

Assessing the effectiveness of environmental improvement measures

Developing a toolkit to rank success and inform policy



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Executive summary

Key findings

- A shortlist of decision aiding approaches were examined including: Decision Conferencing; Structured Decision Making; Strategic Choice Approach; and Multicriteria Mapping. Based on these criteria and the decision aiding approaches reviewed, Multicriteria Mapping was selected.
- Multicriteria Mapping was deemed as being very useful for assessing the effectiveness of existing and future measures.
- Multicriteria Mapping will be trialled by SEPA in collaboration with the EU LIFE SMART Waste Project (LIFE 13 ENV/UK/00549) Smarter Regulation of Waste in Europe, and this will be reported separately.

Introduction

This report provides a recommendation to SEWeb for a decision aiding approach to assess the effectiveness of existing and future measures, as required by the SEWeb EU LIFE project. A 'measure' is defined as any action put in place to achieve an environmental objective. The approach allows for evidence-based decision making but focuses on using expert judgement.

Research aims and objectives

The purpose of this project was to review widely used decision aiding approaches that could be used to compare the effectiveness of environmental measures. A literature review was carried out to compare and contrast a set of widely used decision aiding approaches. That review is provided as an annex to this report. These approaches included: Decision Conferencing, Structured Decision Making, Strategic Choice Approach and Multicriteria Mapping. They were assessed based on criteria that included:

- (i) simplicity of use
- (ii) inclusion of qualitative 'expert' information as well as quantitative information
- (iii) scientific and practical reliability. Based on these criteria and the decision aiding approaches reviewed, Multicriteria Mapping was selected for demonstration.

A phased series of trials of Multicriteria Mapping was carried out. The first phase involved familiarisation and testing of Multicriteria Mapping by the research team. The second phase of testing involved facilitating an interview with the clients.

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Rationale for the project and brief background

This report provides a recommendation to SEWeb for a decision aiding approach to assess the effectiveness of existing and future measures, as required by the SEWeb EU LIFE project. A 'measure' is defined as any action put in place to achieve an environmental objective. Several widely used decision aiding approaches were reviewed including: Decision Conferencing; Structured Decision Making; Strategic Choice Approach; and Multicriteria Mapping. They were assessed based on the following criteria (developed with SEWeb staff):

- (i) simplicity of use
- (ii) inclusion of qualitative 'expert' information as well as quantitative information
- (iii) scientific and practical reliability. Based on these criteria and the decision aiding approaches reviewed, Multicriteria Mapping was selected for demonstration.

This report contains a summary of the approaches reviewed and why Multicriteria Mapping was chosen for further trialling. A longer 'tool kit' overview of Multicriteria Mapping then follows (Appendix 1) to guide potential users and to provide a stepping stone to the Multicriteria Mapping manual (Appendix 2 contains a glossary of terms). In addition a summary of the review activities carried out is included to provide an introduction to multicriteria analysis and the approaches reviewed (Appendices 3 and 4).

Summary of approaches reviewed

A search was carried out for decision aiding approaches that would meet pre-agreed criteria. These criteria were based on:

- (i) simplicity of use
- (ii) inclusion of qualitative 'expert' information as well as quantitative information
- (iii) scientific and practical reliability.

These criteria guided searches for existing approaches. This produced a shortlist of approaches that were examined in greater detail including: Decision Conferencing; Structured Decision Making; Strategic Choice Approach; and Multicriteria Mapping. Based on these criteria and the decision aiding approaches reviewed, Multicriteria Mapping was selected for trialling in SEPA.

Overview of the testing/trialling of Multicriteria Mapping

A phased series of trials of Multicriteria Mapping was carried out. The first phase involved familiarisation and testing of Multicriteria Mapping by the research team. The second phase of testing involved facilitating an interview with the clients. Their conclusion was that Multicriteria Mapping would be very useful for assessing the effectiveness of existing and future measures (and more widely across SEWeb partners). A follow-up teleconference was held with Prof Andy Stirling (who developed Multicriteria Mapping) to answer remaining questions, and to learn more about how various ways Multicriteria Mapping had been used to aid decision making.

Justification for choosing Multicriteria Mapping

Pros

- An important strength of Multicriteria Mapping is the manual, that clearly sets out the underlying values and aims to guide an interviewer/facilitator.
- These underlying values help ensure a robust and useful appraisal is carried out that is clear about inclusion, opening up the appraisal process, enables participants to drive the process and is transparent.
- The web-based application is well designed and easy to use (Figure 1).
- The high quality of the application and manual leads to Multicriteria Mapping being accessible and useable.
- Exploring and using Multicriteria Mapping is relatively low cost compared to buying a license for other decision aiding software.
- A feature of Multicriteria Mapping analysis is that the subjectivity and conditionality of inevitable judgements are rendered transparent by: the relatively open framing; the multiple finely-specified parameters; and the clear way in which sensitivities can be displayed and explored in interrogating associated results.

Cons

- Multicriteria Mapping emphasises eliciting, capturing and using qualitative information from the engagements/ interviews.
- Many users of Multicriteria Mapping who do not have a qualitative social background may not be familiar with the collection and analysis of qualitative information.
- A further challenge, which is a weakness as well as a strength is the flexibility in analysis provided by Multicriteria Mapping. As this could be viewed as difficult and unclear by an interviewer/facilitator who is not experienced in qualitative analysis techniques, and is potentially time-consuming.



Figure 1 Multicriteria Mapping home page

Brief description of Multicriteria Mapping

Multicriteria Mapping enables robust structured appraisal from a range of perspectives on how best to achieve a shared focal goal. Multicriteria Mapping supports opening up of appraisals i.e. giving balanced attention to exploring and illuminating contending views, through collection and exploration of qualitative and quantitative information. Where appraisal is a broad social process of exploring a shared focal goal through different perspectives to fulfil a shared aim, function, quality or value based on the options available. This information is elicited through 'one to one' or small homogeneous group engagements/interviews. Multicriteria Mapping facilitates the transparent collection and analysis of relevant quantitative and qualitative information for sharing across projects, further analysis by others and provides a record for auditing the process. The aim of a Multicriteria Mapping project is to explore the ways in which different pictures of strategic choices of options, change based on the view taken. Options are a core set of sets of practices, policies, strategies or technologies to achieve shared focal goals that are appraised from a range of perspectives.

A Multicriteria Mapping project is based on structured engagements/interviews with selected participants and subsequent analysis. Multicriteria Mapping makes use of a dedicated online application (Multicriteria Mapping tool www.multicriteriamapping.com) and is supported by a detailed manual to enable the collection and analysis of relevant information. There are three main parts to a Multicriteria Mapping process (Figure 2). These are:

- (i) planning and designing the appraisal
- (ii) carrying out the interviews/engagements with participants
- (iii) analysis and reporting back.

Defining the focal goal, the core options to be appraised, and recruiting relevant participants are all interdependent parts of planning an appraisal. The interviewer/facilitator guides

interviews of participants in a neutral and open manner through a series of steps that include: selecting options; defining criteria; assessing scores; assigning weights; and reviewing ranks of options. The aim of the structure is to enable consistent and fair comparison of the options across all the participants' perspectives. The interviewer/facilitator then reviews and analyses the qualitative and quantitative information collected from each of the engagements/interviews and reports back.

Who has used Multicriteria Mapping and for what?

Multicriteria Mapping has been developed and applied over the past ten years in a wide range of appraisals from Natural Resource Management to health care decision making by Professor Andy Stirling at the University of Sussex. The current format of Multicriteria Mapping that includes the web application was launched in October 2014. Further information on applications of multicriteria mapping are available at www.multicriteriamapping.com.

How we propose to use Multicriteria Mapping

Multicriteria Mapping is being trialled for SEWEb in collaboration with SEPA colleagues working on the EU LIFE SMART Waste Project (LIFE 13 ENV/UK/00549) Smarter Regulation of Waste in Europe. The trial addresses the focal goal "what interventions are most effective in combating or reducing waste related crime?" A full description of the trial methodology and results will be available in a separate SEPA report once the trial has been completed.

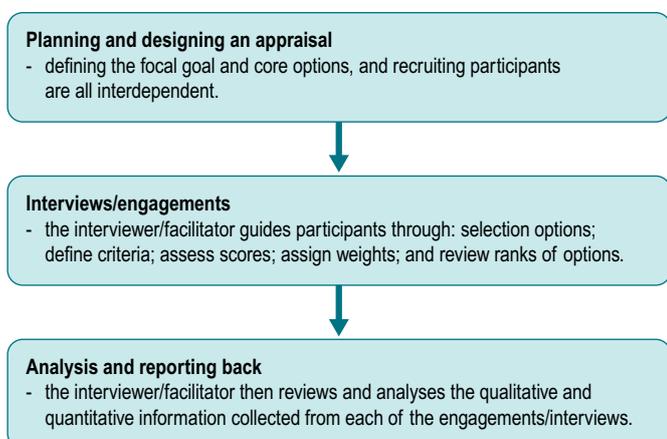


Figure 2 Three main parts to a Multicriteria Mapping process

Appendix 1

'Tool Kit' summary of Multicriteria Mapping

This section contains a longer introduction to the Multicriteria Mapping process designed for SEWeb colleagues who are considering facilitating such a process in conjunction with an individual decision maker or a group making a decision. Covering broadly what is the starting point for Multicriteria Mapping and what it involves. This summary provides a stepping stone to the longer Multicriteria Mapping manual and could be used by those within SEWeb partner organisations who are thinking of running a 'process'. It could be sent to those participating to provide an overview. The Multicriteria Mapping website and supporting manual contain clear and detailed guidance on the values and aims of Multicriteria Mapping, along with easy to follow steps for planning and designing, carrying out the engagements/interviews, and analysis and reporting. The following sections summarise the more detailed manual.

What is the starting point for Multicriteria Mapping?

Information on the Multicriteria Mapping 'process' and web based application can be found here www.multicriteriamapping.com (see Figure 1). The Multicriteria Mapping 'process' is based around a software application that is well designed and supported. A free trial (60 days) can be started in less than two minutes. The web based application contains a worked example and pop-up help boxes at each stage of the process. A detailed PDF manual is available (via FAQ page) that sets out the values and aims, as well as guiding a facilitator/interviewer through setting up and carrying a Multicriteria Mapping 'process'.

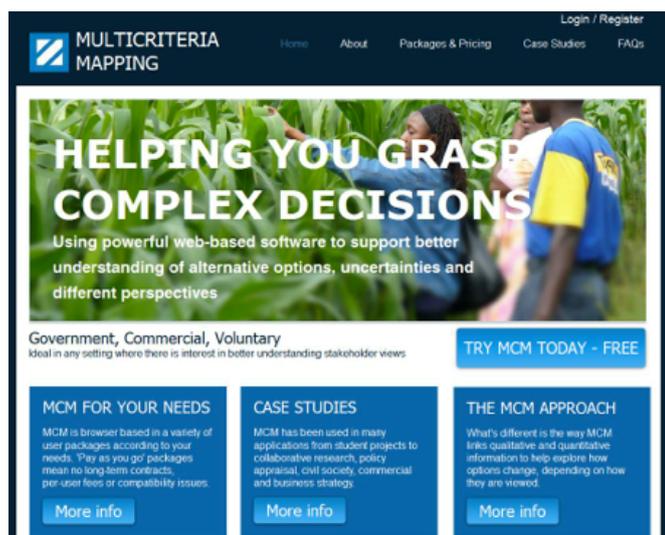


Figure 1 Multicriteria Mapping home page

What does a Multicriteria Mapping 'process' involve?

The overarching purpose is to represent as authentically as possible a range of different appraisals, conducted from diverse perspectives, concerning the best ways to achieve some broadly shared focal goal. In other words, the aim of Multicriteria Mapping is to explore the ways in which different pictures of strategic choices change, depending on the view that is taken –not to prescribe a particular 'best choice'. One consequence of this 'heuristic' approach is that (unlike some other multicriteria analysis techniques), the qualitative information elicited in a Multicriteria Mapping engagement is (if anything) more important than the quantitative information. The Multicriteria Mapping process involves five basic steps: select options; define criteria; assess scores; assign weights; and review ranks (Appendix 4). It is important the participant is in the driving seat and facilitators and interviewers ensure they are open, sensitive and neutral.

There are three main parts to a Multicriteria Mapping process. These are planning and designing the appraisal, carrying out the interviews/engagements with participants, and analysis and reporting back (Figure 2).

Interviews/engagements are arranged with the identified participants, either individually or in small homogeneous groups (2-3 hours per interview/engagement). The aim of the structure is to enable consistent and fair comparison of the options across all the perspectives of the participants.

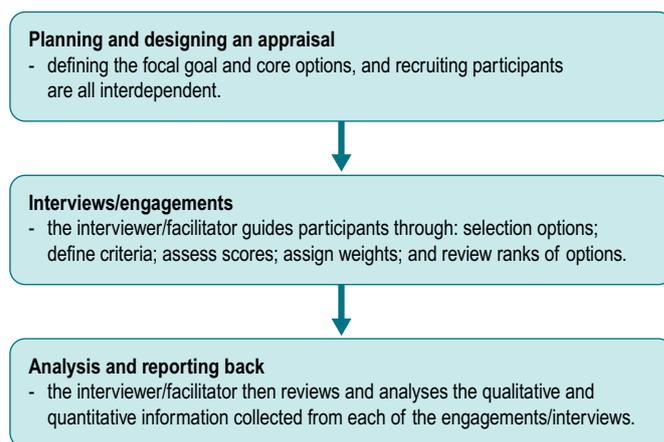


Figure 2 Three main parts to a Multicriteria Mapping process

Appendix 2

Glossary of terms for Multicriteria Mapping process (Stirling and Coburn, 2014)

What it is

Multicriteria Mapping. A process enabling individual deliberation and transparent exploration of ways in which technical judgements, quantitative assessments, qualitative assumptions and subjective values interact to yield divergent possible appraisals of the best way to go about achieving a particular focal goal. The process may be undertaken by means of individual interviews or in group sessions. In either case, the process makes use of the MCM software tool to record MCM interview data and conduct MCM analysis of the results. The acronym is MCM.

Appraisal. The process of assessing the pros and cons of a range of options under an array of criteria according to a variety of perspectives. The term is intended to imply a broader process than purely quantitative assessment (e.g. in assessing scores), since it includes equal consideration of a wide range of qualitative issues. MCM offers just one approach to this broader process of appraisal.

Heuristic. A form of appraisal tool whose primary aim lies in facilitating the systematic, transparent and accurate exploration of a challenging policy or decision problem. This contrasts with a more prescriptive approach, whose primary aim lies in delivering apparently clear results, even if these conceal hidden conditions, constraints or sensitivities. Multicriteria mapping is a heuristic.

Framing the question

Focal Goal. A broadly shared aim, in itself clear and uncontroversial across a range of diverse perspectives, that forms the common aim for a variety of alternative options. This may be a particular social function or objective, the options for achieving which form the focus of an MCM exercise. For clarity, this might be expressed in the form of a question, like: *“by what policies can society best reduce obesity?”*

Choosing options and criteria

Option. A specific way to achieve a particular focal goal, which is judged by at least one participant or the research team to be appropriate for appraisal as part of an MCM exercise. Depending on the context, options may include diverse kinds of practices, policies, strategies or technologies.

Pre-defined Option. The collective term for core options and discretionary options. An option that has been defined in a standardised fashion by the research team to enable consistent and comparable appraisal by all participants.

Core Option. An option that has been defined in a standardised fashion by the research team to enable consistent and comparable appraisal by all participants, and which all participants are asked to appraise.

Discretionary Option. An option that has been defined in a standardised fashion by the research team to enable consistent and comparable appraisal by all participants, but which may or may not be selected by a participant for appraisal, at their own discretion.

Initial Criteria. An optional group of criteria that may be defined by the research team in building an MCM project and which are presented as a default to all participants to appraise. It is generally recommended that no initial criteria are defined.

Planning the engagement

MCM Engagement. A discrete stage in a process for conducting an MCM appraisal, during which the MCM tool is used to elicit the viewpoint of an individual or small group of participants. This may take the form of an individual MCM interview conducted by an MCM researcher, or a group MCM session facilitated by an MCM researcher.

MCM Interview. An MCM engagement in which an MCM researcher uses the MCM tool to aid a one-to-one interview of a participant.

Group MCM Session. An MCM session in which an MCM researcher uses the MC-Mapper tool in order to help facilitate an appraisal by a small (usually homogeneous) group of participants.

Groupings. The collective term for groups of participants (perspectives), criteria (issues) or options (clusters).

Homogeneous Groups. A group of MCM participants meeting face to face, gathered on the basis of some perceived common shared attribute that makes them homogenous with respect to some hypothetically key issue in defining perspectives.

Pilot MCM session. A smaller, quicker, more simple and less onerous MCM exercise, used to help shape and design a more elaborate and rigorously-designed project.

Scoping interview. An initial interview with a prospective MCM participant, carried out to check some basic design features of the ensuing MCM and inform the participant in advance of what the process will involve.

Reference

Stirling, A., Coburn, J., 2014. Multicriteria Mapping Manual: Version 1.0. SPRU-Science and Technology Policy Research, University of Sussex.

Appendix 3 Literature review

Overview of multi-criteria analysis and multi-criteria decision analysis

Every decision we take requires the balancing of multiple factors (i.e. criteria). Advantages of using multi-criteria analysis (MCA) over informal judgement unsupported by analysis includes: the group's choice of objectives and criteria are open to analysis and to change if decided later they were inappropriate; the scores and weights are explicit and developed based on tried and tested techniques; the scores and weights used provide an audit trail; a wide range of experts can contribute; and it provides a means of communication within the decision making body and with wider communities (UK Government, 2009). Decision analysis has been suggested to be "a formalisation of common sense for decision problems that are too complex for informal use of common sense" (Keeney, 1982).

MCA differs from cost benefit assessment (CBA) in that CBA seeks to value the expected impacts of an option in monetary terms, which are based on well-developed economic theory of valuations based on willingness to pay or accept. MCA generates preferences between options (also called alternatives) by reference to an explicit set of objectives and a corresponding set of established measurable criteria to assess how well these objectives have been met. They can be used to identify a single most preferred option, rank options, to short list a limited number of options for subsequent detailed assessment or to identify acceptable and unacceptable options. There are a wide range of MCA techniques since there are different types of decisions that are addressed, the time, data and analytical skills available to support the analysis may differ, and the administrative culture and requirements of the decision-making organisation can vary. Criteria for selecting a particular MCA technique can include: ease of use; software availability, where needed; internal consistency and logical soundness; transparency; data requirements consistent with the importance of the issue being considered; realistic time and manpower requirements for the analysis process; and ability to provide an audit trail (UK Government, 2009).

Multi-criteria decision analysis, or MCDA for short, is a form of MCA that has found a wide range of applications in both public and private sector organisations. MCDA is an approach and a set of techniques with the aim to provide an ordering of options. One of the primary aims of MCDA approaches is to enable decision makers to learn about the problem faced, and the priorities, values and objectives of those involved and to organise and synthesize information so that they can make decisions and minimise post-decision regret by taking into account all of the important factors (Belton and Stewart, 2002). MCDA is "an umbrella term to describe a collection of formal approaches which seek to take account of multiple criteria in helping individuals or groups explore decisions that matter" (Belton and Stewart, 2002). Belton and Stewart (2002) dispel three myths about MCDA: that it will provide the 'right' answer; it provides 'objective' analysis which relieves decision makers of the responsibility of taking difficult decision; and it takes the pain out of decision making. MCDA is an aid to decision making that provides a process that aims to "integrate objective measurements with value judgements" and "make explicit and manage subjectivity" (Belton and Stewart, 2002).

The primary aim of MCDA is to enable decision makers to learn about the problem faced, and the priorities, values and objectives of those involved to help identify a preferred approach and solution (Belton and Stewart, 2002). The main stages in MCDA are identification of the issue or problem, problem structuring, building the model, then using the model to inform and challenge thinking, and finally to determine a plan of action (Belton and Stewart, 2002). In their book Belton and Stewart (2002) highlighted that the traditional way of using MCDA techniques in isolation needed to be improved and MCDA to be seen in a more integrated way e.g. greater integration with other problem structuring and decision evaluation methods. There are three broad categories of approaches to MCDA: value measurement models; goal, aspiration or reference level models; and outranking models (Belton and Stewart, 2002). Value measurement models are based on developing numerical scores for each criterion and aggregating these to identify preferred options. In goal, aspiration and reference level models the process tries to identify options that are likely to result in these goals or aspirations which have been identified for each of the criteria. Outranking models compare pairwise alternatives based on each criterion to assess the overall strength of one alternative course of action over another.

Belton and Stewart (2002) stress that if MCDA is to have a real impact on practical decision making then analysts need to gain expertise in the wider process that includes problem structuring. Decision making occurs at the border of several disciplines and uses concepts and methods from psychology, economics, decision analysis, biology, ecological science, engineering, management science, facilitation and negotiation analysis. The value of decision analysis is in challenging initial gut feelings.

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Appendix 4

Summaries of group decision aiding approaches

The focus was on generic decision aiding/ analysis approaches that balanced rigour and useability to best inform SEPA. A set of group decision aiding approaches were selected. These included: Strategic Choice Approach; Structured Decision Making; Decision Conferencing; Multi-Criterial Decision Analysis (as an approach) as set out in the UK Government MCA Manual (UK Government, 2009); and Multicriteria Mapping. Summaries of these group decision aiding approaches are presented in the following pages under the sub-headings: Summary; Description and purpose; Methods, techniques and tools utilised; Strengths; Weaknesses; Further reading and resources; and Main steps.

Approach: Multi-criteria decision analysis (MCDA)

Summary

Multi-criteria decision analysis (MCDA), a form of multi-criteria analysis (MCA), is an approach and a set of techniques that aim to order a set of options/alternatives. Here MCDA as an approach as set out in the UK Government MCA Manual is presented.

Description and purpose

The purpose of MCDA is to enable decision makers construct coherent preferences, examining complex problems that contain both monetary and non-monetary objectives. The problem is broken down into manageable pieces to enable data and judgements to be applied to individual components. These components are then used to present a coherent overall picture to decision makers. MCDA is not just a technical process, it requires an effective process to structure and conduct the analysis. It is important to get the right mix of people to assist at each stage. MCDA can be used to assess things that have already been allocated resources or to assess proposed actions.

Methods, techniques and tools utilised

There are a range of MCDA techniques that have been developed since the 1970s that provide different ways of disaggregating complex problems, measuring the extent to which options achieve objectives and putting the components back together. Supporting these techniques are proprietary and free software tools, developed to assist with the mathematical aspects.

Strengths

MCDA has been demonstrated to improve decision making than more traditional meetings. It is widely used in government and commercial settings.

Weaknesses

There is a range of techniques for scoring and weighting the criteria. Computer software is required to carry out the mathematical calculations, and participants need to have confidence it is representing their input transparently.

Examples of application

Used widely in the UK from assessing the suitability of sites for nuclear waste disposal to UK government's appraisal of transport investments.

Further reading and resources

Belton, V., Stewart, T., 2002. Multiple criteria decision analysis: an integrated approach. Springer. This book set out MCDA and how it should be used in a more integrated approach to support decision making.

UK Government, 2009. Multi-criteria analysis: a manual. Department for Communities and Local Government, London, UK. This is an approachable manual on multi-criteria analysis (MCA) that goes from introducing MCA to taking the reader through the steps of MCDA and illustrating it through case studies. It provides advice on using MCA and MCDA. One of the authors is Laurence Phillips who has developed and applied Decision Conferencing since the 1970s.

Main steps

What (and why)	How
<p>Establish the decision context. Clarity about the aims of the MCDA helps to define the tasks for subsequent stages and keeps the analysis on track.</p>	<p>Establish aims of the MCDA, and identify decision makers and other key players. A key player is anyone who can make a useful and significant contribution and represents one or more of the important perspectives. Need to consider what stakeholders and other key players should be involved, and the extent of their participation in the analysis.</p> <p>Design the socio-technical system for conducting the MCDA. The social and technical aspects need to be considered together. What form of MCDA is to be used (technical)? When and how are the stakeholders and key players to contribute to the MCDA (social)? Facilitated workshops of stakeholders and key players are widely used. Impartial facilitation focuses on process and ensures the work stays task focussed.</p> <p>Consider the context of the appraisal. Through asking questions about the current situation, goals to be achieved and framing helps provide the setting for the analysis. Looking at the strengths, weaknesses, opportunities and threats (SWOT analysis) aids developing options. Considering the larger political, economic, social and technological (PEST) environment and how these may develop in the future through scenario analysis.</p>
<p>Identify the options to be appraised.</p>	<p>In all cases, whether the options are provided or they need to be developed, those conducting the MCDA need to be open minded about the possibility of adding or modifying options during the analysis.</p>
<p>Identify the objectives and criteria. Assessing options requires consideration of their consequences, as it is these that are being assessed and not the options themselves.</p>	<p>Identify criteria for assessing the consequences of each option. This requires considering the fundamental reasons for the organisation's existence and its core values. It is useful to separate means and ends objectives through asking 'why do you care about that?'</p> <p>Organise the criteria by clustering them under high-level and lower-level objectives in a hierarchy. Produce a value tree with the most important trade-off between objectives at the top, which is often between costs and benefits. This can stimulate thinking about new options through highlighting conflict between objectives.</p>
<p>'Scoring'. Assess the expected performance of each option against the criteria. Then assess the value associated with the consequences of each option for each criterion.</p>	<p>Describe the consequences of the options. Write down simple qualitative descriptions for each option based on each criterion. For simpler problems use a performance matrix and for more complicated problems based on a value tree use an appraisal summary table.</p> <p>Score the options on the criteria. This involves constructing scales representing preferences for the consequences, then weight the scales based on their relative importance, and to finally calculate weighted averages across the preference scales.</p> <p>Check the consistency of the scores on each criterion. This is important and is usually achieved during the process of assessing scores.</p>
<p>'Weighting'. Assign weights for each of the criterion to reflect their relative importance to the decision.</p>	<p>Units of preference for each criterion may differ and the relative importance of these scales is required. The most common method is to use 'swing weighting' elicit weights for the criteria (e.g. SMARTS). The weight on a criterion reflects the range of differences of the options and how important those differences are. Swing weighting method can be carried out with nominal-group technique when working with a group. The setting of weights highlights which preferences count most. Process of deriving weights can be achieved through one to one meetings with key people and then compared, with an opportunity for reflection and change, followed by broad consensus.</p>
<p>Combine the weights and scores for each option to derive an overall value.</p>	<p>Calculate overall weighted scores at each level in the hierarchy. This demanding computational task involves multiply an option's score on each criterion by the importance weight of the criterion, and then sum the products to give overall preference score for that option.</p> <p>Calculate overall weighted scores. This technique of simple weighting averaging is dependent on all the criteria being mutually preference independent.</p>
<p>Examine the results. Agree the way forward or make recommendations.</p>	<p>The ordering of options is given by the weighted average of all the preference scores. It can be useful to look lower in the value tree and display options based on benefits versus costs. Results from MCDA need to be digested before decisions are taken. They can be surprising and may require further meetings to examine the results. It is important to recognise difference between the model results and people's intuitions.</p>
<p>Sensitivity analysis.</p>	<p>Conduct a sensitivity analysis: do other preferences or weights affect the overall ordering of the options? Sensitivity analysis enables assessing the extent to which disagreements between people of vagueness about inputs affect the final overall result. Interest groups can be consulted on their preferences and weights.</p> <p>Look at the advantages and disadvantages of selected options, and compare pairs of options. Computer programmes enable these comparisons. These are useful especially when one option is a natural standard.</p> <p>Create possible new options that might be better than those originally considered. If new options are generated add them to the list of options and score them on all criteria. Weights do not have to be changed if no information is provided on existing options and criteria.</p> <p>Repeat the above steps until a 'requisite model' is obtained. A 'requisite model' is just good enough to resolve the issues under focus. Often the MCDA models have little sensitivity to many individual scores and weights.</p>

Approach: Structured Decision Making

Summary

Structured Decision Making (SDM) is a decision-focused organising approach that incorporates methods and insights from a range of other assessment tools. It is a facilitated and collaborative application of multi-objective decision making and group deliberation methods to environmental management and public policy problems. The goal of SDM is clarity and insights for those responsible for making a decision or for developing recommendations about a difficult choice.

Description and purpose

The aim of SDM is to clarify possible actions and their implications across a range of relevant concerns. Its primary purpose is to aid and inform decision makers, rather than to prescribe a preferred solution. Its distinguishing feature is the attention to both the values of people affected and factual information concerning the potential consequences (Gregory et al., 2012). This dual focus is the basis of defensible decisions: explicit value based choices based on the best available information. SDM is not a unified theory or specified technique. Instead it is both a way of thinking and a bundle of methods aimed at providing insight to decision makers about difficult decisions. What exactly is done at each SDM step and to what level of rigour and complexity will depend on the nature of the decision, the stakes, and the resources and timeline available. A defensible SDM process seeks to foster deliberation informed by analysis. The goal is that it should be 'good enough' for the decision at hand, based on the complexity and urgency of the problems and preferences of the stakeholders.

Methods, techniques and tools utilised

It draws on a range of individual methods including facilitation, influence diagrams to structure the problem, and expert elicitation.

Strengths

SDM has recently been developed based on long history of theory and practice of value based decision making. It is based on multi-attribute utility theory. It stresses broader participation and helping participants to think critically about the decision.

Weaknesses

SDM has only recently started to be used by a wider range of practitioners and could be seen as less developed compared to Strategic Choice Approach or Decision Conferencing that have been developed and practiced since the 1970s.

Examples of application

It has been used extensively in Canada, for example to support decisions about hydropower schemes.

Further reading and resources

Gregory, R., Failing, L., Harstone, M., Long, G., McDaniels, T., Ohlson, D., 2012. *Structured Decision Making: A Practical Guide to Environmental Management Choices*. Wiley-Blackwell, Chichester, UK. This recent book sets out the basis and key components of Structured Decision Making.

www.structureddecisionmaking.org

The authors of the above book have provided a detailed web site that sets out more clearly the steps involved and case studies.

Main steps

What (and why)	How
<p>Clarify the decision context. Define the question or problem to be addressed and why. Identify who needs to be involved and how. Establish scope and bounds of the decision and the roles and responsibilities.</p>	<p>Hold a scoping session that involves the key people and pass through the steps of the SDM process. The objective is to produce a decision charter/project-summarises the approach to planning and consultation.</p>
<p>Define objectives and evaluation criteria. A set of well-defined objectives and evaluation criteria define what matters about the decision, search for alternatives and comparison of alternatives.</p>	<p>Brainstorm what matters (individually first). State the objectives. Separate means from ends. Build a hierarchy of more specific objectives. Test objectives to ensure their usefulness</p>
<p>Develop alternatives. Generate policy or management alternatives to address the objectives. These should present decision makers with real choices through different approaches to the problem or different priorities across objectives.</p>	<p>Developing good alternatives is iterative and involves: technical evaluation of the consequences; and evaluation of the alternatives deliberatively in terms of their desirability. Joint gains, important trade-offs and uncertainties are identified.</p>
<p>Estimate consequences. Performance of each alternative is estimated based on the identified evaluation criteria. A consequence table is of central importance as it illustrates estimated consequences of various alternatives on the objectives of the participants.</p>	<p>Analytical task undertaken by technical experts to estimate the consequences of alternatives based on available knowledge and predictive tools. Identify which uncertainties are critical. Data collection and analysis should be spread across the evaluation criteria in proportion to their expected contribution. Build a consequence table to summarise across alternatives.</p>
<p>Evaluate trade-offs and select. SDM helps find win-wins and identifies trade-offs between alternatives. It requires decision makers to be explicit about the choices they make. It allows use of structured preference assessment techniques to enable participants to improve their understanding of their preferences when considering complex trade-offs. Stakeholder consensus is desirable, but not mandatory. Areas of agreement and disagreement among stakeholders and the reasons for disagreement should be documented and presented to decision makers. The extent of differences in the views of technical experts and the views of non-technical stakeholders and their reasons should be captured.</p>	<p>Involves evaluating these trade-offs and making value-based choices. These trade-offs are exposed and gain understanding of how those most affected by them, view them. The decision will determine who is consulted and who participates in making choices.</p> <p>Legitimate stakeholders do the evaluation based on their own values and their understanding of the values of those affected. Decision makers need to make explicit choices about which alternative is preferred. Trade-offs in the consequence table are then reviewed holistically. Then assign ranks or preferences to the alternatives directly. Participants think about which impacts are more or less important and which trade-offs are more or less acceptable.</p>
<p>Implement and monitor. As decisions are implemented then some of the uncertainties will be reduced. Continually assess the outcome of the decision so it matches expectations. A decision process that is serious about sustainability will create a legacy of learning and adaptation, leading to greater capacity – in terms of technical information, human resources and institutional capacity.</p>	<p>Identify mechanisms for on-going monitoring to ensure accountability based on improvements, additional research to improve knowledge base for future decisions and establish a review mechanism so new knowledge can be incorporated into future decisions. Plan ahead for identifying which elements need ongoing monitoring and what conditions would trigger a review of the decision cycle.</p>

Approach: Decision Conferencing

Summary

Decision Conferencing is an approach for helping a group of key individuals to work together to resolve issues, under the guidance of an impartial facilitator and a decision analysis model is constructed to represent the participants' perspectives.

Description and purpose

Decision Conferencing is a socio-technical approach to problem solving through combination of a social process with technical modelling. It benefits from skilled and impartial facilitation, on the spot modelling and use of IT. The modelling aids thinking and provides a language for dialogue and is concerned about giving the right or optimal answer. Phillips calls the modelling approach in Decision conferences to be 'good enough' models or 'requisite' models (Phillips, 1982, 1984). The purpose of the produced 'requisite' model is to help decision makers construct a new reality, one that more effectively achieves their objectives. This model is a 'tool for thinking' and does not provide an optimal solution or the right answer. Participants generate a shared understanding of the issues and produce a sense of common purpose and commitment to the way forward. They are encouraged to highlight difference between the model results and intuitive judgements. Decision Conferencing has been developed since the late 1970s, in a large part by Lawrence Phillips.

Methods, techniques and tools utilised

Decision Conferencing relies on excellent facilitation and multi-criteria decision analysis (MCDA) modelling.

Strengths

Studies have demonstrated the value of decision conferences

compared to normal meetings. Decision conferences are valued compared to traditional meeting since: they enable generation of a shared understanding; but do not require consensus on all issues; participants gain a sense of common purpose that accommodates differences in individual perspectives; and a commitment to the way forward that preserves individual paths. Decision Conferencing has been found to be more successful than prescriptive approach as the client continues to own the problem and the solution.

Weaknesses

Since a decision conference is wholly based on facilitated group elicitation it is open to the suggestion that it may induce group think. Phillips suggests that expert facilitation can reduce/eliminate this.

Examples of application

- Assessment of drug harm in the UK (Nutt et al., 2010)
- Evaluation of flood control measures (Costa et al., 2004).

Further reading and resources

http://www.lawrencephillips.net/Decision_conferencing.html

Summary of decision conferences by leading proponent Lawrence Phillips.

Phillips, L., 2006. Chapter 19: Decision Conferencing. A Working Paper LSEOR 06.85, Operational Research Group, Department of Management, London School of Economics & Political Science.

Useful overview on Decision Conferencing by Lawrence Phillips.

<http://www.catalyze.co.uk/>

Catalyze are a strategic decision consultancy that use and develop Decision Conferencing in the UK.

Main steps

What (and why)	How
<p>Initiation and scoping. The need and motivation for change indicates a Decision conference could be useful to deal with a hot issue. Decision maker and facilitator assess if it would be useful and who needs to attend.</p>	<p>Decision maker decides there is a need for a Decision conference. The facilitator meets the decision maker to explore nature of issues and identify key individuals/ perspective to attend.</p>
<p>Invitation. An invitation is sent out to key participants to inform them and to save dates.</p>	<p>Set out the purpose of the meeting, administrative details, paragraph on decision conference with an attachment about decision conferencing, any preparation asked of participants and to keep those two days clear.</p>
<p>Decision conference. This is the main activity to discuss and agree objectives; ground rules; transparent discussion, model building, testing and revising; and the three generic aspects of decision conferencing: shared understanding, sense of common purpose and commitment to the way forward.</p>	<p>Decision conference begins with a discussion and agreement of the objectives. The facilitator establishes that information is to be shared freely and treated as a neutral commodity. Explains the three generic aspects of a decision conference and how the group will build a model e.g. MCDA (and less use of decision trees and influence diagrams) that includes the key elements required for addressing the issues. The group discuss the issues, build a model based on these and explores the results. Participants compare their knowledge and gut feelings with the outputs of the model. New insights to the group's shared understanding can be gained from exploring these differences. Sensitivity analysis is carried out to demonstrate how the results are affected by differences in opinion and other input data. The process settles down as a sense of common purpose develops and agreement about the way forward.</p>
<p>Reporting back.</p>	<p>Facilitator produces a short report and holds meetings to resolve remaining issues.</p>
<p>On-going process.</p>	<p>Series of interviews, workshops and decision conference results in overall process of Decision Conferencing.</p>

Approach: Strategic Choice Approach

Summary

Strategic Choice Approach (SCA) is a well-developed approach to planning as a strategic choice that is about choosing in a strategic way and the connectedness of decisions. It is based on working through four interlinked and iterative modes: shaping; designing; comparing; and choosing.

Description and purpose

Planning refers to “loosely defined process of choosing strategically, in which the activities of making plans, decisions and policies can come together in quite subtle and dynamic ways” (Friend and Hickling, 2005). Based on their considerable experience of practice, (Friend and Hickling, 2005) suggested five broad dimensions of difficult choices of balance in strategic choice: a more focused and synoptic treatment of problem scope; a simplified and more elaborating treatment of complexity; a reactive and interactive treatment of conflict; a more reducing and accommodating treatment of uncertainty; and an exploratory decisive treatment of progress through time. Where the task is attaining an appropriate balance over a changing situation.

Methods, techniques and tools utilised

SCA relies heavily on group facilitation. One of the authors

developed software to complement the paper based approach (STRAD Strategic Advisor software tool).

Strengths

Development of theory and practice through many international case studies has resulted in a detailed and robust process. Considers the interlinked nature of many decisions, yet enabling focus on most important areas. The steps/modes are clearly presented in their book. (Friend and Hickling, 2005).

Weaknesses

Could be viewed as mainly relevant to professional environmental planners and less so to wider parties involved in planning type activities. The two main developers have long since retired and it is not clear how this approach is being maintained or developed.

Examples of application

Many applications from the UK and internationally are recounted in their book 'Planning Under Pressure.'

Further reading and resources

Friend, J.K., Hickling, A., 2005. Planning under pressure: the strategic choice approach. Routledge.

An excellent guide to SCA. It clearly sets out and illustrated SCA with informative figures and case studies.

Main steps

What (and why)	How
Shaping mode: structure situation/problem; decision links and graph.	Start with building an unstructured list of decision areas. Individuals can be invited to add their own. Rearrange decision areas by field or levels or both when an unstructured list is long. Think about particular decision areas that overlap with others. Introduce links between decision areas, even tentative ones. Reposition decision areas if there is a need to improve clarity of the decision graph. Highlight different possible problem foci and key decision areas based on grounds of urgency or consequences. Distinguish between different areas of organisational or departmental responsibility. Identify areas for more specialised analysis.
Designing mode: Identify decision options and option bars to produce decision scheme.	When first identifying options within decision areas and when revisited, it is useful to question whether additional options should be included to make the set of options more representative of a fuller range of choice available. It can be helpful to see if breaking down a decision area into two or more separate, but connected decision areas may be useful. Record assumptions why particular options bars so to challenge or justify their validity. Occasionally, it can be useful to identify multiple option bars, often avoided by reformulation of decision areas. Consider coalescing closely linked decision areas. Estimate the number of feasible decision schemes. Set out the decision schemes in a tree and alter order if needed. Explore consistency between levels of choice.
Comparing mode: model comparison area for alternatives; relative assessments of consequences; and shortlist.	Develop a set of comparison areas relevant to a specific problem focus, by comparing each decision area in turn. Build a balanced evaluation framework by cross referencing to broader evaluation frameworks. Compare short term alternatives of policy or other stances. When focus is narrowed to a few alternatives uncover the elements in an assessment procedure. Verbally elicit limits of surprise through stepwise questioning. Combine advantage judgements across comparison areas. When options can be assessed on simplified scale you can reduce range based on constraints of max or min acceptable levels. Shortlist across multiple comparison areas.
Choosing mode: uncertainty areas; timing considerations in action schemes; and commitment package.	Build a working list of uncertainty areas (typology). Place uncertainty area in a decision perspective using a radial uncertainty graph. Reformate composite uncertainty areas into more specific elements. Compare alternative responses to uncertainty. Weigh uncertainty against the urgency in decision making. Accommodate and present uncertainty in future decision space in tree figure. Build an appropriate commitments package (table) that includes immediate and future decisions. Help decision takers to make progress by presenting the action proposal in a familiar form e.g. report, that reflects underlying structure of SCA.

Approach: Multicriteria Mapping

Main steps

What (and why)	How
Register for a Multicriteria Mapping (MCM) account and create a new project	<p>Register for an MCM account and follow instructions to set up a new project: www.multicriteriamapping.com. The MCM manual offers detailed advice on how to do MCM. It suggests how to: go about planning and designing a typical MCM project; how to engage with participants, and how to analyse the results getting the most out of the online MCM application.</p> <p>In the Project Admin screen you can edit the details of the project, manage the researchers with the project, and archive, delete, unarchive or undelete projects. Add a project name based on the focal goal along with a short description.</p>
Plan appraisal and start building your project	<p>Initial tasks of defining a focal goal and core options, and recruiting participants are all interdependent. This will be carried out through collaboration with the individual or group you are supporting in their decision making.</p> <p>In the 'Build' section of the MCM application you can define core and discretionary options and if wished add initial criteria. This set of core options is key as all participants will be asked to appraise them. It is worth spending time discussing these and revising them prior to the engagements/interviews with the participants. Fine tuning these three elements should be undertaken together.</p> <p>Crucial elements of framing an appraisal include choice of possible actions that are included or excluded from scrutiny and those particular perspectives (knowledges and values) that are included or excluded from the process.</p> <p>The core options can be defined by prior analysis or engagement process and/or careful attention to relevant literatures. These should cover the key dimensions of variation across relevant options possible options in wider debate and define these consistently.</p> <p>An initial set of candidate participants is identified from prior analysis or engagement process and/or careful attention to relevant literatures. These should cover the key dimensions of variation across all relevant perspectives in wider debate around the focal goal. Depending on the context these participants may be interviewed to identify additional participants and to identify issues.</p>
Preparing for an engagement/ interview	<p>Each participant should be contacted in advance of the interview (by telephone) to discuss the general context and aims of the MCM activity to ensure they are understood and satisfactory. These scoping interviews are essential to ensure the participants are well informed and comfortable about what is expected of them (see scoping interview checklist in MCM manual 5.1).</p> <p>It is worth discussing with all participants the core options and identify any you have missed out, as the aim is for all participants to appraise all main/core options.</p> <p>Interviews can be carried out online or offline i.e. connected to the internet or using MCM software downloaded in advance. If an interview is carried out offline then a 'template file' should be created in advance (see checklist of materials for an interview in MCM manual 5.3).</p>
During the interview	<p>Enter additional options, criteria, principles, scores, weights and annotations into the software as the interviews proceed. Ensure the interviewees are comfortable that the final option ranks reflect their perspectives. It is crucial the interviewer adopts a neutral and open manner.</p>
Starting the interview (10-20 minutes)	<p>Ensure the venue is suitable and interviewee has sufficient time (two-three hours). Explain the 'basis for engagement' and outline the MCM approach.</p>
Identify options (10-20 minutes)	<p>Define the 'core options' and explain that these represent a range of possible strategies, technologies, policies or other courses of action to achieve the focal goal. It is essential that the interviewees appraise each of the core options. Explain that in the next step it is possible to reject options based on a clearly set out principle. Make notes. Ask if they see any gaps in the set of core options. Introduce any 'discretionary options' identified by project team and not included due to time constraints. Consider 'additional options' identified by the interviewee and create a new Options Group. It is advised to limit the number of options to an initial set of seven to nine.</p>

What (and why)	How
Define criteria (10-20 minutes)	Explain that 'criteria' are the different factors that the interviewee has in mind when they choose between or compare different options. These may address any issue related to the performance assessment of any of the options. These will be applied equally to assessing all of the options. Encourage the interviewee to suggest and define their criteria. Emphasise it is important to be as specific as possible. It is important to point out that appraisal may be undertaken in two quite different ways, according to 'criteria' that can be traded off, or 'principles' that cannot. It is advisable to begin with a relatively modest number of criteria: four to six is suggested. If you are running an offline engagement, back up the engagement file.
Assess scores (60-90 minutes)	Explain that having defined their criteria, the interviewee can now evaluate the relative performance of the different options under each of these criteria. The performance of options under each individual criterion is expressed by using numbers to rate option performance under some arbitrary personal scale. With high scores indicating good performance. The interviewee can use any scale they wish for scoring. The interviewer may recommend a scale of 1-100. Assigning the first score is often most difficult and interviewees often find it easiest to start with the best or worst performing option, or the present status quo. The interviewer explains that scoring is a relatively technical part of the appraisal and the interviewee will be asked to explain and justify their scoring. Explain early on that MCM approach asks for two score values for each option under each criterion, not one. This enables them to reflect how uncertain, variable or sensitive the scores are, so allowing two different scenarios: pessimistic (minimum score) and optimistic (maximum score). The interviewer documents the specific reasons why each score takes a particular value.
Assign weights (10-20 minutes)	The process of assigning weights is different to that of assigning scores as it involves thinking about subjective values rather than technical scores. When first opening the weighting screen it is advisable to close the top ranking panel to help avoid confusion. Explain that weights are different to scores. The interviewee can then proceed on their own terms. The task of the interviewer is to encourage time for reflection rather than rushing through assigning weights. One method is to identify the least important criterion and assign a weight of 10 to this and then move to the most important. Another useful way to think about the end result is the sharing of say 100 'importance points' across all criteria. Then reflect on the final ranks using the chart in the upper panel of the weighting screen. Allow the interviewee to experiment with alternative weighting schemes. Dissatisfaction with the final ranks should not, in itself be taken as grounds to revisit the scoring of options under individual criteria. Wind up the weighting process, concluding the interview only when the interviewee is satisfied the ranking picture provides a reasonable expression of their view based on the nature of the engagement.
Winding up the interview (10-20 minutes)	Closing the MCM process involves confirming the interviewee has arrived at their final ranking picture that is a reasonable expression of their view on the performance of the different options. It is important to reflect by asking the interviewee for feedback on the nature of the MCM process. Then brief them on the ongoing process, saying all MCM interviews take place in the context of the wider research of consultation exercise. Touch on this and issues related to publication and confidentiality or anonymity. After the interview ensure files are saved and labelled. As soon as possible take notes reflecting on the interview. Review all the notes taken during the MCM interview and ensure they are sufficiently comprehensive and clear.
Preparing and loading data for MCM analysis	<p>It is a fundamental principle of MCM analysis, that qualitative and quantitative data are considered together, each informing the interpretation of the other. The qualitative data includes names and definitions of the options; deliberate statements made by the participants during the elicitation process and recorded as notes; and audio recordings of verbal discussions during MCM sessions. Notes added by the interviewer should be placed in brackets. Quantitative data includes: numerical values for pessimistic and optimistic scores for individual options under particular criteria; the interval between these scores reflecting the associated uncertainties; the weights attached by each participant to each of their criteria that reflect the relative priority they attach to these; and the ranks that are computed by the MCM software to express the overall performance of each option under all criteria taken together. Carefully record external data that have been used including additional documents.</p> <p>Preparing the qualitative data: in addition to the automatically loaded data the interviewer is advised to read the transcript of each interview in advance of the analysis. Highlighting passages where the participant makes statements which seem likely to be relevant to the later interpretation of analysis. Highlighted notes may reveal pre-conceptions or assumptions of options or criteria; reveal meanings or definitions that people give to the options or criteria; reveal detailed reasons why particular values have been used; express relationships between criteria or options; record salient responses to the picture emerging as the MCM process unfolds; indicate general disposition or perspective of the participants in question or expectations of other participants; and reactions to the structure of the MCM process itself. See MCM manual 14.9 summary of procedure for preparing and loading data.</p>

What (and why)	How
Move engagements to analysis	Once finished entering data for an engagement, you need to move each engagement into to analysis section of the application.
Setting up an MCM analysis session	Open the MCM software online and go to the 'Analyse' section. Update the data to be used in the Analysis: ensure completed MCM engagement are synchronised by clicking on the 'Data Synchronisation' link on the Analyse screen.
Elements of MCM analysis	<p>The main aim is to explore different possible pictures of the results obtained in an MCM appraisal. This can directly inform policy debates or practical decision making by revealing the patterns in the performance of the different types of option under different types of perspectives or conditions. And indirectly and of great value, background 'understanding' concerning the particular reasons why specific types of option tend to be viewed favourably or unfavourably under different types of perspectives or conditions.</p> <p>MCM analysis is based around grouping participants, options and criteria: there are three main kinds of groupings to experiment with. Groupings of the different types of participant that have been involved in the appraisal. These are termed 'perspectives'. Groupings of the different types of options that have been appraised by participants. These are termed 'clusters'. Groupings of the different types of criteria used by participants to appraise the options. These are termed 'issues'. Consequences of different groupings include: depending how participants, options and criteria have been grouped these different perspectives, cluster and issues may display contrasting patterns.</p> <p>There are two main ways which MCM analysis can be used to include or exclude participants in perspectives, options in clusters or criteria in issues. The first is based on 'external categories' (drawn from outside the analysis) and the second is based on 'internal categories' (categories drawn from the inside the analysis itself) e.g. options that display a certain type of feature or different criteria that share a common attribute. Internal categories can also be informed by emerging patterns in scores, uncertainties, weights or ranks. In practice MCM analysis will iterate between the use of external and internal categories as the basis of different possible groupings. The key point being there is no 'objective' or 'definitive' way of defining perspectives, clusters or issues.</p>
Main stages in the analysis and reporting	<p>MCM analysis revolves around iterations of the grouping of data, and the representation of the resulting patterns. The simplest grouping and reporting involves displaying ranks for an individual participant. This report begins with the simplest of charts showing the overall ranks obtained by the selected participant for each of the options that they assessed, taking account of all the criteria that they thought relevant. To create a report for the selected individual, go to the Report section and select Ranks. Select the perspective you created for the single participant and select all issues.</p> <p>Interpreting the 'Ranks for Participant' chart. On the vertical axis, the chart displays all the 'predefined options' that were defined for all participants as well as 'additional options' defined by this participant. On the horizontal axis the chart displays an arbitrary scale from 0 to 100 expressing the ranks assessed for each option by the participant in question.</p> <p>There is a wide range of possible analysis and reporting options that include: displaying ranks for a selected perspective; displaying uncertainties by perspective; displaying ambiguities for perspectives; displaying issue weighting; aggregating scores over perspectives and issues; and uncertainties and ambiguities in aggregate scores.</p> <p>Although MCM analysis does not proceed in a linear or mechanical fashion, it is possible to identify a series of distinguishable stages, which inform each other in an iterative way until a satisfactorily robust picture is produced. These are not fixed 'rules' for conduct of MCM analysis, but rather a framework of sensible provisions:</p> <ol style="list-style-type: none"> a. Become familiar with the material b. Take an early look at the grouping of data c. Explore the consequences of different assumptions d. Keep a complete and systematic record e. Form and test explicit hypotheses f. Investigate detailed features g. Check the qualitative data h. Take a balanced approach to representing findings i. Involve participants in reviewing interim results. <p>Ideally, a draft report of interim findings should be circulated to participants, with identities coded anonymously and each recipient knowing only their own coding. Though any feedback is not binding, the resulting comments may be useful in challenging, substantiating and augmenting the emerging picture. Depending on the project this can be on a one to one basis face to face at a workshop if enough participation can be assured.</p>

What (and why)	How
Main stages in the analysis and reporting <i>(continued)</i>	The bottom line. Of course, in any MCM exercise on an issue of practical strategic importance to decision making, there is likely to be greatest interest in the 'bottom line' results the clusters or individual options that look best and worst overall, taking into account all the different criteria assigned under the viewpoints of all the particular participants.



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