Qualitative and Quantitative Risk Analysis

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All projects have risks and uncertainties. In some cases, for example in most research and development project the effect of such risks and uncertainties can be very significant. However many managers still did not employ proper project risk management and analysis processes for their projects. In many cases they don't believe, that establishing and implementation of such process will be beneficial, since it is difficult to predict all potential risks and their affect of the project.

Here is a classic example. One of the Intaver Institute's clients, a large oil company, drilled a well with a total cost about $2M. The project schedule was created based on analogs: data from similar wells in the similar geological conditions. In the middle of drilling the well, the mud used to lubricate the drill, started to disappear. The onsite engineers tried several different solutions before a successful one was found. The delay was so significant, it virtually doubled the cost of the well. In a later review of the project, the project manager suggested that it would have been cheaper to abandon the well and drill on a new site, or not have selected the original location in the first place.. Unfortunately the company did not have well established project risk management process at this time. It the review it became obvious that there had only been a superficial analysis of the site, when what should be done was to properly analyze the project with risks and uncertainties and then continuously monitor and reassess risks (as required) during a course of the project.

To explain how a suitable risk management process would help, let us analyze some of the psychological issues related to estimations. . In 2002, Daniel Kahneman was awarded the Nobel Prize in economics "for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty." According to this theory, fundamental limitations in human mental processes cause people to employ various simplifying strategies or heuristics to ease the burden of mentally processing the information required to make judgments and decisions. During the project managers rely on heuristics or rules of thumb to make estimations and manage the project. Under many circumstances heuristics lead to predictably faulty judgments or cognitive biases.

One of such “rules of thumb” is availability heuristic. Decision makers assess the probability of an event by the ease with which instances or occurrences can be brought to mind. For example, project managers sometimes estimate the chance of risk occurrence based on similar tasks that have been previously completed. If they are making their judgment based on risks they remember, it can cause inaccurate estimation.

The anchoring heuristic refers to the human tendency to remain close to the initial estimate. For example, during brainstorming meeting engineers estimated the probability of a risk is 10%. During a further evaluation, they became anchored to that figure(10%) and eventually determined that it could have a range between 8 and 12 percent without really questioning whether or not the initial 10% estimate was in fact accurate.

Judgments concerning the probability of a scenario are influenced by amount and nature of details in the scenario in a way that is unrelated to the actual likelihood of the scenario. This is called the representativeness heuristic. For example the project has two potential risks. One of them is very well documented and the other has a very limited information. Because the first risk has more detail, people can better imagine it, and it may sometimes make them assume the probability of it occurring is higher than the second risk, which in reality may not be the case.

Decision makers can be exposed to many cognitive and motivational factors that can lead to biases in perceptions. This effect is often referred to as selective perception. For example, estimation of a task’s cost can be influenced by the intention to fit the task into the project’s budget. As a result, some of the project parameters may be underestimated. Another type of bias relates to management’s push for better project performance, which may cause project managers to underestimate the probability or impact of certain risks.

With so many potential pitfalls in decision-making, is there any way to mitigate these biases and increase the accuracy of estimates? While many project managers recognize this issue, project risk analysis and management is often either ignored or only given cursory attention.

Most uncertainties in project management are related to the lack of knowledge about the incoming activities and risk. To perform risk analysis on these so called epistemic uncertainties, there are two major strategies :

1. Capture all historical information for analysis and estimation.
2. Track project performance including information about risks and uncertainties; update estimates when new information about current project performance becomes available.

In reality, most projects have multiple risks and uncertainties that impact projects in many different ways. In these projects, the only feasible method to analyze and manage these risks is to use software tools.

Let’s see how qualitative risk analysis software can help to mitigate negative effect of heuristics and biases.

If all project risks and uncertainties are registered in a comprehensive database, this archive will help to mitigate the availability heuristics. Decision makers will be able to assess the probability of an event’s occurrence based upon a reliable dataset. In qualitative risk management software, each risk is accompanied by the set of standard

parameters: severity, impacts, mitigation plans, etc. This helps to minimize the representativeness heuristic as decisions will less likely to influenced by more detailed scenarios. If risks are properly registered and updated during the course of the project, it helps to mitigate negative impact of selective perception and management biases. Assessment of risks in future projects will performed using an objective analysis of risks in the current project. If risk assessment is performed based on objective recorded historical data, the "anchor" for decision making may never be set and therefore reduce negative impact of anchoring.

Sets of risks recorded and analyzed in qualitative risk management software can be a foundation of quantitative cost and schedule risk analysis . Quantitative risk analysis will help the manager to determine a chance, that project will be completed on time and within a budget, identify critical project parameters, which could impact the project schedule the most, determine project success rates, make a decision about viable project alternatives, etc. All these wonderful things can be meaningless, if they are not based on reliable set of historical data about risks and uncertainties. Moreover, such data must be updated during the course of project based on actual inputs. The absence of this process as part of the project risks management is referred to as "Garbage In – Garbage Out". Quantitative risk analysis will always be subject to the same heuristics and biases mentioned previously. The easiest solution is to link the data for quantitative analysis with the qualitative project risk management software. This type of integration is already available between some qualitative and quantitative risk management software tools.

Quantitative risk analysis software can statistically process data from qualitative tools. Most quantitative schedule risk analysis tools perform Monte Carlo simulations to determine how risks may affect a project schedule. One of the methods of modeling risks and uncertainties is called Event Chain Methodology. According to this methodology, an activities in projects are not a continuous uniform process. They can be affected by external events that transform the activity from one state to another. These events should be properly captured in qualitative risk management software. Events can cause other events, which will create the event chains, which will significantly affect the course of a project. The identification of the critical chain of events makes it possible to mitigate their negative affects.

Now if we go back to our original drilling example. If the oil company had qualitative risk analysis software and had recorded and stored all of their project data, they would have had access to a comprehensive historical archive upon which to perform their assessments and improve their decisions. Even if the decision was still to drill at the same location, if the engineers had a system of qualitative and quantitative risk management software it would have helped them to assess further courses of action and could save millions of dollars.