Quantitative Risk Analysis with Microsoft® Project

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Abstract

Quantitative Risk Analysis has become an important component of project management. Microsoft Project and particularly Microsoft Project Server implement qualitative risk analysis methodology. But what about quantitative analysis? Quantitative Risk Analysis gives the project manager ability to see how project schedule will be affected if certain risks are occur. As a result, project managers are able to mitigate risk factors and manage their projects better. Although Microsoft Project does not perform quantitative risk analysis by itself it can done using third party tools or add-ins.

Monte Carlo Simulation Tools

Monte Carlo simulations can be used to perform quantitate risk analysis of project schedules. Monte Carlo is a mathematical method used on risk analysis in many areas and is used to approximate the distribution of potential results based on probabilistic inputs. Each simulation is generated by randomly pulling a sample value for each input variable from its defined probability distribution, e.g. uniform, normal, lognormal, triangular, beta, etc. These input sample values are then used to calculate the results, i.e. total project duration, total project cost, project finish time. The inputs can be task duration, cost, start and finish time, etc. This procedure is then repeated until the probability distributions are sufficiently well represented to achieve the desired level of accuracy. They are used to calculate the critical path, slack values, etc. Monte Carlo simulations have been proven an effective methodology for the analysis of project schedule with uncertainties.

To use Monte Carlo simulations with Microsoft Project you need to have add-on tool. There are a number of such tools available on market including These software tools will help you find answer on the questions such as:

- What is the chance of your project being completed on schedule and within budget?
- What is the chance that the particular task will be on the critical path?
- What tasks affect the project duration at most?
- What is the project success rate?

Some Monte Carlo simulation tools can be access using toolbar (ribbon) in Microsoft Project (Figure 1). Using such toolbars you can assign statistical distributions to cost and duration, risk events, perform calculation and see results. Other tools can open Microsoft Project file (extension mpp). Some tools include both functionalities.

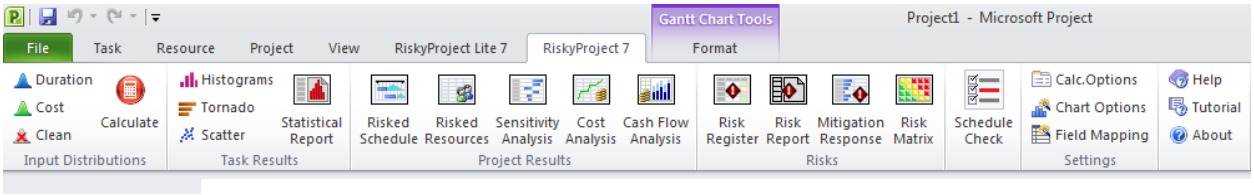

Figure 1. Toolbar for Project Risk Analysis in Microsoft Project (RiskyProject software by Intaver Institite Inc – www.intaver.com).

Monte Carlo Simulations Functionalities

Each Monte Simulation tool has its own specific functionalities; however, some features are common for all of them. First, all of these software allow the user to: assign different statistical distributions including custom distributions to project inputs (task duration, cost, etc.), perform Monte Carlo simulation, and output results in different formats. For example, you can use a frequency or cumulative probability charts or histograms to see the chance that the project will be completed within a given period of time (see Figure 2). You can calculate the criticality index or probability that a task lies on the critical tasks.

You can perform a sensitivity analysis or calculate how sensitive the project outputs (project duration, cost, risks, finish times, etc.) are to the uncertainties of the project inputs (task duration, finish time, etc.). Results of sensitivity analysis can be shown on a the chart, as in Figure 3. The tasks which are listed highest on the chart have the potential to affect project duration the most.

Monte Carlo simulation tools may offer features such as probabilistic or conditional branching. An example of probabilistic branching is when the user defines that there is 40% chance that task A will be successor of task B and 60% chance that task C will be successor of task B. An example of conditional branching is when the user defines that task A task will be followed by task B if task A duration is greater or less then a certain value.

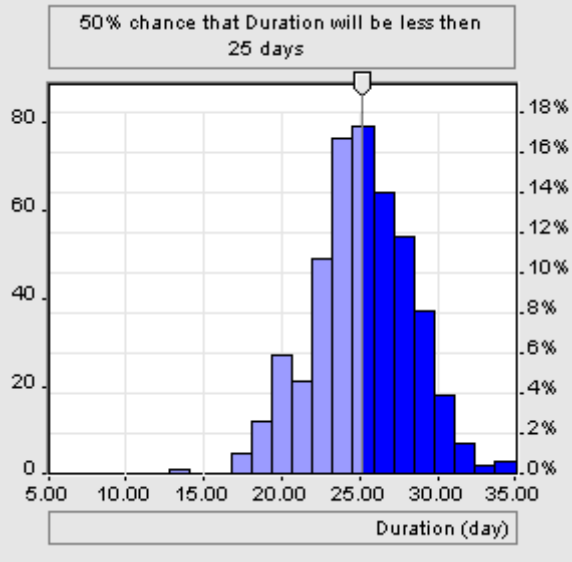

Figure 2: Frequency chart can be used to assess the chance that project will be completed within a given period of time

	Name	Sensitivity Chart	Coeffici...
1	Task Web site development		0.671
2	Task Web site content development		0.671
3	Task Writing information topics		0.652
4	Task Beta testing (by three selected clients)		0.558
5	Task Web Site Design		0.285
6	Task Web site layout and structure design		0.185
7	Task Evaluation and purchase of web site templates		0.171

Figure 3: Results of sensitivity analysis

The classic Monte Carlo simulation method has a number of limitations. Statistical distributions of project inputs such as task durations should be obtained based on reliable historical data and in many cases this data is available. For example, a project manager usually knows that particular construction job will task between 1 and 3 days and can be defined by normal distribution. However, in some cases, especially for research and development projects, this information is not available and using Monte Carlo simulation may not improve your estimations. It is also very important to constantly track your project performance and update input data and associated distributions using performance measurement data. Another problem associated with Monte Carlo simulations is that, if a project slips, project managers usually perform certain actions. It is difficult to define and forecast the management response within a Monte Carlo simulation method.

To overcome these and other challenges Event Chain Methodology has been developed as an extension of the classic Monte Carlo simulation method. Project uncertainties can be defined as a

set of risks or probabilistic events (risk lists), which can be assigned to tasks, resources, or project schedule. Such events can occur at the middle of the task and can lead to task delay, restart, cancellation, etc. Events can cause other events and generate event chains. Result of analysis – risk adjusted project schedule or project schedule generated as a result of Monte Carlo risk analysis (Figure 4). Most risk analysis tools allow bringing risk adjusted schedules back to Microsoft Project, so it can be managed in Microsoft Project. Project managers can monitor risk events, determine the critical risks - which affect project schedules the most - and mitigate them.

Event Chain Methodology allows you to perform Quantitative Risk Analysis by combining project schedule and risk lists.

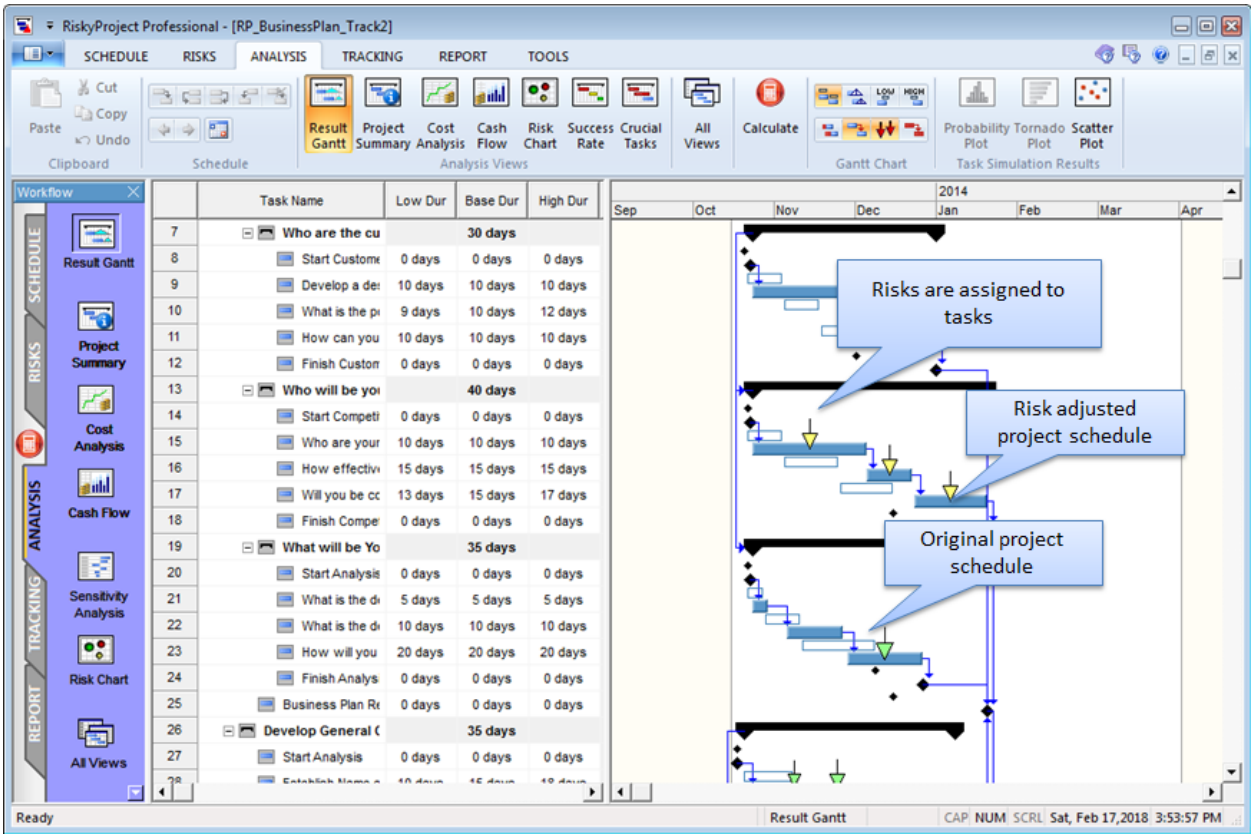

Figure 4. Risk adjusted project schedule with risks assigned to the tasks.

Project Risk Analysis in Microsoft Project Server

Project risk analysis for schedules for Microsoft Project Server is performed similarly to schedules in Microsoft Project client. Most add-ins can read schedules from Project Server and perform Monte Carlo simulations. Microsoft Project Server has list of risks, which can be used by add0ins to perform risk analysis with events or event chains.

Some risk analysis tools support multiple projects, which can be taken from Microsoft Project Server. In this case it is possible to rank project based on their risk exposure calculated as of Monte Carlo simulations (Figure 5). The result of analysis can be presented as risk chart:

- A horizontal axis is a risk exposure. It can be expressed as standard deviation, P10, P90, etc. of project duration or cost
- A vertical axis is a project duration or cost
- Size of the circle represents cost if vertical axis is duration and duration if vertical axis is cost.

Risk in project which higher risk exposure must be mitigated first.

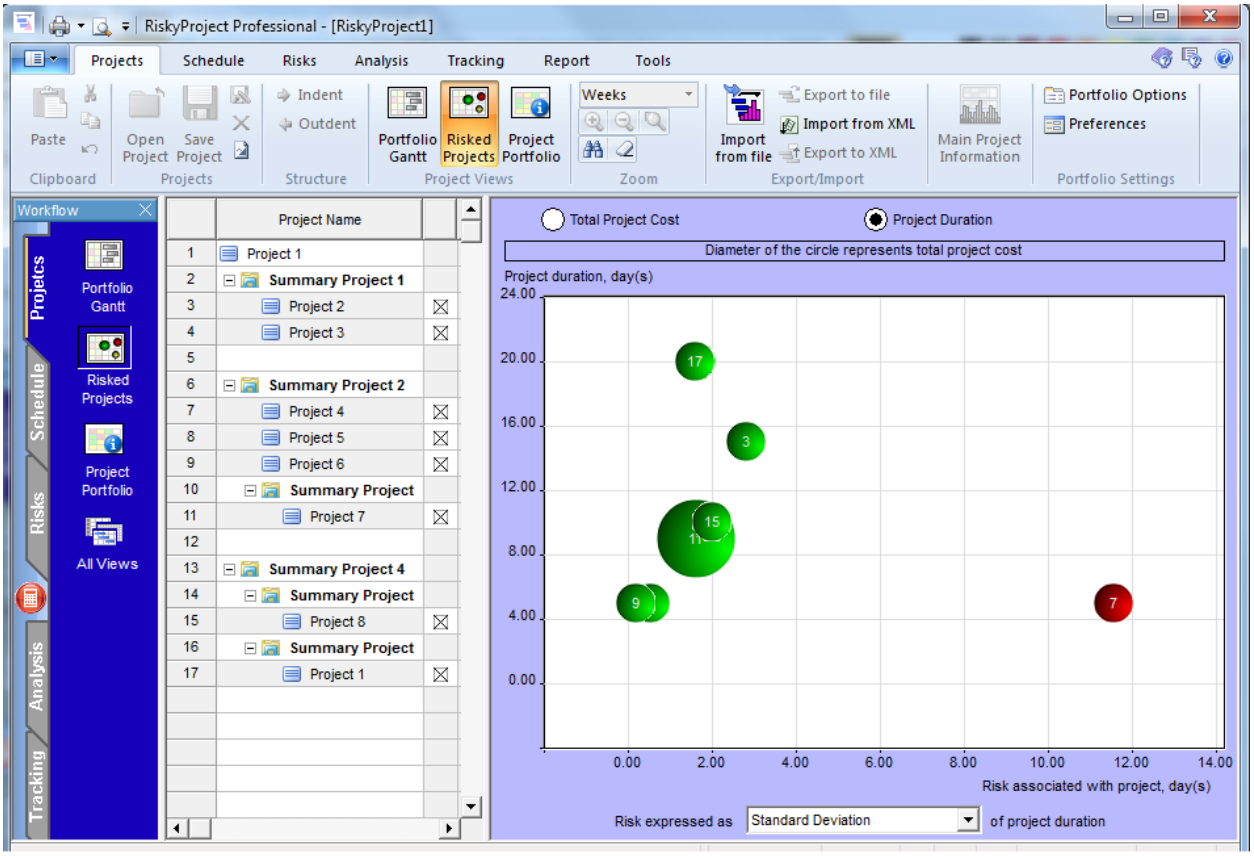

Figure 5. Ranking projects in the project portfolio obtained in Microsoft Project Server

You do not need to be a statistician to use Monte Carlo simulation tools with Microsoft Project. They are designed for project managers who want to bring the power of Quantitative Risk Analysis to the project. Project managers are successfully using such tools in different industries for years.