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InfrastructureRisks

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An early recognition of the need for risk analysis?

- "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

This talk

- Investment risks
- Actuaries and civil engineers
- Front-end thinking – infrastructure
- What we mean by “risk” and “uncertainty”
- Managing uncertainty
- RAMP and managing project risks
- Causes of bias in appraisals
- Checklist for investors
- Conclusion

Investment risks

- Construction – design, contractor, materials, etc
- Post-construction faults
- Forecasts of net revenues
- Social changes and political problems
- Gearing issues
- Credit deterioration
- Natural disasters, flooding, war, terrorism
- Premature obsolescence

Examples of social/environmental risks

- Woodland destruction benefits owner in cash terms, but locals see it as priceless asset
- 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
- New road might increase pollutants for local residents or globally
- Climate change might shorten life of infrastructure
- Small probability risks – nuclear, oil-well leak, dam burst, chemical explosion, flooding underground railway – big consequences

Actuaries and Civil Engineers

- How co-operation came about
- Synergies – both are engineers, though terminology differences
- Publication of RAMP in 1998, 2005, 2014
- STRATrisk Guide 2006
- Work on operational risk, 2008
- Front-end thinking Guide, 2017
- Avoiding another Grenfell Tower, 2017

Front-end thinking for infrastructure projects

- What is it?

London Olympics 2012 – an example of success

- Clear objectives
- Good organisation and leadership
- Stakeholder involvement
- Much thought about complex details and requirements for smooth operation
- Effective risk mitigation and control

Result – delivered to time and budget, and anticipated benefits fulfilled or exceeded

Examples of failure (continued)

- SNCF’s new trains
- Port Elizabeth bus rapid transport system
- Denver automated baggage handling system
- Flint Michigan water supply

Examples of failure (continued)

- The *Titanic*
- Government computer schemes
- Fukushima
- Scottish Parliament building
- Edinburgh trams

- Deeper thought at outset might have avoided some of the failures

Issues in front-end thinking

- First thoughts
- Clarifying the Purpose
- Understanding the project context

- Deciding on governance
- Choosing methods of appraisal
- Designing the project development process

- Exploring alternative projects
- Developing the favoured project further

- Making key decisions

First thoughts about a project

Clarifying the Purpose

- Intended impacts – which wider policies would be assisted?
- Core purpose – what services, problems, opportunities? Is infrastructure needed at all? What will constitute success?
- Sponsor – who? If joint, how can problems be avoided? Competence?
- Stakeholders – who? What objectives and agendas? Involvement?
- Risk tolerances – how tolerant are sponsor and stakeholders of significant risks, e.g. delays, cost over-runs, low demand?
- Constraints – affordability, other projects, political aspects, resources?
- Government requirements – what are they and how can we comply?

Understanding the context

- Background – existing Plans and role of project within them? Relevant existing studies? Environmental context? Other relevant projects? Future projects?
- Project objectives? – benefits, costs, success criteria? Integration?
- Beneficiaries – who are they, and what benefits would they gain?
- Resources of money, labour, materials – who decides (and how?). Funding?
- Key assumptions – population, employment, incomes, economic prospects?
- Uncertainties – What are they? How can they be reduced?
- Lessons from the past ?
- Complementary needs?

Governance

Need for a framework – a link between:

- Management and leadership
- Assessments and decisions
- Information and wisdom

Some components –

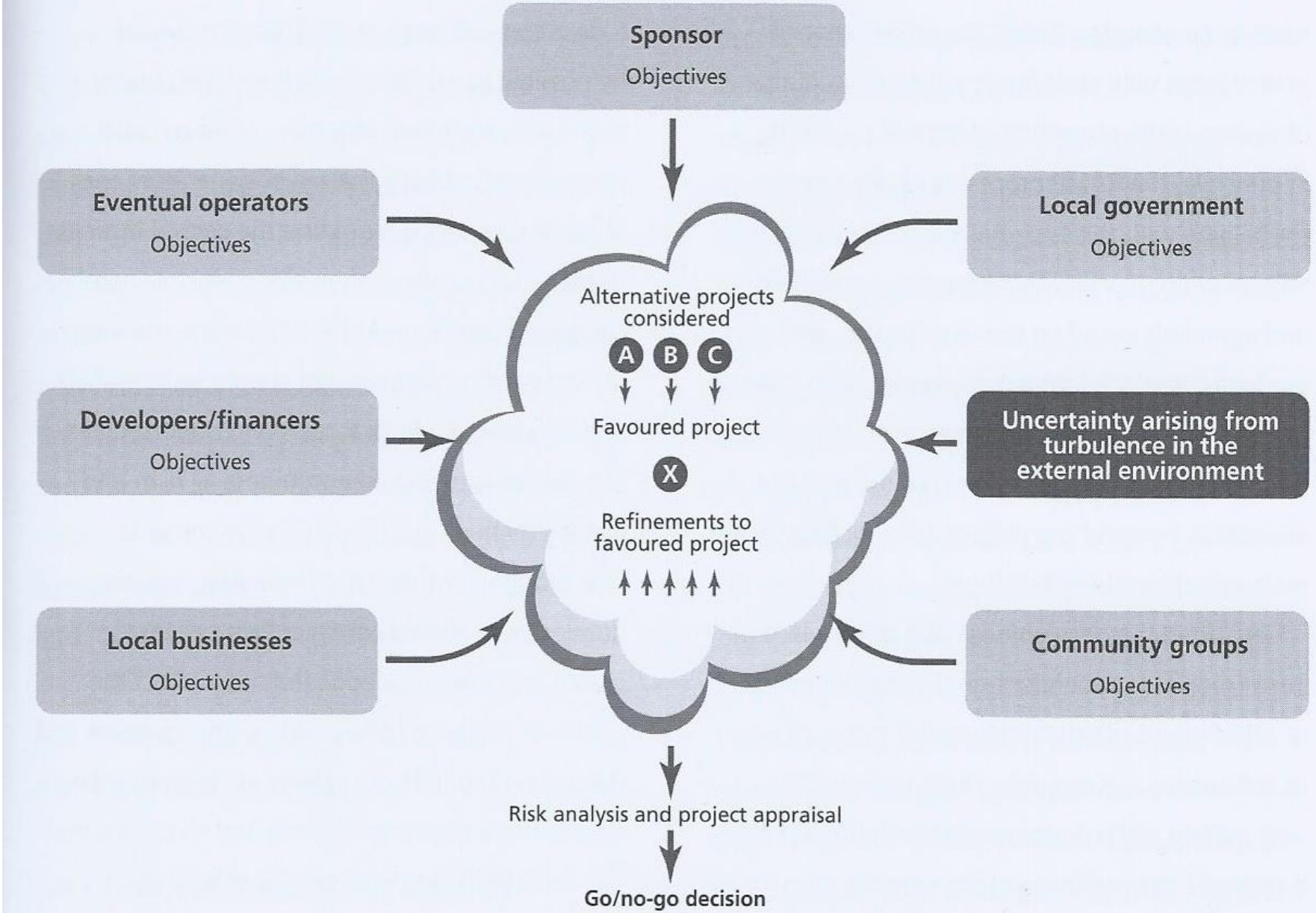
- Project board?
- Sources of advice?
- Competence of project team?
- Stakeholder consultation?
- Public relations? (avoid premature commitment)

Choosing methods of appraisal

- Which business and appraisal models?
- Analysis models? Monetary values? Risk-adjusted Net Present Values? Assessment of environmental and social factors?
- Opportunities – how to be identified and assessed?
- Risk management – which method?
- Risk mitigation – how will options be identified and assessed?
- Scenario analysis – how should scenarios be chosen?

Designing the development process

- What process? Phases? Budget? Gateways? Timetable?
- “Scope creep” controls?
- How much work before authorisation?
- Influence of operator?
- Continuing uncertainty studies?
- Managing alterations to meet changing context?
- Validation of forecasts – costs, demand, benefits



Infrastructure project development process

Exploring alternative projects

- Aim – to find the best project. How will all potentially viable alternatives be found and validated?
- Appraisal – to what degree of depth will they all be appraised?
- What work will be done to identify people adversely affected?
- Project boundaries – how determined?
- Criteria for choosing favoured project? Purpose, Resources, Timescales, Economic efficiency, Risk-adjusted NPVs, Environmental, Social, Acceptability, Risk Tolerance, Need for further infrastructure, Robustness, Adaptability, Sustainability?

Developing favoured project further

- Flexibility, resilience, robustness – can extra cost be justified?
- Cost estimates – how to get full confidence?
- Other projects with impacts – how to identify and assess them?
- Complementary projects – will decisions on these be linked?
- Contingencies – what allowances for adverse events?
- Which risk mitigation options should be recommended? Will there be secondary risks?
- Risks – will risks remaining after mitigation action fall within risk tolerances?

Making the key decisions

- Basis of decision to authorise – Figures, political and other factors, funding?
- Final check on figures – independent validation? Past experience? Bias?
- Final check on work needed outside project boundaries?
- Risks – will risk-analysis results be presented? Risk tolerances?
- Risk mitigation – will a package be recommended? How authorised?
- Support for project? Management of political realities?

What we mean by “risk”

- Risk – possibility of outcomes different from expected (threats and opportunities)

- Enterprise Risk
  - Strategic (big risks)
  - Project (risks in change projects)
  - Operational (“business as usual” risks)

Components of Enterprise Risk

Two Systems

- System 1 – the Enterprise
  - People with their own personal goals
  - Imperfect information, differs for each person
  - Hard to predict reactions between people
  - Equipment, finance and other resources
  - Risk capacity may differ from risk appetite

- System 2 – the Outside World
  - Even more complex and unpredictable

- Understand relationships between the two Systems
  - Identify opportunities and hidden pressures
  - Devise strategies for robustness, flexibility and success

What is Uncertainty?

- Uncertainty is a LACK OF SUFFICIENT KNOWLEDGE about threats and opportunities, including
  - Hidden connections and interactions between risks
  - Unforeseen future interactions between the enterprise and the changing outside world
  - The possibility that outcomes now perceived as threats may turn out to be opportunities, and vice versa
  - Probability or impact of some risks may be much greater than currently perceived
  - Unexpected human reactions
  - Unknown technological developments
- How should we manage uncertainty in our business and projects?

Managing Uncertainty

- Uncertainty is lack of knowledge
- Hence we need to increase our relevant knowledge
- Think about the business as a dynamic system within the system of the outside world – and both are changing
- Do concept mapping and THINKING about the future
- Look for hidden pressures
- Do a focused search to acquire new knowledge and reduce fuzziness (data, competition, probabilities, etc)
- Do not stop the search prematurely
- Decide on action to make the business more robust and less vulnerable to remaining uncertainty

Managing Project Uncertainty

- Study uncertainty systematically
- Do research and experiments, eg investigate site and prior projects
- Do brainstorming
- Search for hidden assumptions
- Seek out ambiguities in objectives and success criteria
- Refine data, probabilities, impacts
- Reduce vulnerability to lack of knowledge and seek greater robustness/flexibility
- Reduce bias

What is RAMP?

- A strategic framework for managing project risk and its financial implications, to assist in making decisions about projects

NOTE – RAMP and STRATrisk are used by Crossrail

RAMP

- A generic framework for managing project risks
- Not just for physical assets
- Concentrates on strategic and financial aspects of projects
- Looks at cost-effectiveness of possible risk responses
- Carries through to project implementation
- Same principles as for a country walk

A country walk

- Identify objectives
- Choose route for best opportunities
- Risks – storm, muddy path, getting lost
- Look at likelihood of risks and impact
- Identify response options – umbrella, boots, map, phone – and choose which to adopt
- Consider secondary risk of phone being stolen or lost
- Control remaining risks
- Afterwards review success, learn lessons

Project risks – the risks of change

- Risk of choosing the wrong project
- Need for a framework such as RAMP which values risks financially and helps to choose between competing projects
- From the outset RAMP considers risks throughout project lifetime
- Disaster risks highlighted - not buried in a model
- Particularly needed at planning/design stage
- RAMP can take account of social and environmental risks
- RAMP can point to which mitigation actions are cost effective – it is often worth spending £1,000 to mitigate a risk worth £3,000

Summary of RAMP (1)

- Covers both threats and opportunities
- Methodology – risk identification, analysis, responses. Residual risks, decision processes, risk control.
- Used with NPV models to provide range of possible NPV outcomes
- Can use scenario analysis and stochastic models
- Based on “whole-life” concept

Summary of RAMP (2)

- An iterative process
- Pays special attention to disaster risks
- Analyses dependent risks and underlying causes
- Manages uncertainty, not just foreseeable risks
- Evaluates risk responses (threats and opportunities) and their cost-effectiveness
- Seeks to minimise bias

Responding to project risk

- Important to start from concept/design stage and look ahead to operations risks
- Increasing opportunities may be as important as the mitigation of downside risks
- We need to find the BEST response options
- The options we choose must be cost-effective

Risk mitigation through insurance

- Project has positive NPV of £20m to £60m
- But 3% chance of event X costing £90m
- Result of X occurring would be NPV of -£70m to -£30m
- Insurance against X would cost £4m
- Result would be NPV of £16m to £56m

Example - new computer system

Year	Cash flow £000s
1	-1000
2	+300
3	+400
4	+400
5	+400
Total	+500
NPV@6%=	+292 (i.e. Expected NPV)

Scenario analysis

Scenario	Event	Probability	Impact £000
A	None	55%	None
B	Know-how sale	10%	+200 year 2
C	Tech. Delay	15%	-300 year 2 and receipts delayed a year
D	Faults	10%	- 100 p.a.in receipts
E	C+D	10%	As in C+D

Effects of scenarios

Scenario	Net flow £000	NPV £000	Prob
A	500	292	55%
B	700	481	10%
C	200	-64	15%
D	100	-54	10%
E	-200	-391	10%

Risk-adjusted NPV = £155,000 (the weighted average). It compares with £292,000 for the Expected NPV.

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

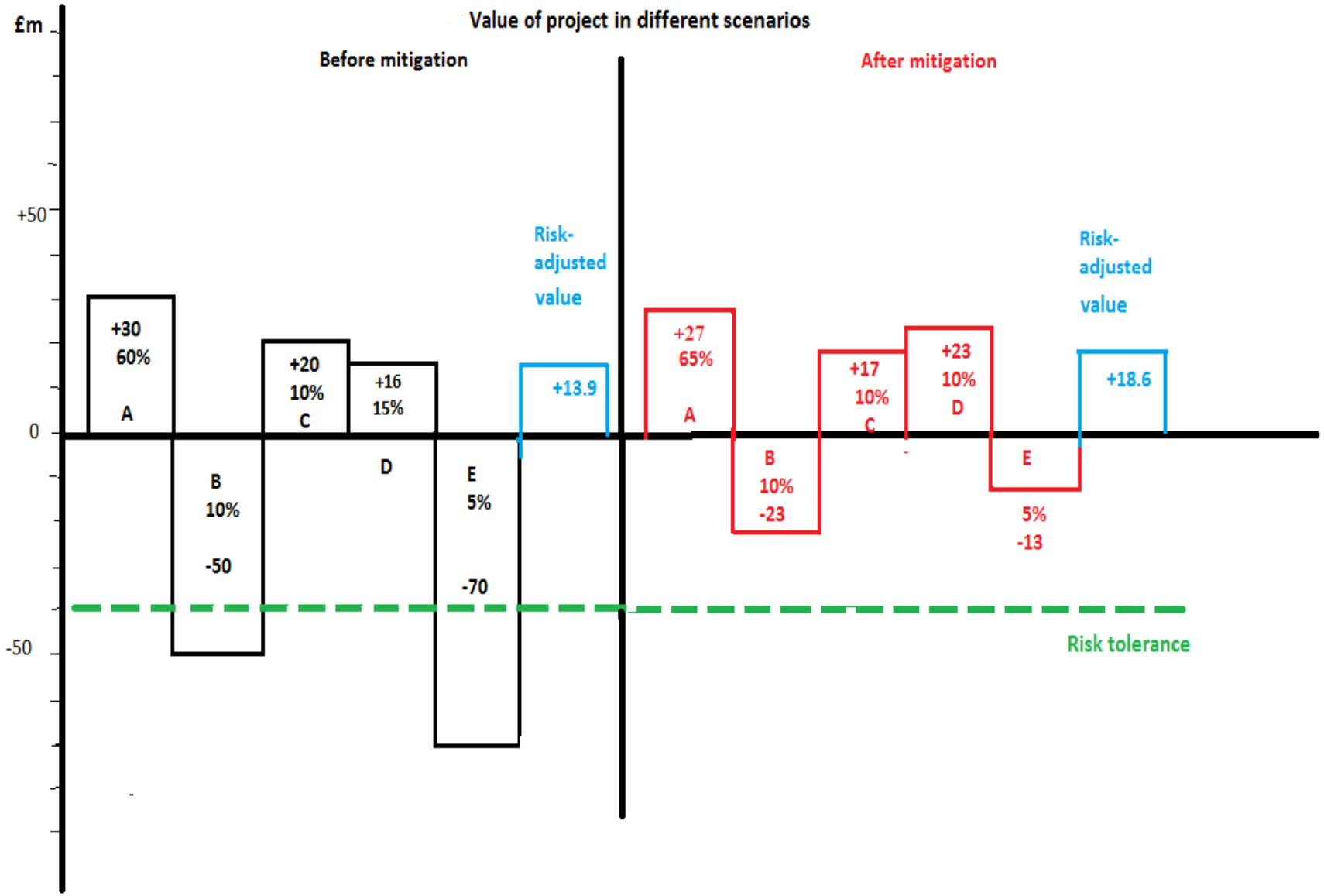
Scenario	Net flow	NPV	Prob
	£000	£000	
A	420	212	55%
B	620	401	10%
C	420	139	15%
D	20	-134	10%
E	20	-188	10%

Risk-adjusted NPV = £145,000 (instead of £155,000)

Lower risk-adjusted NPV but reduced loss if the worst happens (up to £188,000 loss instead of £391,000)

Risk-adjusted NPV

- The risk-adjusted NPV is the weighted average of the NPVs under each of the main scenarios, allowing for the likelihood of each scenario.
- It is a simple measure of the true worth of a project.
- It is usually less – often much less – than the NPV if all goes according to plan.
- It can be calculated both before and after risk mitigation. The “after” figure should be greater than the “before” figure.
- Useful for comparing projects and for deciding whether to proceed with the present project.


£m
Value of project in different scenarios
Before mitigation
After mitigation
+50
0
-50
+30
60%
A
B
10%
-50
+20
10%
C
+16
15%
D
E
5%
-70
Risk-
adjusted
value
+13.9
+27
65%
A
B
10%
-23
+17
10%
C
+23
10%
D
E
5%
-13
Risk-
adjusted
value
+18.6
Risk tolerance

Which project to choose?

	Project	
	A	B
Expected NPV *£m*	310	274
Risk-adjusted NPV *£m*	200	220

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 impact on other activities
- Wrong assumptions
- Arithmetical mistakes

Multiple Criteria Analysis

- MCA considers all factors and risks, both monetary and non-monetary
- Prioritised good stakeholder management
- It enables objectives, concerns, values and priorities of all stakeholders to be reconciled as far as possible – and weighted accordingly - in a transparent way
- Leads to optimisation of project-design and planned risk-management
- Can provide framework for project monitoring and evaluation
- Includes CBA and Social CBA

Social cost-benefit analysis

- Social CBA can also be part of Multiple Criteria Analysis
- It includes approximate monetary valuations of some (though not all) of those social and environmental factors and risks which are not reflected in the expected cash-flows
- Example - time savings due to lower street congestion resulting from a new railway
- Can help to justify a public subsidy

Uses of RAMP for decisions (1)

- Useful for choosing between competing projects
- Identifies risk factors in context
- Helps to justify the chosen project and its design (e.g. Crossrail)
- Scenario analysis provides probability distribution of NPVs and a risk-adjusted NPV is a convenient value of project allowing for risk
- Shows whether risk-response options are cost effective
- Managing broader uncertainty will increase knowledge of possible outcomes and lead to better project design
- RAMP can help to show there is a sustainable business case

Uses of RAMP for decisions (2)

- To proceed or not?
- Are the proposed risk responses cost-effective?
- What are the residual risks if risk responses adopted?
- What is the likely range of the project's financial outcomes? (as a simple probability distribution)
- What is the effect of sensitivity testing?
- Are our assumptions justifiable?
- What about uncertainty, flexibility, bias and political factors – and intuition?
- What effect on shareholder value or overall community benefit?

Checklist for investors

- Has there been enough front-end thinking by the sponsor?
- Have we seen a high-quality “whole life” risk analysis?
- Is there a risk response plan and a risk management plan ?
- Are the revenue forecasts and other figures reliable?
- How adaptable and robust is the asset?
- Have credit and gearing risks been considered?
- Do the prospective returns compensate for the risks?

Conclusion

- Investors need to be aware of the risks and look out for bias
- Front-end thinking is the most important process
- Managing uncertainty is a necessity
- RAMP can help in analysing possible future events and scenarios
- Placing financial values on risk aids decisions, e.g. which project to choose and whether to adopt risk response options
- Simplified presentations for decision-makers are crucial

Key guides

- RAMP (2014). *RAMP – Risk Analysis and Management for Projects*, 3rd edition, 2014 See https://www.ice.org.uk/knowledge-and-resources/best-practice/risk-analysis-and-management-for-projects

  and video at

  https://www.ice.org.uk/eventarchive/risk-analysis-and-management-for-projects

- Front-end Issues (2017). *Major Infrastructure Projects: Key Front-end Issues.* Can be downloaded at https://www.actuaries.org.uk/search/site/Major%20Infrastructure%20Projects%20Key

- STRATrisk (2006). *Strategic Risk – A Guide for Directors*, 2006

  See video at www.stratrisk.co.uk

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