Risk Analysis and Management for Projects

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Looking ahead

• “We may daily observe that no strange accident doth at any time happen, but it is by some means foreshowed or foretold.”

- John Hayward, *The Life and Raigne of King Henry IIII*, published in 1599
Actuaries and Civil Engineers

• How co-operation came about
• Voluntarily working together
• Synergies – both are engineers
• Terminology differences, however
• Publication of RAMP in 1998, 2002, 2005
• STRATrisk Guide 2006
• Work on operational risk, 2008
• Now working towards ERM
This talk

• What we mean by “risk” and “uncertainty”
• What is RAMP?
• How does RAMP work?
• Risks in large infrastructure projects
• Uses for RAMP
Risk and Uncertainty

• Risk – possibility of outcomes different from expected (threats and opportunities), allowing for uncertainty

• Uncertainty – lack of sufficient knowledge about risk - includes:
  – Unknown threats and opportunities which may emerge
  – Hidden connections and interactions between risks
  – The possibility that outcomes now perceived as threats may turn out to be opportunities, and vice versa
  – The possibility that the probability or impact of some risks may turn out to be very much greater than currently perceived
  – Unexpected human reactions

• Enterprise Risk
  – Strategic (big risks)
  – Project (risks in change projects)
  – Operational (“business as usual” risks)
Components of Enterprise Risk

- Strategic risk
- Project risk
- Operational risk
Project risks

How they can be managed
What is RAMP?

- A framework for managing project risks and uncertainty
- It attaches financial values to risk
- It assists in making choices about competing projects
- It helps when deciding whether to spend money on risk mitigation
- From the outset RAMP considers risks throughout project lifetime
- Disaster risks are highlighted - not buried in a model
- Focuses attention on need for special care at planning/design stage
- Recommended by HM Treasury and senior management of OGC
Summary of RAMP

- Covers both threats and opportunities

- Methodology – iterative process, risk identification, analysis, responses, residual risks, decision processes, follow through to risk control.

- Used with financial models to provide range of possible NPV outcomes for different scenarios

- Looks at underlying causes of risk

- Considers uncertainty, not just foreseeable risks

- Considers whether to spend money on risk mitigation

- Focuses on assumptions and bias as sources of risk
An Approach to Uncertainty Management

1. Assess what we think we know already.
2. Assess what we know we don't know and fill the gaps at least partly.
3. Assess fuzziness and gather further data to reduce it.
4. Identify additional areas of knowledge which MAY be relevant, analyse them, and gather further information in those areas which ARE relevant.
5. (Step 5)
6. Assess the residual uncertainty, design risk-efficient responses to it, and make the business more robust and flexible.
7. Keep uncertainty under review and continually seek new knowledge.
Concept mapping – a tool for spotting risky areas

Objective: make a profit of 10% on capital employed

- Few passengers
  - Competitors reduce fares
  - Buses often late or cancelled
  - Unpredictable traffic congestion

- Serious accident
  - Poor customer service
  - Poor quality of staff
  - Poor maintenance of buses

- High costs
  - Wage rises above expectations
  - Fuel price rises
  - Some staff need to be replaced
Causes of bias in appraisals

- Insufficient care
- Key risks omitted, accidentally or deliberately
- Risk independence wrongly assumed
- Inadequate past experience of disasters
- Cashflows guessed
- Insufficient attention to economic cycle
- New technology risks understated
- Credit taken for benefits which would have been received anyway
- Insufficient account taken of effect on other activities
- Wrong assumptions
- Arithmetical mistakes
Use of RAMP for decisions

- To proceed or not? And which project?
- Identify residual risks after risk responses
- Use investment model to generate probability distribution of NPVs
- Do sensitivity testing
- Add in the assumption risks
- Consider uncertainty, flexibility, bias and political factors. Add intuition.
- Decide
Valuing risk financially

• A 10% chance that the project site will flood, costing £100,000

• Is it worth spending an extra £5,000 to mitigate this risk?

• Would it be worth spending £12,000?

• Or £18,000?
Risk Mitigation Example

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flow £000s</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>-1000</td>
</tr>
<tr>
<td>2</td>
<td>+300</td>
</tr>
<tr>
<td>3</td>
<td>+400</td>
</tr>
<tr>
<td>4</td>
<td>+400</td>
</tr>
<tr>
<td>5</td>
<td>+400</td>
</tr>
<tr>
<td>Total</td>
<td>+500</td>
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</table>
## Scenario analysis

<table>
<thead>
<tr>
<th>Scen</th>
<th>Event</th>
<th>Prob</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>None</td>
<td>55%</td>
<td>None</td>
</tr>
<tr>
<td>B</td>
<td>Know-how</td>
<td>10%</td>
<td>+£200k yr2</td>
</tr>
<tr>
<td>C</td>
<td>Delay</td>
<td>15%</td>
<td>Extra year</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-£300k</td>
</tr>
<tr>
<td>D</td>
<td>Faults</td>
<td>10%</td>
<td>-£100k p.a.</td>
</tr>
<tr>
<td>E</td>
<td>C+D</td>
<td>10%</td>
<td>As in C+D</td>
</tr>
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</table>
# Effects of scenarios

<table>
<thead>
<tr>
<th>Scen</th>
<th>Net flow</th>
<th>NPV</th>
<th>Prob</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>500</td>
<td>292</td>
<td>55%</td>
</tr>
<tr>
<td>B</td>
<td>700</td>
<td>481</td>
<td>10%</td>
</tr>
<tr>
<td>C</td>
<td>200</td>
<td>-64</td>
<td>15%</td>
</tr>
<tr>
<td>D</td>
<td>100</td>
<td>-54</td>
<td>10%</td>
</tr>
<tr>
<td>E</td>
<td>-200</td>
<td>-391</td>
<td>10%</td>
</tr>
</tbody>
</table>

Weighted average NPV = £155,000
Risk mitigation

• Contractors will bear the whole cost of extra development costs (as in scenarios C and E) provided contract price increased by £80,000. Should we agree?
Effects of risk mitigation

<table>
<thead>
<tr>
<th>Scen</th>
<th>Net flow (£000)</th>
<th>NPV (£000)</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>420</td>
<td>212</td>
<td>55%</td>
</tr>
<tr>
<td>B</td>
<td>620</td>
<td>401</td>
<td>10%</td>
</tr>
<tr>
<td>C</td>
<td>420</td>
<td>139</td>
<td>15%</td>
</tr>
<tr>
<td>D</td>
<td>20</td>
<td>-134</td>
<td>10%</td>
</tr>
<tr>
<td>E</td>
<td>20</td>
<td>-188</td>
<td>10%</td>
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Weighted average NPV = £145,000

Lower average NPV but reduced risk of a very big loss
Ten tips for project success

• Get full understanding of objectives of all key stakeholders
• Define project’s scope, objectives and success criteria thoroughly
• Make design as flexible as possible, involving ultimate users
• Identify and analyse all significant threats and opportunities and plan responses
• Prepare high-quality appraisal, avoiding bias
• Establish good risk-governance and communication system for project
• Draw up project plan and ensure sufficient resources
• Develop contingency plans
• Have a good change control process with cut-off date
• Ensure sufficient funding in place for completion of construction
A framework for assessing large infrastructure projects taking account of social and environmental risks
Multiple Stakeholders and S&E factors

- Infrastructure projects are associated with a wide range of social and environmental factors + associated risks affecting multiple stakeholders

- Challenge is to identify and engage with broad range of stakeholders

- Definitions of S&E factors will vary with stakeholder and are in constant flux

- Must draw out range of stakeholder interests and values, who values what and how much?
Examples of social/environmental risks

• Woodland destruction benefits owner in cash terms, but locals see it as priceless asset (but under valued so can be exchanged for community centre)

• Water quality deterioration unknown by local community

• Objections might cause re-routing at late stage

• While people in some areas may benefit, others may lose

• Small probability risks but big consequences – nuclear, oil-well leak, dam burst, chemical explosion, flooding underground railway
Multiple Criteria Analysis

- MCA considers all factors and risks, both monetary and non-monetary
- Prioritises good stakeholder management
- Enables objectives, concerns, values and priorities of all stakeholders to be reconciled as far as possible in a transparent way
- Leads to optimisation of project-design and planned risk-management
- Provides framework for project monitoring and evaluation
- Includes cost-benefit analyses
Conclusion

- RAMP - a useful tool for project managers and sponsors
- Civil Engineers played a key role in developing it
- Actuaries can help with financial modelling etc
- Placing financial values on risk helps in making decisions, e.g. which project to choose and whether to mitigate risk
- For large infrastructure projects RAMP can be used within a Multi-Criteria Framework
- RAMP is all about methodically thinking through the project and its context – looking ahead and considering achievement of benefits as well as delivery within time and budget