Appendix 2: Multi-criteria analysis

The rapid growth of composite indexes in recent decades attests to their seductive qualities. Popular indexes include a species that ranks the 'world's most liveable cities', including one version published by the Economist Intelligence Unit. World university rankings attract considerable attention among tertiary education aspirants, while the Worldwide Governance Indicator, the Global Slavery Index, the Climate Change Vulnerability Index, the Global Democracy Ranking, and many others, regularly attract the attention of the media.

Composite indexes seek to summarise disparate data about a specific topic or issue, typically conflating them into a single numerical value. Numerical rankings are based on various measures for different characteristics or criteria, generally weighted by their relative importance in the index, and then aggregated. Multi-criteria analysis (MCA) is ultimately based on the same approach.

Detailed critiques of composite indexes and MCA can be found in Luskin and Dobes (1999), Vincent (2007), Cox (2009), Dobes and Bennett (2009), and Pollitt (2010), amongst others. It is not the intention to replicate these arguments here, but rather to illustrate the arbitrariness of analyses based on composite index methods by presenting a simplified example of an MCA process. We are not aware of any textbooks that present comparable material.

Dobes (1999) bemoaned the fact that it was not possible to obtain a 'live specimen' of an MCA, despite the fact that at least one state road agency was then using the method. This circumspection on the part of governments was noted again by Dobes and Bennett (2009) after a futile request for a copy of the unpublished MCA that was used by the Victorian Government to justify diversion of Goulburn River water to Melbourne in the Sugarloaf Pipeline Project.

Due to the paucity of published government MCAs, a simplified example of an MCA is used below to illustrate the essential approach. Proponents of the MCA method would rightly point out that there is a considerable body of mathematically and statistically sophisticated superstructure related to the selection of criteria, weights and scores (Chankong & Haimes, 1983), but the intention here is to examine the underlying fundamentals.

Table A2.1 portrays a hypothetical approach to a road-widening project in the form of a goals-achievement matrix (GAM) that is typically used in MCA. The first column is the key to the process, because it specifies the factors — termed attributes or criteria — that are to be taken into account in the analysis. There is no theory or specific guideline governing their choice, so their selection is essentially arbitrary and may reflect the priorities of politicians, decision-makers or special interests (i.e. 'stakeholders'). Cost-benefit analysis, on the other hand, requires that the costs and benefits that affect all members of society must be taken into account.

Apart from the temptation for an analyst to second-guess the preferences of decision-makers, there is considerable risk of double counting in MCA due to its emphasis on a set of desired outcomes specified by the analyst. In Table A2.1 this is deliberately illustrated by including both the creation of jobs and the growth in local business revenue, a not unusual set of policy-desirable attributes. Sophisticated MCA practitioners, however, would undoubtedly seek to reduce the scope of double counting by, for example, checking on correlation levels between attributes.

No specific numeraire is used in MCA, with attributes assessed by allocating a score to the estimated impact of the project on each attribute. In Table A2.1, a Likert scale that ranges from –4 to +4 has been used. The weight allocated to each attribute reflects its relative importance in the expected outcomes from the project. Scores and weights may be determined by the analyst, a focus group, or a decision-maker, but there is no theory to guide their determination so that they are essentially subjective and arbitrary. The final step is shown in the right-hand column, where the products of the scores and weights in Table A2.1 are shown and aggregated, giving a unitless total weighted score of 190.

Table A2.1: Simplified goals-achievement matrix for a road-widening project

Attribute	Units	Impact	Score (–4 to +4)	Weight %	Weighted score
Travel time saving per trip	Minutes	13	2	10	20
Growth in local business p.a.	Revenue ($)	56,000	4	40	160
Reduction in crashes p.a.	Number	4	3	10	30
Employment	Jobs	23	3	20	60
Cost of project	$	89,000	–4	20	–80
Total				100	190

Source: Leo Dobes

Table A2.2 demonstrates the effect of a change in the nominated attributes of the project. In this case, a different hypothetical analyst may have decided to take into account the environmental aspects of the road-widening project by including wombat mortality rates and greenhouse gas emissions. Because there is no underlying theory to guide the selection of attributes, or their number, there is no reason to either exclude or include these environmental effects. The scoring scale remains the same, but the weights have necessarily been adjusted to ensure that they continue to add up to 100: a different analyst might also have chosen different weights for each of the attributes. The total weighted score has now changed to 30. Because the weighted aggregate score is unitless, it is not possible to conclude whether it is slightly worse, much worse or not at all worse than the previous result of 190. Nor is it possible to compare either result to an alternative use of resources like building a hospital or a school.

Table A2.2: Selection of different attributes for the project

Attribute	Units	Impact	Score –4 to +4)	Weight %	Weighted score
Travel time saving per trip	Minutes	13	2	10	20
Growth in local business p.a.	Revenue ($)	56,000	4	10	160
Reduction in crashes p.a.	Number	4	3	10	30
Employment	Jobs	23	3	10	60
Cost of project	$	89,000	–4	20	–80
Dead wombats	Number	27	–4	20	–80
More CO_2	Tonnes	55	–4	20	–80
Total				100	30

Source: Leo Dobes

A different scoring scale has been used in Table A2.3, but with no other change from Table A2.1. The extension of the scoring range from –4 to +4 to the new range of –5 to +5 yields a total weighted score of 250. Again, there is no theory to guide a decision to use one or the other scoring scale, or to assess the significance of the difference in results.

Table A2.3: Different scoring scale used to assess the project

Attribute	Units	Impact	Score –5 to +5)	Weight %	Weighted score
Travel time saving per trip	Minutes	13	3	10	30
Growth in local business p.a.	Revenue ($)	56,000	5	40	200
Reduction in crashes p.a.	Number	4	4	10	40
Employment	Jobs	23	4	20	80
Cost of project	$	89,000	–5	20	–100
Total				100	250

Source: Leo Dobes

As would be expected, a change in the weights used in Table A2.1 will produce a different total weighted score, as shown in Table A2.4. As before, there is no method grounded in theory that allows the determination of the relative significance of the results.

Table A2.4: Different weights attached to each attribute

Attribute	Units	Impact	Score (–4 to +4)	Weight %	Weighted score
Travel time saving per trip	Minutes	13	2	20	40
Growth in local business p.a.	Revenue ($)	56,000	4	20	80
Reduction in crashes p.a.	Number	4	3	10	30
Employment	Jobs	23	3	40	120
Cost of project	$	89,000	–4	10	–40
Total				100	230

Source: Leo Dobes

Proponents of MCA sometimes argue that it is preferable because it does not require the monetisation of factors that are considered in assessing a project. Unless all cost considerations are fully excluded, however, MCA does in fact produce implicit monetary values. In Table A2.4, for example, the project cost of $89,000 is estimated to create 23 jobs, a cost per job of about $3,870. A similar calculation can be made for the number of crashes avoided, or for travel time savings, raising the question of whether these outcomes could not have been achieved at lower cost by some other means.

The MCA approach is also attractive, if not seductive, because it is relatively easy to carry out. It essentially requires only an ability to specify criteria, scores and weights. The production of numerical scores also provides a semblance of systematic analysis. The mathematical appropriateness of aggregating disparate attributes measured in incommensurable units by linking them to scores and weights must, even so, be subject to serious reservation.

Absent the aggregation of weighted scores, the least desirable aspect of MCA would be avoided because incommensurable units would not be combined mathematically. Nevertheless, the selection of criteria to be addressed, and the allocation of weights and scores still involve a degree of arbitrariness. The MCA approach therefore begs the question of why one should expend effort on employing numerical values when a simple qualitative comparison of the positive and negative criteria of a project could achieve the same outcome.

If, despite the above reservations, MCA is used as an analytical tool, its use will present decision-makers with a dilemma because there is no consistent way of choosing between, say, a road-widening project and the construction of an art gallery or the preservation of a wetland. Each project has different attributes, so that comparisons of their aggregated weighted scores would be meaningless.

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