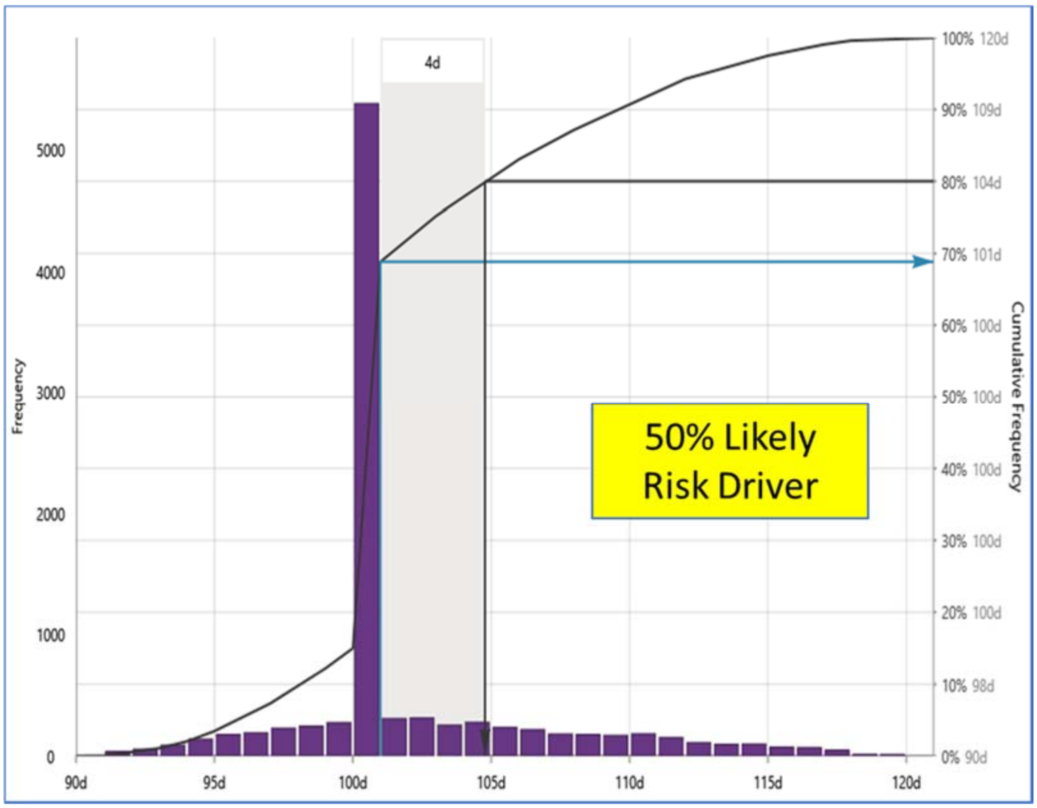
Identified risks are root causes of variability that can be identified and potentially moderated or mitigated. These are identified, usually in the Risk Register but also in the confidential risk interviews where we always identify new risks, perhaps those that are "known but cannot be spoken of" or unknown knowns. There are generally two types of these risks:

- *Project specific risks* generally arising from technical, external, organizational and even project management sources. They apply to the particular project or are brought over from other projects of a similar nature.
- *Systemic risks* of a more strategic nature such as complexity of the project, degree of new technology or materials, strength of the project team compared to the challenges and low degree of scope definition at the time of planning. Stressors to magnify these risks' impact include, notably, project schedule pressure, which "dooms more megaprojects than any other single factor."[8]

The typical expression of an identified risk represents:

[7] https://www.isixsigma.com/dictionary/common-cause-variation/
[8] Edward W. Merrow, *Industrial Megaprojects*, 2011, John Wiley and Sons

- The probability that the risk will occur on this project, implemented as the probability that the risk occurs on any iteration of the Monte Carlo simulation, such as 40% (occurs in 2,000 of 5,000 iterations, chosen at random, during simulation).
- The impact that the risk has on the duration of the activities it affects, if it occurs. If it is represented as a Risk Driver the computer will select a multiplicative factor from the range of such factors derived from the interviews (e.g., 95%, 110%, 130%). Because of proportionality, the multiplicative factor can be applied to long – and short-duration activities equally. An example of a risk driver with 40% probability is shown below.



- The activities that will be affected if the risk occurs. For instance, a risk may affect site work, piping, foundations, MEP or other grouping of activities. Sometimes a risk will affect only one activity, but other times it may affect dozens or even hundreds of activities. Strategic and systemic risks tend to be applied to multiple activities.

Identified risks are similar to Special Cause in Six Sigma and can potentially be reduced (mitigated).[9]

[9] https://www.isixsigma.com/dictionary/variation-special-cause/

Monte Carlo Simulation of a Project Schedule

Monte Carlo simulation is a way to develop a large, though synthetic, database of projects just like the one under consideration. Monte Carlo simulation is appropriate for solving complex but messy problems such as project schedules that are not susceptible to mathematical solution by conducting multiple trials solving for the finish date or other milestones (and costs at Level 5) to derive statistical statements of the possibility of project finishes.

The model used is a project schedule, usually developed to WBS level 3 to capture main interfaces but not usually the full detailed contractor's schedule. An analysis schedule can capture all of the work at a summary level with less detail than is needed for daily work and can usually be developed or revised to comply with best scheduling practices. Hence, risk analyses can be done on small- to medium-sized schedules of 150 – 3,000 activities. The schedule should be reviewed by the contractor and the owner to ensure a level of agreement with both parties.

Using the project analysis schedule and the risks derived from the interviews of project team members and leads both the platform and the risks are specific to the project. The results for the project's finish date (and cost) can be interpreted to apply to the project's prospects.

The Project Risk Analysis Maturity Journeymap[10]

There are different levels of risk analysis maturity that characterized different project management organizations. This represents risk analysis maturity, not overall project risk management maturity. The steps in this maturity model are shown below.

Risk Analysis Maturity Journeymap
Level 5: Advanced Integrated Cost-Schedule Risk Analysis
Level 4: Modern Quantitative Schedule Risk Analysis
Level 3: Basic Quantitative Risk Analysis
Level 2: Qualitative Risk Analysis
Level 1: Basic Risk Awareness
Level 0: Unaware of Cost or Schedule Risk

Characteristics of the Analysis Maturity Model levels can be summarized:

Level 0: Unaware of Cost or Schedule Risk

These organizations accept the estimates and schedule results without question and promise to them.   They will be surprised and play fire-fighter whenever project risks occur

[10] Derived from work on project risk management maturity performed at Petronas, Malaysia, presented as: "Assessing Project Risk Management Maturity in a Large Energy Company," Yaacob Salim and David Hulett, PMI Global Congress Asia Pacific, 2008

Level 1: Basic Risk Awareness

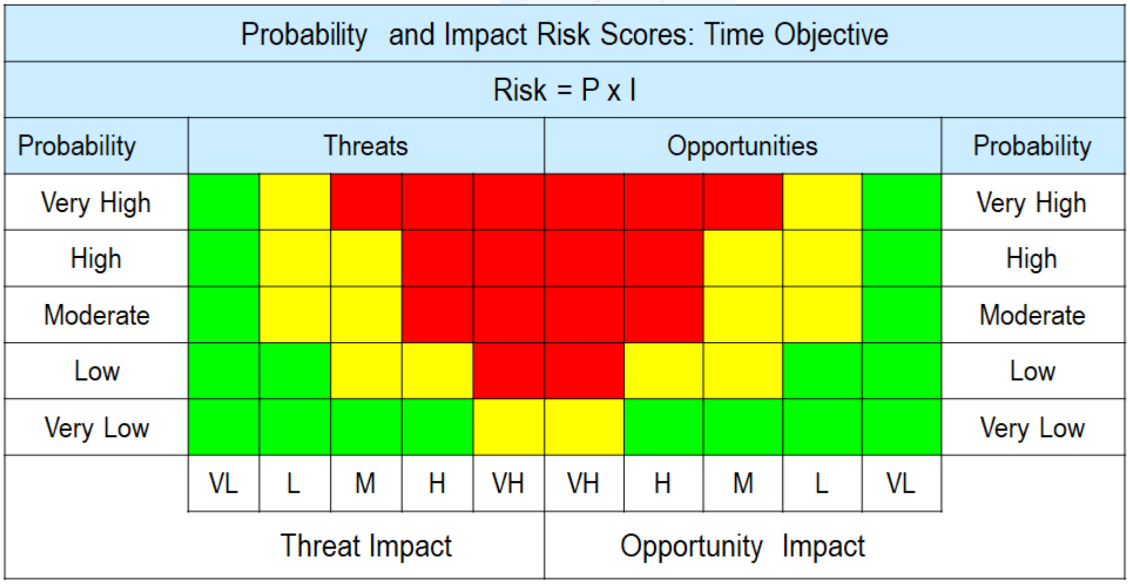
These organizations talk about risk frequently and there may be a risk champion who is called upon to respond to risks. They do not follow any method or system, relying on the champion every time. Hence their approach is not organized or repeatable.

Level 2: Qualitative Risk Analysis

This method is probably most appropriate at early project stages before estimates and schedules are available. Risks are identified and sorted by their perceived probability and impact on finish dates, costs, and scope. Impacts are estimated without benefit of models and the risk parameters are assessed in ranges of outcomes. Definitions of probability and impact are constructed and used to evaluate each risk. An organizing principle at this level is the definition and application of a consistently-defined set of ranges for risk impacts on objectives. An example is shown below.

Defined Conditions for Impact Scales of a Risk on Major Project Objectives Examples for Negative Impacts Only					
Project Objective	Very Low 1	Low 2	Moderate 4	High 8	Very High 16
Cost	Insignificant Cost Increase	<$.5 million Increase	$.5 – $5 million Increase	$5 - $20 million Increase	>$20 million Increase
Time	Insignificant Time Increase	<2 weeks Increase	2 – 5 weeks Increase	6 to 10 weeks Increase	> 10 weeks Increase
Scope	Scope Decreases Are barely Noticeable	Minor Areas of Scope Affected	Major Areas of Scope Affected	Scope Reduction Unacceptable to Sponsor	Project End Item is Effectively Useless
Quality	Quality Degradation Barely Noticeable	Only Very Demanding Applications are Affected	Quality Reduction Requires Sponsor Approval	Quality Reduction Unacceptable to Sponsor	Project End Item is Effectively Useless

A typical tool at Maturity Level 2 is the probability and impact matrix, an example of which is shown below.

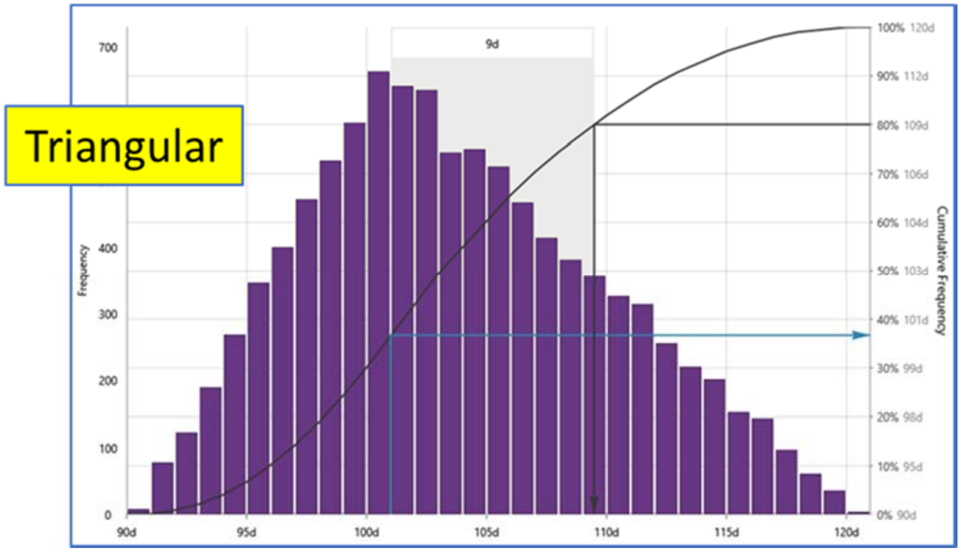


Since the risks are identified and assessed individually this method at Maturity Level 2, this method cannot provide a viable estimate of total project finish date or project cost.

Level 3: Basic Quantitative Risk Analysis

This level uses a project schedule and / or estimate as the platform. A range of low, moderate, and high durations is discovered by interviews or workshops and applied directly to the activities' durations. A Monte Carlo simulation is conducted, so histograms of finish dates are produced.

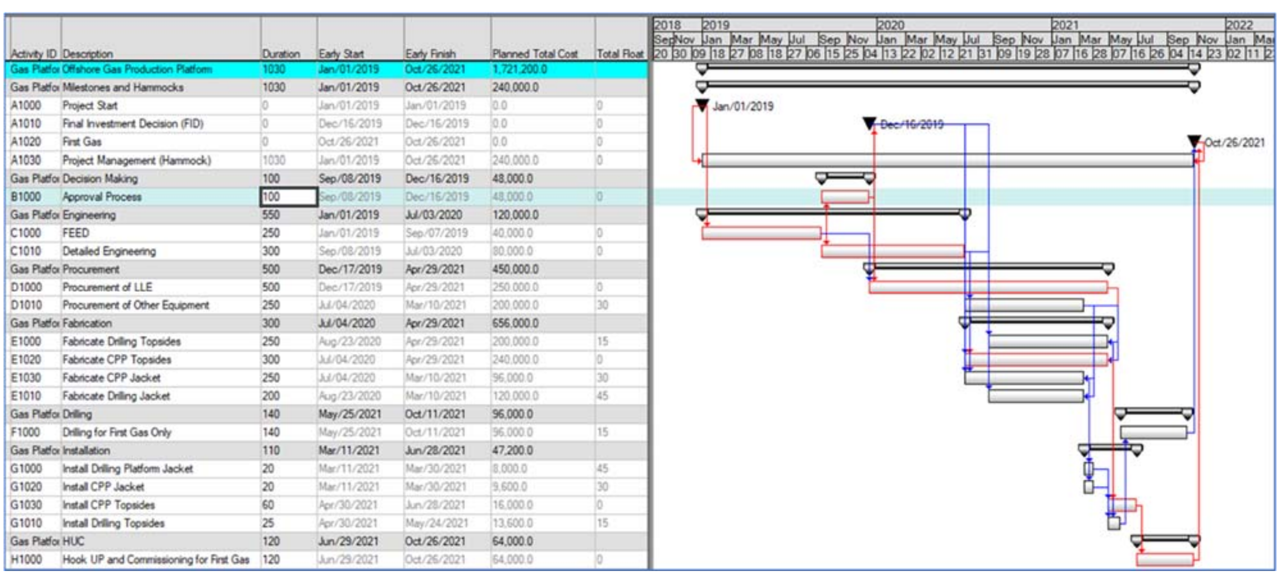
However, the individual risks that cause fluctuations are not identified so cannot be applied to those activities' durations they affect, including to multiple activities for truly strategic or systemic risks. Identified risks are not used to drive the simulation, nor can individual risks be identified and prioritized for mitigation. The full effect cannot be found of a risk that influences duration of multiple activities. Probability distributions applied directly to the activity duration must incorporate the impact of all risks affecting that activity, so it is the "image" of those risks, some of which are less than 100% likely, that are projected on the activity durations by distributions such as the triangular distribution below.



Level 4: Modern Quantified Schedule Risk Analysis

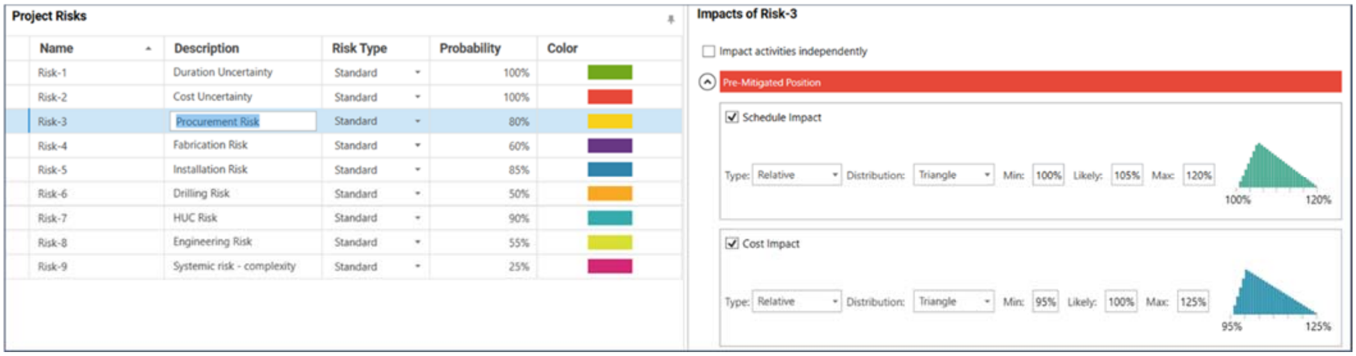
At this level root cause risks are identified, quantified and modeled against the project schedule. This means that they can affect one, two or even many activities' durations depending on the level of generality they represent if they occur during an iteration in the Monte Carlo simulation. Root cause project-specific risks can be assigned to whole phases or even whole projects. Systemic risks can be modeled as well. Uncertainty is included as a base level of variability that cannot be reduced. The simulation produces histograms and cumulative distributions that indicate the finish dates with probabilities of success, and consequently the amount of time contingency needed and prudent to support contracts and other promises of reliable finishes.

An example summary schedule can be used to illustrate these concepts. The Offshore Gas Production Platform project schedule is shown below:



Activity ID	Description	Duration	Early Start	Early Finish	Planned Total Cost	Total Float
Gas Platfo	Offshore Gas Production Platform	1030	Jan/01/2019	Oct/26/2021	1,721,200.0	
Gas Platfo	Milestones and Hammocks	1030	Jan/01/2019	Oct/26/2021	240,000.0	
A1000	Project Start	0	Jan/01/2019	Jan/01/2019	0.0	0
A1010	Final Investment Decision (FID)	0	Dec/16/2019	Dec/16/2019	0.0	0
A1020	First Gas	0	Oct/26/2021	Oct/26/2021	0.0	0
A1030	Project Management (Hammock)	1030	Jan/01/2019	Oct/26/2021	240,000.0	0
Gas Platfo	Decision Making	100	Sep/08/2019	Dec/16/2019	48,000.0	
B1000	Approval Process	100	Sep/08/2019	Dec/16/2019	48,000.0	0
Gas Platfo	Engineering	550	Jan/01/2019	Jul/03/2020	120,000.0	
C1000	FEED	250	Jan/01/2019	Sep/07/2019	40,000.0	0
C1010	Detailed Engineering	300	Sep/08/2019	Jul/03/2020	80,000.0	0
Gas Platfo	Procurement	500	Dec/17/2019	Apr/29/2021	450,000.0	
D1000	Procurement of LLE	500	Dec/17/2019	Apr/29/2021	250,000.0	0
D1010	Procurement of Other Equipment	250	Jul/04/2020	Mar/10/2021	200,000.0	30
Gas Platfo	Fabrication	300	Jul/04/2020	Apr/29/2021	656,000.0	
E1000	Fabricate Drilling Topsides	250	Aug/23/2020	Apr/29/2021	200,000.0	15
E1020	Fabricate CPP Topsides	300	Jul/04/2020	Apr/29/2021	240,000.0	0
E1030	Fabricate CPP Jacket	250	Jul/04/2020	Mar/10/2021	96,000.0	30
E1010	Fabricate Drilling Jacket	200	Aug/23/2020	Mar/10/2021	120,000.0	45
Gas Platfo	Drilling	140	May/25/2021	Oct/11/2021	96,000.0	
F1000	Drilling for First Gas Only	140	May/25/2021	Oct/11/2021	96,000.0	15
Gas Platfo	Installation	110	Mar/11/2021	Jun/28/2021	47,200.0	
G1000	Install Drilling Platform Jacket	20	Mar/11/2021	Mar/30/2021	8,000.0	45
G1020	Install CPP Jacket	20	Mar/11/2021	Mar/30/2021	9,600.0	30
G1030	Install CPP Topsides	60	Apr/30/2021	Jun/28/2021	16,000.0	0
G1010	Install Drilling Topsides	25	Apr/30/2021	May/24/2021	13,600.0	15
Gas Platfo	HUC	120	Jun/29/2021	Oct/26/2021	64,000.0	
H1000	Hook UP and Commissioning for First Gas	120	Jun/29/2021	Oct/26/2021	64,000.0	0

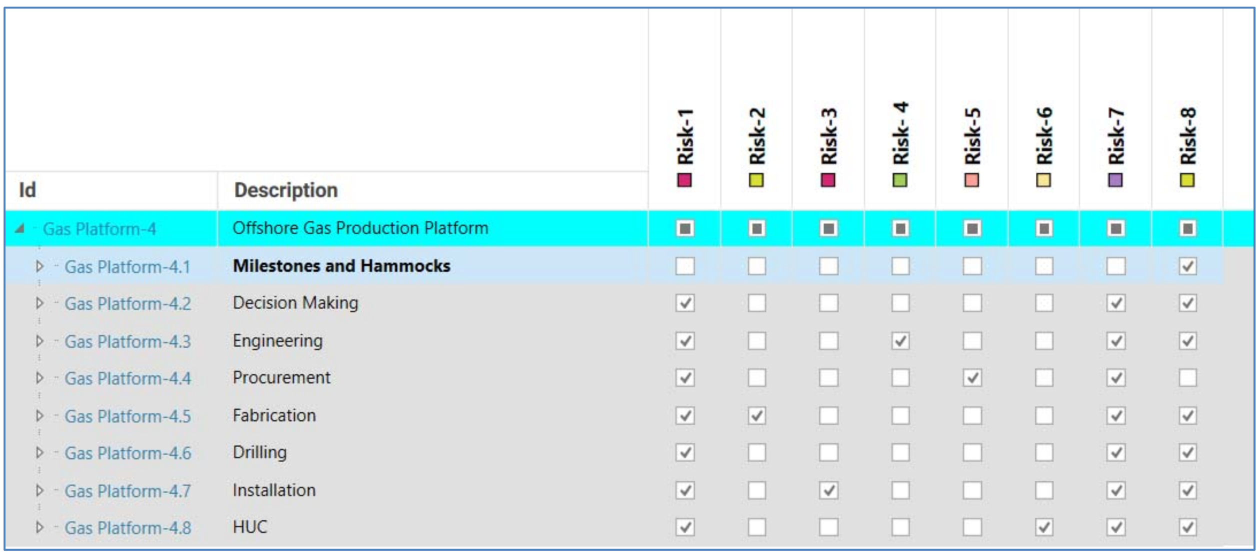
The risks can be identified and quantified with their estimated probability and impact, as shown below.



Project Risks

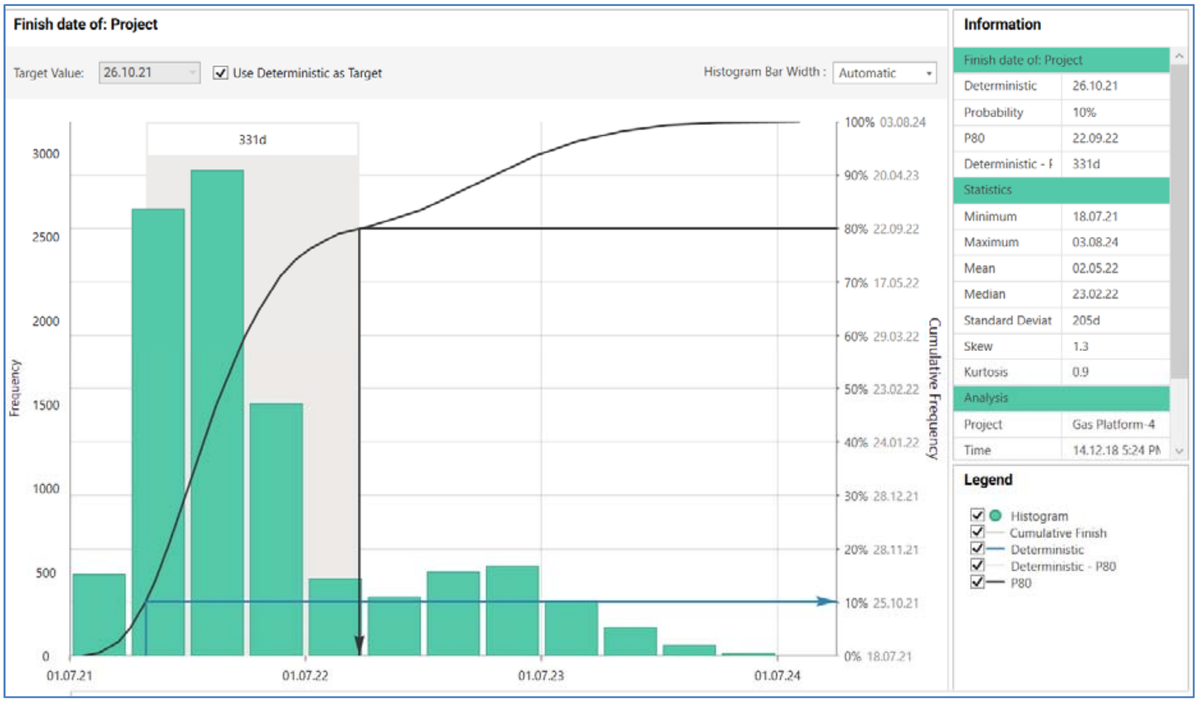
Name	Description	Risk Type	Probability	Color
Risk-1	Duration Uncertainty	Standard	100%	
Risk-2	Cost Uncertainty	Standard	100%	
Risk-3	Procurement Risk	Standard	80%	
Risk-4	Fabrication Risk	Standard	60%	
Risk-5	Installation Risk	Standard	85%	
Risk-6	Drilling Risk	Standard	50%	
Risk-7	HUC Risk	Standard	90%	
Risk-8	Engineering Risk	Standard	55%	
Risk-9	Systemic risk - complexity	Standard	25%	

The risks can then be applied to activities or groups of activities as shown.



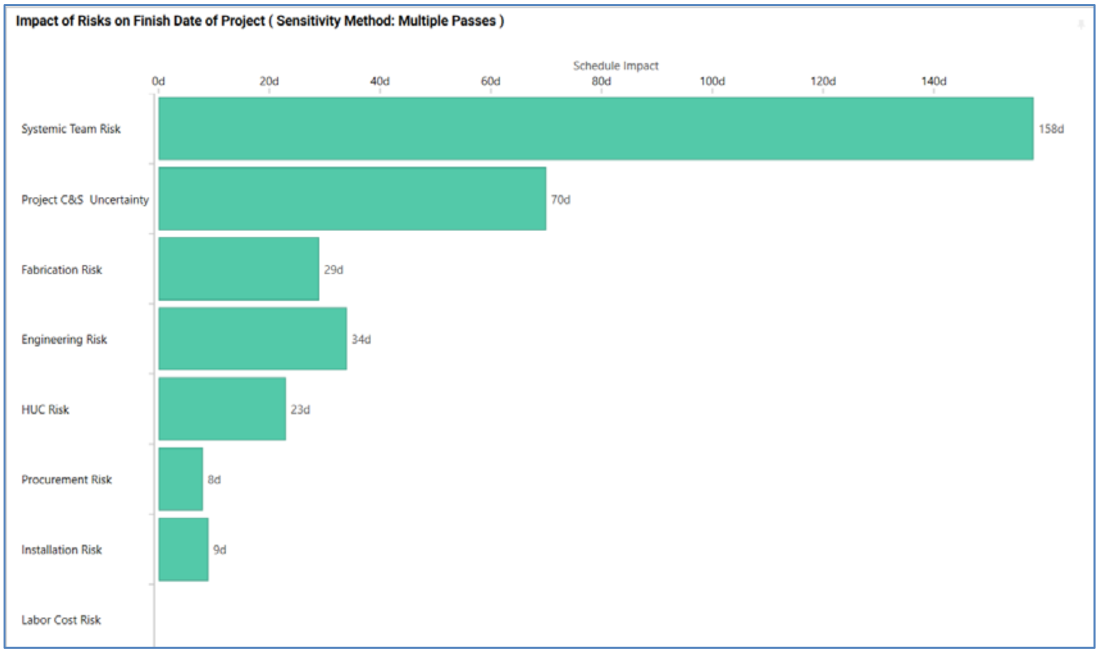
Id	Description	Risk-1	Risk-2	Risk-3	Risk- 4	Risk-5	Risk-6	Risk-7	Risk-8
Gas Platform-4	Offshore Gas Production Platform	■	■	■	■	■	■	■	■
Gas Platform-4.1	**Milestones and Hammocks**								✓
Gas Platform-4.2	Decision Making	✓						✓	✓
Gas Platform-4.3	Engineering	✓			✓			✓	✓
Gas Platform-4.4	Procurement	✓				✓		✓	
Gas Platform-4.5	Fabrication	✓	✓					✓	✓
Gas Platform-4.6	Drilling	✓						✓	✓
Gas Platform-4.7	Installation	✓		✓				✓	✓
Gas Platform-4.8	HUC	✓					✓	✓	✓

The Monte Carlo simulation produces a histogram and a cumulative distribution curve from which statistical results of the modeling can be derived. For instance, see the schedule risk results below.



In this case the results at P-80 show 331 calendar days until a date, September 22, 2022. There is an 80% likelihood of finishing on that date or earlier. It also shows that the deterministic date of October 26, 2021 is about 10% likely, pre-mitigated. In terms of percent overrun in this case study, from the 1,030 deterministic duration the P-80 adds 32% pre-mitigated. The bimodal distribution is at about 1,600 days or plus 55%, driven by the systemic risk hypothesized as a weak project team given the challenges of this project

Because the identified root cause risks (as well as background uncertainty) are driving the simulation they can be sorted out in priority order at the end of the pre-mitigated simulation results. The payoff for a risk analysis includes the opportunity to perform a risk mitigation workshop that develops specific mitigation actions to improve the probabilistic results for a post-mitigation scenario. The best way to prioritize the risks is with an iterative simulation approach that calculates the impact of each risk when it is fully mitigated to the desired level of certainty (e.g., P-80). The best purpose-built software tools have automated this job that would otherwise be quite time-consuming. An example of prioritizing using an iteration of simulations choosing the most impactful risks (and uncertainty) in terms of days saved if fully mitigated, measured at the P-80 level of confidence, is shown below.



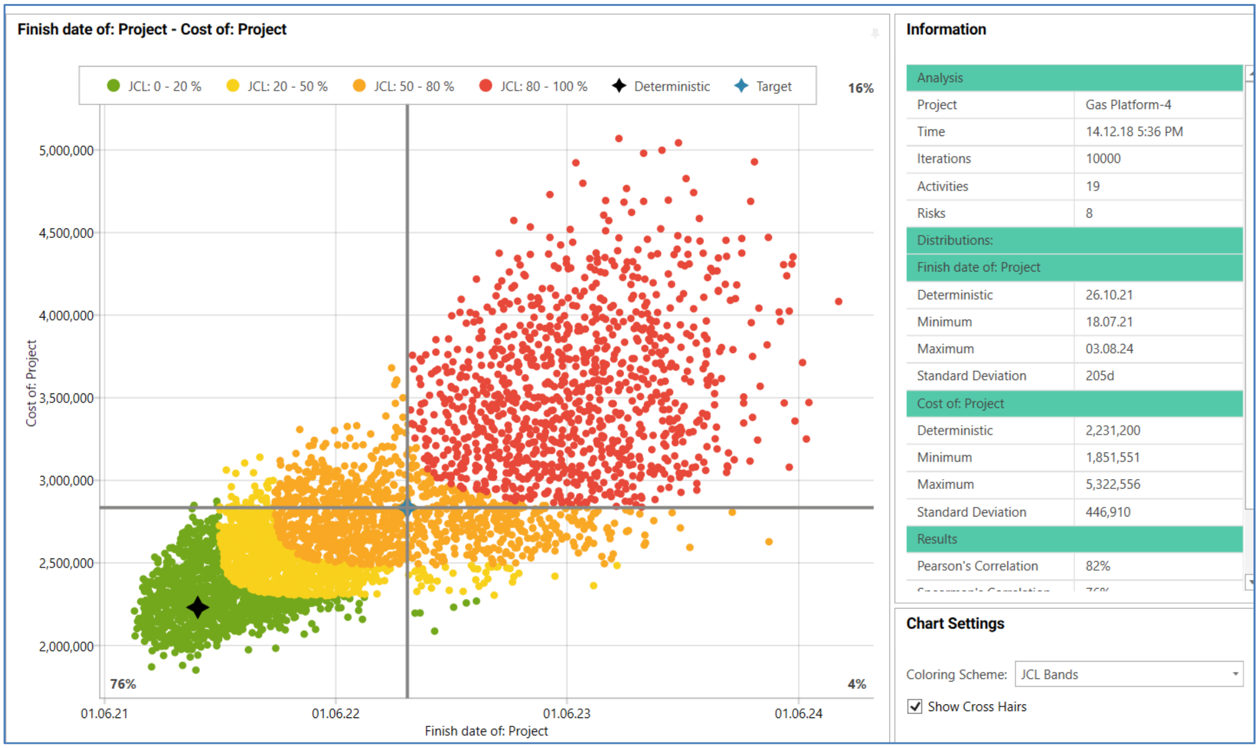
Level 5: Advanced Integrated Cost-Schedule Risk Analysis

This level of maturity represents the most comprehensive simulation-based risk analysis approach for project cost and schedule. All of the methods available and strengths performed at Level 4 are available at Level 5. What is missing is the cost connection. This refers to the impact of schedule duration of activities that are supported by labor and other labor-type resources such as rented equipment. To reflect this cost risk the resources must be distinguished by labor and material types. No further detail is needed for risk analysis, though this detail is not sufficient for resource management or detailed progress reporting.

In addition, the costs need to expressed free of contingency for risk. Typically cost estimates will have a contingency amount "below the line." That contingency should not be included in the scheduled at-completion cost to avoid double-counting, since the modeling and simulation will re-estimate the cost contingency. Schedules typically do not have contingency amounts of time added for risk, but if they do have them, these schedule contingency activities should be removed as well. Contingency embedded in the cost or duration estimates should be eliminated, if possible, also to avoid double-counting.

Both task-dependent and hammock (level of effort) activities' costs react this way. When the activity or the phase takes longer, it is logical that the labor-type resources will cost more. The assumption is that the cost of those resources may be proportionate to the increase in duration applied to the average daily expenditure ("burn") rate. This relationship between duration and cost implies that, for each iteration, the schedule finish and the total cost will be internally consistent, having been driven by uncertainty and those activities that occurred during that iteration.

There are other risks that occur to affect cost. Typical cost risks such as material cost or labor rate variability may affect cost even if the schedule is perfect. Also, the cost of material resources may vary, especially before procurement and construction contracts are signed. So, cost and schedule are not correlated 100% but are not independent either.



The integrated cost and schedule risk analysis is shown using the finish date and total project cost scatter diagram.

That diagram shows a color scheme following "JCL" bands. JCL stands for Joint Confidence Level, which is a name for integrated cost and schedule risk analysis results invented by the US National Aeronautical and Space Administration (NASA) and adopted for their larger projects (over $US 250 million) and at Key Decision Point (KDP) – C. There is some analysis of results that show that, since NASA adopted the JCL for their requests to US Congress, their ability to achieve the targets has improved.[11] This result does not mean that they are suddenly better project managers but that they are better at forecasting where their projects will end up. For large publicly-funded projects this improvement in accuracy of budget requests

[11] Bob Bitten, Bob Kellogg, Eric Mahr, Sarah Lang, Debra Emmons, "The Effect of Policy Changes on NASA Science Mission Cost & Schedule Growth," *NASA Cost and Schedule Symposium*, August 2018

The P-80 date and cost from the individual histogram are plotted with the cross-hairs, and show that they only provide a 76% likelihood of accomplishing both targets.

The correlation between time and cost is shown at 82%, which is fairly high, so to achieve an 80% probability of hitting both cost and schedule the adjustment to later date and higher cost will not be extreme.

In order to provide stakeholders with date and cost targets that can both be met with a desired level of confidence, a point on the scatter diagram with that level of confidence for both time and cost should be selected. In general, to the extent that time and cost are not perfectly correlated, the date will be later and the cost greater than those found in the simulation's histograms and cumulative distributions for time and cost alone.