Quantitative Methods in Project Management

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Intaver Institute Inc.
Calgary, Canada
• How to estimate project duration or cost?
• What are the most critical risks and how to mitigate them?
• How to measure project performance?
• How to make an informed decision about future course of the project?
• How to select an a balanced project portfolio?
Solution: Quantitative Methods in Project Management

- Project Risk Analysis
- Quantitative Decision Analysis
- Risk-driven portfolio management and optimization
- Project performance measurement
So far actual use of quantitative methods in project management remains limited

Why?

1. Many project manager don’t believe in benefits of quantitative methods

2. Most methods and tools remain relatively complex and require special training
What about other industries?
Quantitative Methods in Oil and Gas Industry

• Managing of uncertainties in exploration and production
• Evaluation of oil and gas reserves
• Capital planning

Companies which established advance risk and decision analysis process usually perform better
Quantitative Methods in the Pharmaceutical Industry

- Project Decision Analysis
- Risk-driven portfolio management
Quantitative Methods in Financial and Insurance Industries

- Calculation of insurance rates
- Quantitative analysis of financial performance
- Analysis of stock prices
Why project managers don’t believe in benefits of quantitative analysis?

- Decision and risk analysis, portfolio management and optimization, project performance measurement
- Mathematical and statistical component
- Psychological component
Heuristics and Biases in Project Management

The Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel 2002

Daniel Kahneman

for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty

Decision makers use “heuristics”, or general rules of thumb, to arrive at their judgments.

In certain instances, this will lead to systemic biases.
Some examples of heuristics in project management

- **Representativeness** – unwanted appeal to detailed scenarios
- **Availability** – access the probability of an event by the ease with which instances can be brought to mind.
- **Anchoring** – human tendency is to remain close to the initial estimate
Garbage In/Garbage Out: Project managers know it

Uncertain input data

Advanced analytical tools

Useless results of analysis

Solutions:
1. Perform analysis based on reliable historical data
2. Track project performance and constantly refine data
Quantitative Methods in Project Management are not trivial

• How to perform the analysis?
• How to interpret results?

Hypothetical Example:

Consider a report that there is *little chance* of a terrorist attack against the American Embassy in Cairo *at this time*. What is the Ambassador’s choice?

*Source:* Psychology of Intelligence Analysis by Richards J. Heuer, Jr.
Solution: Use Modern Tools for Quantitative Analysis

• Easy to define data without advance knowledge of probability and statistics
• Easy to interpret charts and diagrams
• Interface with standard project management software
Project Risk Analysis

- Create project schedule
- Define project uncertainties
- Perform Monte Carlo Simulations
- Analyze results

Types of Uncertainties:

- Duration
- Cost
- Start and Finish Times
- Lags
- Rates and Resource Allocation
- WBS itself (conditional and probabilistic branching)
Project Schedule with Uncertainties

Uncertainties are defined by statistical distributions

The software calculates ranges of output results, e.g. task finish times
### Critical and Crucial Tasks

**Critical Indices:**
Determine when a task fails in a critical path during the simulation.

**Crucial Task:**
Duration or cost of this tasks affect duration and cost of the project the most.

<table>
<thead>
<tr>
<th>Task name</th>
<th>Sens. Dur</th>
<th>Sens. Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Site Design</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Web site layout and structure</td>
<td>0.282</td>
<td>0.355</td>
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<tr>
<td>Database design</td>
<td>0.000</td>
<td>0.187</td>
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<tr>
<td>Evaluation and purchase of software</td>
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<td>0.506</td>
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<td>Web site development</td>
<td>0.000</td>
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<tr>
<td>Web site content development</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>Writing information topics</td>
<td>0.627</td>
<td>0.725</td>
</tr>
<tr>
<td>Graphic Design</td>
<td>0.172</td>
<td>0.300</td>
</tr>
<tr>
<td>Combine graphic design assessments</td>
<td>0.237</td>
<td>0.290</td>
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<tr>
<td>Other tasks</td>
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<td>0.000</td>
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<tr>
<td>Critical path</td>
<td>0.298</td>
<td>0.218</td>
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Sensitivity Analysis

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<tr>
<th>Name</th>
<th>Task ID</th>
<th>Type</th>
<th>Sensitivity Chart</th>
<th>Coeff...</th>
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</thead>
<tbody>
<tr>
<td>Task: Writing information topics</td>
<td>9</td>
<td>Duration</td>
<td></td>
<td>0.627</td>
</tr>
<tr>
<td>Task: Beta testing (by three selected clients)</td>
<td>18</td>
<td>Duration</td>
<td></td>
<td>0.602</td>
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<tr>
<td>Task: Administration tool for customer support</td>
<td>15</td>
<td>Duration</td>
<td></td>
<td>0.334</td>
</tr>
<tr>
<td>Task: Development of customer support input for</td>
<td>14</td>
<td>Duration</td>
<td></td>
<td>0.312</td>
</tr>
<tr>
<td>Task: Evaluation and purchase of web site template</td>
<td>5</td>
<td>Duration</td>
<td></td>
<td>0.307</td>
</tr>
<tr>
<td>Task: Final evaluation and testing (internally)</td>
<td>17</td>
<td>Duration</td>
<td></td>
<td>0.283</td>
</tr>
<tr>
<td>Task: Web site layout and structure design</td>
<td>3</td>
<td>Duration</td>
<td></td>
<td>0.282</td>
</tr>
<tr>
<td>Task: Combine graphic design and information to</td>
<td>11</td>
<td>Duration</td>
<td></td>
<td>0.237</td>
</tr>
<tr>
<td>Task: Web site launch</td>
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<td>Duration</td>
<td></td>
<td>0.185</td>
</tr>
<tr>
<td>Task: Graphic Design</td>
<td>10</td>
<td>Duration</td>
<td></td>
<td>0.172</td>
</tr>
</tbody>
</table>

Determines which input variables (task duration, cost, success rate, lag, etc.) have biggest impact on output (e.g. project duration or cost)
Event Chain Methodology

Many project uncertainties are event driven.

Event Chain Methodology is a method of modeling uncertainties for different time-related business and technological processes.
### Main Principles of Event Chain Methodology

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>1</strong></td>
<td>An activity (task) in the most real-life processes is not a continuous uniform procedure. It is affected by the external <strong>events</strong> (risks), which transform an activity from one <strong>state</strong> to another.</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>The events can cause other events, which will create the <strong>event chains</strong>. These event chains will significantly affect the course of the process.</td>
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<tr>
<td><strong>3</strong></td>
<td>Once events and event chains are defined, <strong>quantitative analysis</strong> using known methods will be performed to determine uncertainties in the process, as well as quantify the cumulative impact of the events.</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>Event chains, which affect the process at most, are the <strong>critical chains of events</strong>. The identification of the critical chain of events makes it possible to mitigate their negative effects.</td>
</tr>
<tr>
<td><strong>5</strong></td>
<td>Probabilities and impact of the events are obtained from the historical data. The monitoring of the activity's progress ensures the analysis performed based on updated information.</td>
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<tr>
<td><strong>6</strong></td>
<td>Visualization of events and event chains using <strong>Event Chain Diagrams</strong> simplifies modeling and analysis of risks and uncertainties.</td>
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Risk-Driven Performance Measurement:

Tracking and forecasting of project performance with risks and uncertainties
# Performance Measurement Issues

**Problem 1:**
Original estimate of an activity’s duration based on historical data is 10 days.

50% of work is completed in 8 days.

**Question:**
What is the forecasted duration?

**Problem 2:**
Original estimate of an activity’s duration is done based on probability of a risk equal 15%.

So far, 50% of the activity is completed, but the risk has already occurred two times.

**Question:**
What is the forecasted duration?

**Solution:**
Combined statistical analysis of historical data and project performance measurement.
Project Estimation Methods

There is no single method that applies to all projects.

**Top-down** value judgments from the business side of the project balance sheet

**Similar-to** judgments from either side of project balance sheet, but most often from the business side

**Bottom-up** facts-driven estimates of actual work effort from the project side

**Parametric** calculations from the cost-history model.

Parametric Model Examples: COCOMO, SEER_SEM (software), PACES 2001 (construction), Price H (Hardware)
This scenario has minimum cost

Select project alternatives based on certain criteria such as minimum cost, minimum duration.

Decision tree node is an activity
Quantitative Methods in Project Portfolio Management

Three core areas:

- **Time Management**: manages deliverable activity timelines and deadlines for projects, tasks, and assignment

- **Resource Management**: manages allocation of available personnel, enables resource leveling

- **Cost Management**: track costs and facilitates chargeback or billing of project expenses
Quantitative Methods in Project Portfolio Management

Other areas:

- **Scope Management** – requirement planning, tracking proposals, estimation
- **Procurement Management** – procurement of external resources and project related goods
- **Communication Management** – document-handling and tracking system
- **Risk Management** – quantitative risk analysis
- **Quality management** – project efficiency measurement and metrics
- **Integration management**: dashboard tools to provide business intelligence
Risk Driven Portfolio Management

Project Portfolio Efficient Frontier:

- Project within a portfolio.
- Risk associated with the particular project.
Decision Analysis Tools

- Precision Tree by Palisade
- DPL by Syncopation Software
- Decision Pro by Vanguard Software
- TreeAge by TreeAge software
Portfolio Management Tools

Leaders:

- Primavera Portfolio Management
- Clarity by Niku (www.niku.com)
- Compuware (ChangePoint) (www.changepoint.com)
- IBM Rational Portfolio Manager
- PlanView (www.planview.com)
- Mercury (www.mercury.com)

Source: Gartner Magic Quadrant for IT Project and Portfolio Management 2005
Portfolio Management Tools

- Oracle Projects
- SAP xRPM
- MS Project ERM Solution
- Lawson Software (www.lawson.com)
- Pacific Edge (www.pacificedge.com)
- ProSight (www.prosight.com)
- Sciforma (www.sciforma.com)
- Artemis International (www.aisc.com)
- Metier (www.metier.com)
- Atlantic Global (www.atlantic-global.net)
- Instantis (www.instantis.com)
- Planisware (www.planisware.com)
- Augeo Software (www.augeo.com)
- UMT (www.umt.com)
Portfolio Management Tools

- Expert Choice (www.expertchoice.com)
- Welcom Portfolio Management (www.welcom.com)
- Tenrox (www.tenrox.com)
- eProject (www.eproject.com)
- Genius Inside (www.geniusinside.com)
- Epicor (www.epicor.com)
- ITM Software (www.itm-software.com)
- eRealize.net (www.erealize.net)
- Automation Centre (www.acentre.com)
Does Quantitative Analysis Brings Real Benefits?

YES, but in two conditions:

1. Quantitative analysis should be part of repeatable project management process within an organization

2. Quantitative analysis should be based on reliable historical or actual data