

**Incorporating Principles of Sustainable Development  
within Design & Delivery of Major Projects:  
Study Undertaken for the Institution of Civil Engineers &  
The Actuarial Profession**

**Multi Criteria Analysis**

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## Context

- RAMP to incorporate Social and Environmental aspects of sustainable development (SD)
- Not all Social and Environmental aspects of Sustainable can be monetized
- Definitions of aspects of S&E aspects of SD vary with stakeholder and are in constant flux
- OMEGA Survey: 84% think CBA alone does not addresses well E&S aspects of SD
- OMEGA Survey: 65% think appraisal of mega transport projects would more effectively employ the use of MCA to cover all factors, rather than an exclusive use of CBA.
- Multiple Criteria Analysis: tool for decision making with multiple stakeholders, with uncertainty over parameters, and with both quantitative and qualitative data.

## Common Appraisal Types: CBA/CEA

- In Cost Benefit Analysis (CBA) systems all the factors considered are measured in money terms – the common medium of exchange - over a defined period of years.
  - Both marketable and non marketable factors are included in the analysis.
  - CBA enables the results to be summarised into overall flows of costs and benefits, from which a single rate of return can be defined.
- Cost Effectiveness Analysis (CEA) compares the costs (on a market basis) involved with alternative ways of providing similar kinds of output.
- Both these methods in principle offer simplicity to the decision makers, compared to the judgement they have to apply in interpreting MCA results.

## Current Approaches to MCA

- Multi Criteria Analysis (MCA) systems are widely used in project appraisal
- MCA systems involve structures to allow quantified and non-quantified indicators to be set out together in a tabulated form
- Decision makers gain a complete picture of the implications of a project across all possible fields of impact.
- Highway investment appraisals use MCA techniques which take into account impacts with both monetary values (such as travel time savings), and social and environmental impacts (noise impacts and blight) which may be quantified but not valued, or assessed only in qualitative terms.

## Current Approaches to MCA cont.d

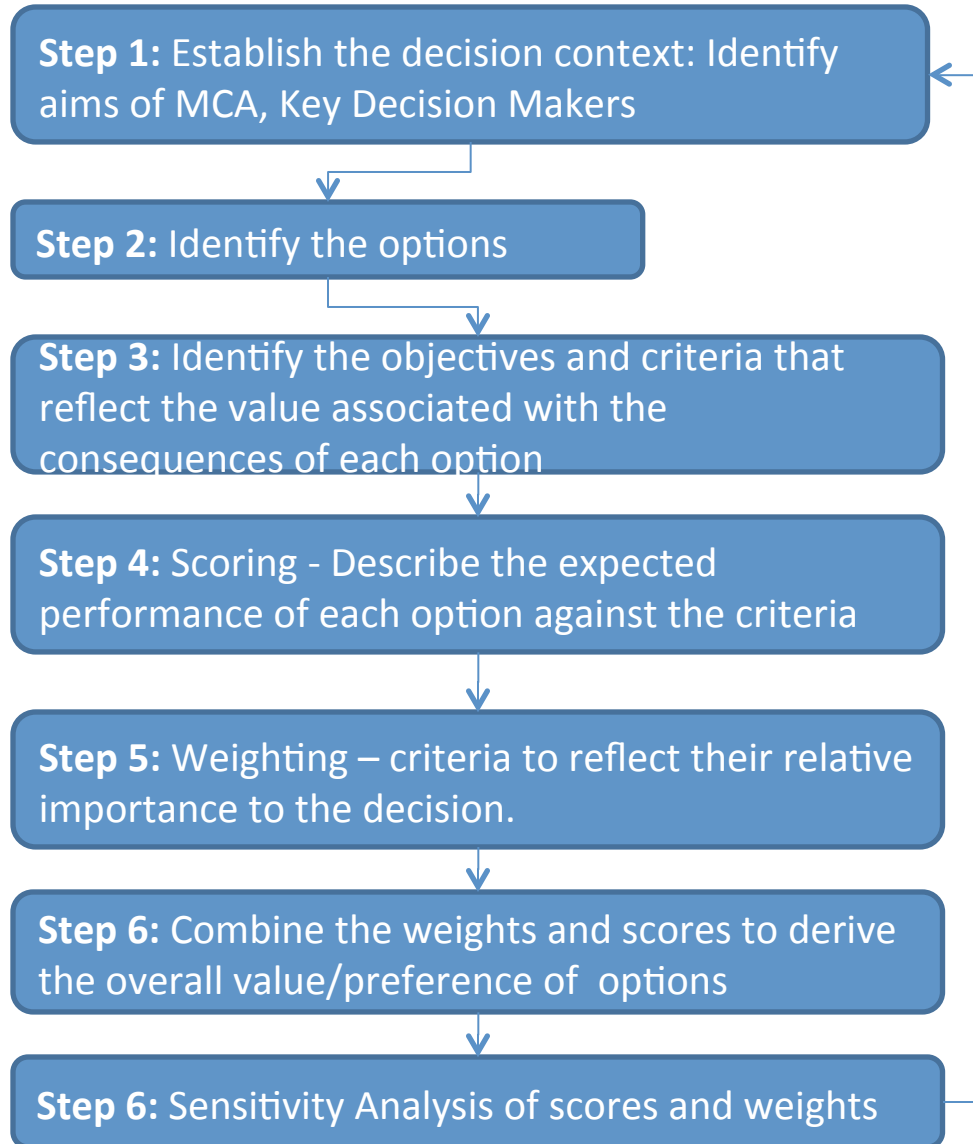
- MCA aims to establish preferences between **options** using an explicit set of **objectives** that the decision making body has identified, and for which it has established **measurable criteria** to assess the extent to which the objectives have been reached.
- gives the decision-makers the opportunity to learn about their own preferences and those of the involved stakeholders.
- It is likely to be most effective when appraisal is integrated within the overall development and decision making process for a project.

## Current Approaches to MCA cont.d

There are three distinct phases of MCA process: problem structuring, model building and use of the model for informing and challenging thinking:

- **problem structuring** : define terms for decision making problem; stakeholders, information to collect for options and related criteria
- **model building** : definition of criteria, relative importance or value attributed to each of the criteria by different stakeholders.
- **apply model** : weights: value of each criterion within the framework; scores: the performance of each alternative
- **decision or feedbacks** to the previous phases

## Form of Generic MCA





## Current Approaches to MCA cont.d

- MCA in the UK: New Approach to Transport Assessment (NATA) .  
Controversial application of MCA used here as an example.
- Core to NATA MCA: An Appraisal Summary Table (AST) that displays the degree to which the five Central Government objectives for Sustainable Transport would be achieved.
- AST allows judgement to be made about the overall value-for-money of the option or options in achieving the Government's Sustainable Transport objectives.
- AST “allows consistent view to be taken about the value of the strategies and plans developed for the different study areas”.

<b>Scheme Name</b> A46 Newark - Widmerpool Imp.	<b>Description :</b> Dual-2 lane, grade separated carriageway; mainly on-line with off-line sections at Kilmington, Bingham, Syerston and Farndon.	<b>Problems :</b> Poor accident record and suffers from congestion. Significant development pressures at Bingham and a need for better links to Newark and Lincoln.	<b>Cost £m :77</b>
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OBJECTIVE	SUB-OBJECTIVE	QUALITATIVE IMPACTS	QUANTITATIVE MEASURE	ASSESSMENT
ENVIRONMENT	Noise	Changes considered at properties having a noise level greater than 57dB and an increase of 1.0dB or more. No allowance has been made for any potential mitigation measures. Decreases due to bypass sections.	Estimated number of people likely to be annoyed by noise levels are: 242 for the "do minimum" situation; 183 for the "do something" situation.	A net decrease of 59 people who would be annoyed by noise in the "do something" situation compared to the "do minimum".
	Local Air Quality	"The project leads to an increase in PM10 levels of at least 2µg/m3 and in NO2 levels of at least 4µg/m3 and concentrations are above the air quality standards NO2 objective of 40µg/m3."	No. properties experiencing air quality - better 305 (NO2) / 519 (PM10) - worse 232 (NO2) / 18 (PM10)	-380 PM10 -3882 NO2
	Greenhouse Gases	12% increase	Difference is + 6252 tonnes CO2	Adverse
	Landscape	A landscape travelled and fought over historically but now managed intensively although appearing quite well wooded. Long views and rolling varied landform give some interest	-	Moderate adverse
	Townscape	Assessed in Landscape	-	Included in Landscape
	Heritage of Historic Resources	An area rich in remains of various periods, esp Roman and Civil War. Many sites likely to be affected since even detailed surveys do not reveal more than 50% of sites found in practice	-	Moderate adverse
	Biodiversity	A substantially agricultural landscape where small pockets of woodland are probably of heightened significance. NB desk search may not include all second tier nature conservation sites.	-	Slight Adverse
	Water Environment	There are several high quality watercourses providing abstractions and dilution of discharges for the area that will be affected by the scheme. Groundwater is also abstracted for industrial and agricultural use. Impacts must be minimised, by mitigation, to protect this environment.	-	Slight Adverse
	Physical Fitness	New opportunities for both pedestrians and cyclists, therefore improving physical fitness.	-	Slight Beneficial
	Journey Ambience	Improved journey ambience for both road users using the bypasses and pedestrians and cyclists within the village boundaries.	-	Moderate Beneficial
SAFETY	-	Substantial improvements to safety by up-grading of current sub-standard single carriageway to dual carriageway and the incorporation of a number of localised bypasses.	Accidents Deaths Serious Slight 1515 n/a n/a n/a	PVB £45.6m
ECONOMY	Journey times & Vehicle op Costs	No VOC calculations made.	Trunk road journey time savings: Peak 19.8 mins; inter peak 4.2 mins	PVB £67.60m 204% of PVC
	Cost	N/A	-	PVC £33.1m
	Journey time reliability			
	Regeneration	Provides link to Newark and Cotgrave both with SRB funded programmes.	Serves regeneration priority area? Development depends on scheme?	Yes No
ACCESSIBILITY	Option values	No new alternative modes provided or additions/removals of existing bus/rail services	-	Neutral
	Severance	Benefits on communities such as Eastside and Farndon outweighed by increased difficulties in crossing the dual carriageway.	-	Slight Adverse
	Access to the Transport System	No provisions for improved access, frequency or routing of existing services nor introduction of new services. Quality of bus stop facilities may improve but access between bus stops remains difficult.	-	Slight Adverse
INTEGRATION	Transport Interchange	No specific improvements to interchange facilities.	-	Neutral
	Land-Use Policy	Consistent with some Land Use policies in Structure Plan and Local Plan, but no specific policies related to the proposed scheme	-	Slight Beneficial
	Other Government Policies	Supports general transport Government policies	-	Slight Beneficial

COBA		PVB: £113.2m	PVC: £33.1m	NPV: £80.1m	BCR: 3.4
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# Issues in use of MCA systems

- **MCA is a is useful for classification:** determining priorities or selecting between alternatives. There is a degree of judgement which can be a matter of concern, but MCA can bring a degree of structure, analysis and openness to classes of decision which lie beyond the practical reach of CBA.
- **The use of MCA tools is particularly valuable for the direct participation of stakeholders,** as it allows for visualizing different perceptions of the relative importance of the criteria by different groups, highlighting how results can change if different stakeholders' interests and perceptions are taken into account. MCA techniques thus provide a platform for consensus reaching
- **MCA techniques help illustrate the solution to a multi-criteria problem.** But they also give the decision-makers the opportunity to learn about their own preferences and those of the involved stakeholders. In consequence the MCA approach can prove a valuable instrument for assessing sustainability and also for carrying out the decision process in a 'sustainably sound' way.

# Issues in use of MCA systems

- **The MCA approach can be used with considerable flexibility.** It allows engagement of all interested parties and should encourage thinking rather than provide a simplistic guide to the ‘right’ answer. This sets it in contrast to the use of CBA techniques alone.
- **MCA techniques require the disciplined use of analysis and measurement as far as these may usefully be employed.** The use of these techniques is in important ways more demanding of experience and good training than the use of CBA or CEA. For example NATA has been criticized for the inconsistent nature of its implementation to projects both within single scheme and appraisals, and between appraisals
- **The MCA process has the disadvantage that it can be manipulated** either through the choice of representative stakeholder groups, which may not be inclusive, through the choice of criteria and/or balance of these in proportion to the project objectives. Or the stakeholder groups may have a prior agenda which unduly influences the outcome of the MCA.

# Issues in use of MCA systems

- **One important lesson from the current application of the NATA MCA** is that the weightings given to objectives by decision makers are left open, and tend to be dominated by transport sector CBA concerns leading to the dominance of time savings in appraisals and the diminished importance of the underlying objectives. This leads to the question of who is best place to define such weightings? 69% of respondents felt public authorities should set clear and firm priorities for appraisal of environmental and social enhancement.
- **CBA in an important part of appraisal, but should not dominate**

Option	Appraisal typology
1	CBA Led
2	MCA – CBA Led
3	MCA – Non CBA Led
4	MCA – Non Sustainable Development Policy Led incorporating CBA inputs
5	MCA – Sustainable Development Policy Led incorporating CBA inputs

# Possible use of MCA in RAMP handbook

<b>Investment stage / Objectives</b>	<b>Principal activities</b>	<b>Key parameters</b>	<b>RAMP process</b>
<b>identification</b> To identify opportunity and decide whether it is worthwhile conducting a full appraisal	Identify business need Define investment opportunity Make initial assessment Decide whether to proceed with appraisal	Broad estimate of capital cost and cash flows Cost appraisal	Preliminary review
<b>Appraisal</b> To decide whether the investment should be made	Define investment objectives, scope and requirements Define project structure and strategy Develop business case Identify funding options Conduct feasibility study Decide (in principle) whether to proceed with investment	Refined estimates of capital cost and cash flows Cost of investment planning phase	Full risk review
<b>Investment planning</b> To prepare for effective implementation of the project	Procure funding Obtain planning consents Preliminary design work Compile project implementation plan Place advance contracts (e.g. site preparation) Make final decision to proceed with investment	Financing cost Refined estimates of capital cost and cash flows	Risk review (priori to final decision)
<b>Asset creation</b> To design, construct and commission the asset, and prepare for operation	Mobilise the project team Detailed planning and design Procurement / tendering Construction Testing, commissioning and hand-over Ensure safety Prepare for operation	Project objectives: - scope - performance / quality - timing - capital cost	Risk reviews (during or towards end of each activity) and risk management between risk reviews
<b>Operation</b> To operate the asset to obtain optimum benefits for sponsor and other principal stakeholders (including investors and customers)	Operate the service Derive revenue and other benefits Maintain and renew the asset	Operating cost Maintenance cost Cost of renewals Revenue Non-revenue benefits	Risk reviews (periodically)
<b>Close-down</b> To complete investment, dispose of asset and related business, and review its success	, transfer, decommissioning or termination of asset and related business Post-investment review	Decommissioning cost Cost of staff redundancies Disposal cost Resale or residual value	Final risk review and RAMP close-down

## Possible use of MCA in RAMP handbook

- The opportunity identification and appraisal stages of the project investment life cycle
  - set up the MCA structure and identify stakeholders who can enhance the social and environmental aspects of the projects decision making.
  - Discussions with such stakeholders to create a pool of social and environmental objectives for the MCA and help establish associated risks which can be passed onto the quantitative risk analysis within RAMP.
  - Some environmental and social factors can be readily assessed in quantifiable terms. This enables criteria and costs to be quantified directly: it also means that risks in relation to them can be expressed in quantifiable and hence monetary terms.
  - Good proportion of factors are non quantifiable. The MCA should allow a clearer understanding of what these risks are and what their potential effect might be. This offers scope for expressing these risks too in quantifiable terms with a clear 'audit trail' of how such values have been derived.

# Key Questions

- How to best manage stake holder engagement to achieve balanced objectives?
- The power of policy is key - who leads policy? What policies are relevant to Social and Environmental objectives?
- How are MCA objective weightings best assigned?
- Is MCA too complex – if so how can its application be streamlined for the RAMP handbook?
- How does MCA become a usable framework? What does the decision need? What does this look like?