Quantitative Schedule Risk Analysis – a valuable Risk Tool for a project team

By Gareth Byatt and John Owen

Introduction

This article is about Quantitative Schedule Risk Analysis (hereon referred to as QSRA) – what it is, why it can be a valuable Risk tool for project teams, and some tips on how to use it to contribute towards achieving successful project outcomes.

Projects are risky by nature

All projects involve taking risk and managing uncertainty – some more than others. Whether your project is to get man to Mars or something more down to earth, good risk management practices and tools help you to succeed with your project by working out how to take the right amount of risk and navigate the uncertainty that matters to your project team and your stakeholders. QSRA is a tool in your Risk toolkit to help you understand and manage schedule risk, as part of an integrated approach to managing project risk.

Many project factors give rise to uncertainty. From design change to scope creep, finance pressures to supply chain problems, and unexpected events being encountered – uncertainty is part and parcel of managing a project. Sometimes the uncertainty may give rise to an opportunity; many times, it leads to a problem that generate negative outcomes.

A common factor for many uncertainties is that, if they occur, they will affect your schedule as they usually incur a time impact, and they may impact the sequence and duration of many activities. What we want to achieve with a project schedule is a realistic and feasible plan of action, one that can be changed as the situation changes, whilst having the right amount of risk contingency built into it – not too much, and not too little. QSRA can help us to achieve this.

How QSRA can help us to manage project “time risk”

QSRA is a semi-quantitative tool that a project team can use to understand time risk in their project schedule. By understanding time risk with the help of QSRA, a team can decide what risks are tolerable and what risks needs to be managed with appropriate controls in place. Using the QSRA semi-quantitative approach, a mathematical model is applied to the schedule through an appropriate IT tool, which simulates how the project schedule could play out. The outputs of this risk analysis are a probabilistic risk-quantified schedule with calculated confidence factors to achieving activities, groups of activities and the schedule as a whole by their target dates. By reviewing this analysis, the project team can decide whether it should change parts of the schedule to lower or increase its risk level to an acceptable level of confidence in order to achieve the project delivery timelines.
Factors that influence schedule risk

Before we discuss methods to apply QSRA, it is worth considering some risk factors that are inherent to any schedule. Every project, no matter how similar it may be to previous projects that have been undertaken, has new elements to it which are subject to uncertainty. A project’s end date as calculated through its schedule is subject to variability and uncertainty. How much variability and uncertainty there is depends on a host of different factors. Here is a quick overview of seven “schedule risk factors” that are worth bearing in mind for any project schedule (independent of conducting QSRA):

1. **The most likely estimate of the duration of a schedule activity is probably too optimistic**
   We tend towards an optimistic outcome of an activity rather than a pessimistic one. Project team “can do attitude” and/or pressures to achieve targets create this optimism. Considering this optimism bias, the net effect of optimism multiplied across a schedule with many activities can be significant. This is not to suggest that we should build excessive contingency into activity durations, for this can lead to complacency and inefficient outcomes.

2. **When we estimate a “range of duration outcomes”, our estimate is usually too narrow**
   When we estimate the duration of activities in a schedule, it is good risk management to consider a range of durations (e.g. best, likely, worst duration) to achieving them. Our natural tendency towards optimism bias usually leads us to use a range of outcomes that are narrower than statistically the reality tends towards. In other words, we often omit outlier possibilities, when we should include them (with, albeit, a low likelihood of an outlier occurrence).

3. **Activities performed in parallel tend to take longer than we expect**
   We create project schedules to formulate the most efficient use of time. This often means sequencing multiple activities in parallel. When tasks are conducted in parallel, we often underestimate the effect that they all have on each other, in lengthening the duration of each one (or many).

4. **The more predecessors there are to an activity, the higher risk it has of starting on time**
   As the number of predecessors for a task increases, the likelihood of it starting on time diminishes. This effect is called the “merge bias”. Schedules with many activity linkages have a greater risk of achieving their completion dates. Accurately identifying and including all activity / activities in the schedule is essential.

5. **When we have a lot of “firsts” in a project, we tend to be over-optimistic about them**
   Every project has unique elements about it. Our inherent and in-built optimism bias means that we tend to veer towards the optimistic spectrum of outcomes, particularly when we do not have much experience about the activities we are to undertake.

6. **Uncertainties in activities are correlated (though you won’t always see it)**
   Activities often have factors in common with each other that affect the duration of each other yet are difficult to spot. A positive correlation means that, when one activity takes longer, others will too. A negative correlation means that, when one activity takes longer, others will take less time. The correlation of activities is often difficult to spot without mathematics, particularly on a large, complex schedule. For example, the risk of team member underperformance on several simultaneous or successor activities can affect many other activities.

7. **We do not always build in sufficient allowance for the possibility of “risk events” occurring**
   We look at ranges of duration outcomes, we develop project Risk Registers, yet the likelihood of significant risk events occurring is seldom linked to and modelled in a schedule. The effect on your project schedule of a “risk event” occurring can be modelled, but we don’t often do this. When “stuff happens” we sometimes go back to the drawing board and start again.
How QSRA can help us to understand, take and manage schedule risk

QSRA can help us to identify, analyse and evaluate the schedule risk that we face by applying statistical analysis to knowledge about schedule risks. By combining good team knowledge about the risks faced with statistical modelling, we can identify and evaluate what is, statistically speaking, most at risk, and most sensitive to change, in our schedule.

QSRA can help us with the following elements:

1. To seek out and understand sensitivity to risk in a project schedule
2. To assign a "confidence level" to schedule activity durations and completion dates
3. To make risk-informed decisions on schedule uncertainty and the impact of change (on design, scope, contingency, safety, reputation etc.)
4. To ensure our schedule is robust and realistic, commensurate to our risk tolerance

If you had a process and tool that allowed you to see new insights to potentially reduce the risk of volatility to your schedule, wouldn’t that be of value? As with other Risk tools, QSRA can help you take risk and potentially save time in your schedule as well as identify elements where schedule timing and durations are at risk of being exceeded.

Success factors for QSRA to be of value

For QSRA to be of value to the project team, the following factors must be in place:

1. There must be genuine buy-in to use QSRA from the project leadership team
2. Time must be allocated to undertake a quality and iterative QSRA process
3. People must have open minds to consider different viewpoints and perspectives
4. Ensure the QSRA is run by a trained and competent person
5. QSRA should be part of an integrated approach to managing project risk
The first factor, about obtaining buy-in from the project leadership team for QSRA, is critical. In order to have the buy-in from leaders, they need to see the value in it. QSRA must be discussed with them, before it is used, to ensure you have their support for it as a project risk tool, not a standalone activity that sits on the perimeter of project activities. Leaders need to be involved in reviewing outputs and recommendations after conducting QSRA. If you do not have project leadership support for QSRA and if it is not seen as an integrated part of managing the project, you will not maximise value from it and the four points below point 1 will not achieve maximum benefit.

Assuming you have project leadership support for QSRA, and that it is agreed as integrated into the project, you need to invite a broad range of people to the QSRA review. These people need to commit to the time required to hold a good quality and in-depth review of the project schedule. The QSRA review should be coordinated by an independent facilitator. This person could be from within your company or external—they may be working on the project, or they may be external to it. If they are external, it is important that they take the time to properly understand the project’s particular circumstances, and this means taking the time to liaise closely with the project team.

The culture of the project team is key to maximising the value of QSRA (as indeed it is for any type of risk management work). For example, having a willingness to “call out” risks, and to be open about reporting risks early (not when it is already too late), is an important determinant of how useful QSRA will be to the team.

A brief word on IT tools required for QSRA

Specific QSRA IT tools play a central role in conducting QSRA. These IT tools are built to read project schedule files from IT scheduling tools. Some QSRA IT tools are extensions to IT scheduling tools, others are stand-alone. This article is not about the different IT tools available. We advise that you do your research to determine the IT solution that fits your needs, or rely on your QSRA facilitator to conduct the activity with their QSRA IT tool.

A methodology for conducting QSRA

Assuming that the success factors are in place (leadership support, seen as part of project management, a good team culture, an independent facilitator et al), the starting point for conducting QSRA, prior to a QSRA workshop, is to review the project schedule logic, including running good practice schedule analytics on it, and that there is a sound understanding of the activities it is comprised of, and the “uncertainty that matters most” to these activities. This initial schedule review can be done as a precursor to the QSRA workshop.

Below is a high-level summary of one QSRA workshop method that you may find useful. Different approaches can be taken – find the one that works best for you and your project:
How long should you spend on a QSRA review?

The time commitment by a project team to spend on QSRA varies, depending on the nature of the project and the complexity and detail of the schedule. You might combine it as part of a broader independent project review. What usually takes the most amount of time in the QSRA process is the review of the schedule, agreement on the key activities to review, and agreement on the range of uncertainties and volatility of these key activities. If you have a very large schedule, with thousands of activities, it is unlikely to be worthwhile discreetly reviewing each activity. Instead, you may choose to focus on the activities, and groups of activities, that have the biggest potential impact. QSRA IT tools allow you to apply parameters to Work Breakdown Structure (WBS) packages of activities where the risk level for them all is similar, or to ignore them. Going through the process of setting up the “uncertainty” in the schedule model is a valuable review in itself, quite apart from the follow-up QSRA mathematical analysis that you perform with it.

The actual activity of running the mathematical QSRA simulation on the schedule, and the resulting outputs from it, should not take long to perform.

A QSRA output typically includes the following:

1. Review a risk-adjusted project schedule
2. Review which schedule activities have the biggest sensitivities and risks

A risk-adjusted project schedule, using an appropriate QSRA IT tool against the project schedule, can provide stakeholders with a view on activities and milestones that are most at risk and / or most volatile. It can show areas for opportunity to save time and money (whilst, if relevant, achieving good safety outcomes).

It could also show an alternate project cash flow, based on a “risk-adjusted schedule” that shows the current schedule together with risk-adjusted timings based on the model that you have created.
It is important to ensure that this risk-adjusted schedule is used for the right purposes. Execution of the project will continue to be to the original current schedule. A risk-adjusted schedule provides certain people with a view on whether changes may need to be considered to the current schedule.

Sensitivity analysis of top-ranked activities (often viewed in “Tornado charts”) allows us to evaluate:

1. Which activities have a large impact on others, should their durations / finish dates change
2. What is critical or near-critical, which may not align with a schedule critical path
3. Opportunities for schedule compression (i.e. save time + money whilst maintaining focus on other elements such as safety and quality)

Put your SQRA findings into a Report

As with any report, it is only worth producing if it is going to be read and considered for actions.

A typical report may cover the following elements:

1. Summary Findings & Recommendations
2. Introduction & Context
3. Analysis of the project schedule
4. QSRA overview & Risk-adjusted schedule (P90, P80, P50)
5. QSRA detail (per plot / segment / WBS group)
6. Conclusion
7. Appendices (including detailed analysis)
Using SQRA with Cost Risk Analysis

When a schedule has been produced with resource loading, a “Joint Confidence Level” or JCL can also be prepared through QSRA.

JCL = Joint Cost and Schedule Confidence Level

A JCL shows the probability that a given activity or project cost will be equal or less than the targeted cost AND the schedule will be equal or less than the targeted schedule date.

JCL is used in industries such as aerospace to review cost and time probability of success throughout the duration of a project. It can be a tool to evaluate whether the right level of cost and schedule risk is being taken.

In this example JCL scatter plot output, each dot represents a result from the simulation calculation (cost and schedule). The cross-hairs can be moved to a date and cost to obtain their joint confidence level.

Conclusion

Project teams need a project schedule that is realistic and feasible yet challenging, with the right amount of risk contingency built into it – not too much, and not too little. QSRA is a tool in your Risk toolkit to help you understand and manage schedule and cost risk, as part of an integrated approach to managing project risk.

By integrating QSRA into project activities, a project team can gain insights and information to help them decide which schedule risks to take, which ones to tolerate, and which ones to manage closely with the right controls in place. When QSRA is integrated into regular project activities, it
can help a project team to make good risk-informed decisions to manage uncertainty in an appropriate way.

In order for QSRA to be integrated into project activities and of value to a project team, it must be seen by project leaders as a tool that adds value. It will not be effective if it is seen as a standalone, ad hoc activity that is performed as an occasional or one-off “tick the box exercise”.

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