Multi-Criteria Analysis: Ignorance or Negligence?

Leo Dobes[1], Jeff Bennett[2]

[1]Crawford School of Economics and Government, The Australian National University

[2]Crawford School of Economics and Government, The Australian National University

Email for correspondence: Leo.Dobes@anu.edu.au

Abstract

Multi-Criteria Analysis is highly subjective and potentially open to abuse through the influence of special interests. Moreover, it is seriously flawed conceptually and mathematically. At best, its continued use by public sector policy advisers and decision-makers is due to ignorance. At worst, it represents gross negligence in the provision of advice to Ministers, and possibly breaches Australian Public Service Values and the Code of Conduct.

1. Introduction

Just over a decade ago, the then Bureau of Transport Economics (BTE) published a widely-read report by Luskin and Dobes (1999) entitled *Facts and Furphies in Benefit-Cost Analysis: Transport*. The final chapter in that report reviewed the technique of multi-criteria analysis (MCA), but noted that 'the BTE was unsuccessful in its informal approaches to personnel in various State road authorities for a "live specimen" of an MCA'.

In truth, several State road authority officers had promised to provide copies of example MCA reports that had been produced by their agencies to advise their Minister on the desirability of specific projects. Subsequent discussion between these officers and their supervisors appears to have dissuaded them from fulfilling their original undertakings to supply the documents. Nevertheless, one courageous public servant did provide a number of 'under the table' reports on condition that they not be cited by the BTE. Examination of their contents was nevertheless useful in confirming the conclusions reached by the author of the BTE chapter on multi-criteria analysis, even though they were not cited.

Little seems to have changed over the last decade in terms of the public unavailability of detailed analyses based on MCA. Indeed, the level of secrecy appears to mask what is apparently a widespread degree of popularity of the technique in guiding investment decisions in a variety of government projects, including transport.

In the continued absence of a 'live specimen' we rehearse some of the key conceptual problems inherent in multi-criteria analysis. We argue that, irrespective of any sophisticated mathematical superstructures, the underlying methodology is fatally flawed. Further, the largely arbitrary and subjective nature of the techniques employed in MCA can permit special interest groups (often euphemistically called 'stakeholders') to have an undue degree of influence in the decision-making process.

This raises the question of why public servants continue to use MCA in providing advice to their Ministers. The question is particularly pertinent to organisations that stress the importance of good governance in their work.

One possibility is that many public servants are not aware of the implications of using multi-criteria analysis. Where this is the case, it is fair to ask whether their ignorance constitutes a failure in governance on the part of their agency in carrying out its duties and responsibilities to its portfolio Minister to provide objective, evidence-based advice.

Less morally attractive is a potential alternative explanation: multi-criteria analysis is used because it allows advisers to second-guess Ministers, or to provide advice that has been clearly indicated as representing the predilections of the Minister. Even if its use is not overt or consciously misleading, it may still represent gross negligence in terms of the provision of objective and rigorous advice. We therefore question whether the use of multi-criteria analysis is entirely consistent with public service values and codes of conduct.

Finally, we renew the offer of a decade ago to undertake analysis of detailed examples of multi-criteria analyses that have been used by government decision-makers in the Australian transport sector.

2. Policy advice in the public sector

Pointing out that evidence-based policy is hardly a new concept, Banks (2009, p. 5)

nevertheless cautioned that:

> 'Without evidence, policy makers must fall back on intuition, ideology, or conventional wisdom — or, at best, theory alone. And many policy decisions have indeed been made in those ways. But the resulting policies can go seriously astray, given the complexities and interdependencies in our society and economy, and the unpredictability of people's reactions to change. ... Among other things, policies that haven't been informed by good evidence and analysis fall more easily prey to the 'Law of Unintended Consequences' — in popular parlance, Murphy's Law — which can lead to costly mistakes.'

However, Weimer & Vining (1998, p. 44-47) highlight the fact that evidence used in policy making is by no means a homogenous quantity. They distinguish between evidence produced by 'objective technicians', 'client advocates' and 'issue advocates'. Client advocates seek to interpret issues and facts from a perspective that puts their clients' interests in the best possible light. Those who advocate specific issues tend to represent special interests in the belief that the furtherance of those issues will benefit society. Faced with analytical results that do not support their preferred perspectives, client and issue advocates will generally question underlying assumptions necessarily made in an analysis, or the criteria on which decisions are being made.

However, the Australian Public Service Commission (2009) clearly specifies in its Values and Code of Conduct that the Australian Public Service is apolitical and performs 'its functions in an impartial and professional manner'. It is also expected to be 'responsive to the government in providing frank, honest, comprehensive, accurate and timely advice ...'. The various equivalent codes of conduct of state government may differ in their wording, but their intent is much the same as that of the Commonwealth Government. Public Service policy analysts therefore fall most naturally into the 'objective technician' category identified by Weimer & Vining (1998).

Another perspective on the issue is that of the principal-agent problem which arises where principals and their agents do not have access to the same information. For example, Australian society, the principal, will have much less information about the costs and benefits of a specific road project than its agent, the government. A similar asymmetry of information

can affect the relationship between a government or Minister (the principal) and their agent, the policy analyst or adviser. If the analyst or adviser presents incomplete or selective information, the Minister cannot make a properly informed decision. At the extreme, this may even result in misleading Parliament when it appropriates funds to the government.

We therefore take as our starting point that the fundamental value that is, or should be held by public service policy analysts is that of analytical integrity. By implication, their advice should be apolitical, objective and based on rigorous methodology that provides a comprehensive analysis of an issue. But most importantly, it should provide advice to decision-makers that provides sufficient information to allow them to consider the interests of society as a whole.

3. Tools for policy analysis

The panoply of analytical approaches available to the public service analyst/adviser is more than matched by the variety of descriptive buzzwords and phrases on offer. Gap analysis, triangulation, balanced scorecards, cost-effectiveness, multi-attribute analysis, fuzzy logic, the triple bottom line, Monte Carlo simulation, systems analysis, heuristics, SWOT analysis, cost-benefit analysis, multi-criteria analysis, meta-analysis, traffic lights, wicked problems, value chains, scenario analysis, etc, are only some of the many techniques and perspectives that have competed for the attention of busy analysts as managerial fads and fashions have come and gone.

Because the transport sector generally entails investment in infrastructure or regulatory activity, the most commonly used analytical tools are essentially cost-effectiveness analysis, cost-benefit analysis and multi-criteria analysis. We examine the latter in more detail in the next section.

As its name implies, cost effectiveness analysis involves comparisons of the cost of a proposed action with the effect that it produces. In Public Service terms, the effect is the actual or expected output or outcome of the implementation of a government policy. Effects are usually expressed in physical or other non-monetised units. The cost of implementation can be expressed in whatever form is appropriate, including budgetary/financial or economic cost, in current or present value (discounted) terms. An example of cost-effectiveness analysis might be the comparison of resurfacing two alternative road routes on the basis of the cost per kilometre of road resurfacing: on route may be longer but cheaper overall to resurface because the existing pavement is in better condition.

Cost-effectiveness has advantages when comparisons are made between alternative policies that have the same output or outcome. By implication, it is particularly apt when a decision has already been taken, for political or other reasons, to implement a specific measure, so that the only remaining issue is the relative cost of alternative methods or scales of implementation.

Although generally used only for a single output or effect, cost-effectiveness analysis can be extended to multiple outputs and inputs through Data Envelopment Analysis (see, for example, Coelli et.al. 2005), a technique based on linear programming. The Productivity Commission (1999), for example, has used Data Envelopment Analysis to compare the productive efficiency of the various Australian railway systems following the implementation of reforms by different jurisdictions.

As a ratio of an effect (output) and a cost (input), a cost effectiveness ratio measures efficiency. Its key disadvantage, however, is that it measures technical efficiency, but not allocative efficiency. It can provide information on the relative desirability of one measure compared to another, but cannot tell us whether the implementation of any of the alternative

measures will produce a net benefit to society or not. In particular, cost-effectiveness analysis tells us nothing about the 'do-nothing' case.

Cost-benefit analysis usually requires more effort and cost than cost-effectiveness analysis because it incorporates estimates of social benefit as well as social cost. Its very significant advantage over all other analytical techniques is that its comprehensive approach is based on estimating the net benefit to society as a whole of a policy measure. Because it employs monetary values as a numeraire, it allows judgements to be made about allocative efficiency. Not only can projects or measures in different sectors, such as hospitals and roads, be compared, but it is possible to determine whether each project on its own will increase the welfare of society or not. Nevertheless, the construction of the Alice Springs to Darwin railway shows that such considerations are not always paramount in government.

An urban myth appears to have taken root in recent years in the public sector that cost-benefit analysis cannot take into account anything but market values. Where markets do not exist, alternative techniques are required, according to this view. The unfortunate outcome is the frequent misuse of Triple Bottom Line reporting (a technique more properly applicable to private sector analyses) and multi-criteria analysis, including egregious double-counting errors, as well as a large dose of subjectivity. Economic analysis, particularly cost-benefit techniques has, as a matter of course, always included non-commercial effects that affect society, including environmental values.

Cost-benefit analysis does not necessarily rely on market values. Indeed, it may be necessary for an analyst to adjust purely market values to allow for externalities and non-competitive distortions to estimate so-called shadow prices which better reflect social values. Where social values cannot be observed directly, a range of techniques, including stated preference surveys and hedonic pricing, can be employed.

The key conceptual difficulty faced by an analyst who employs cost-benefit analysis is the implicit assumption that the marginal utility of money does not differ between individuals. In fact, an additional dollar may have a greater value for a poor student than for a fat cat public servant. How important this problem is overall for a relatively homogenous society like Australia, where extremes in wealth do not predominate, is not clear. While economics textbooks readily and explicitly address this issue, the debate remains unresolved. Nevertheless, by identifying the winners and losers of a particular policy measure, decision-makers at the political level can take any perceived differences in utilities into account, as well as the likely broader distributional consequences.

4. Multi-Criteria Analysis

Multi-Criteria Analysis is generally presented in the form of a so-called Goals Achievement Matrix. A typical, but simplified illustrative example of a matrix is shown in table 1 below.

The hypothetical policy analyst of the proposed road widening project in table 1 has selected what he or she considers to be the most important impacts or goals of the project. In reality, a more sophisticated analysis would be likely to also include alternative projects for comparative purposes.

It is sometimes argued that governments require the use of 'triple bottom line' analyses (a form of multicriteria analysis) for presentational reasons, for example to be seen to be considering environmental and social factors, as well as economic ones. Whether this approach constitutes mere political 'spin' is not an issue addressed here. However, this claimed government requirement does not detract from our argument that, unless rigorous cost-benefit analysis is conducted, Ministers cannot make informed social decisions.

4.1 Biases due to lack of conceptual underpinning

Note that no provision has been made for a range of other effects in table 1 that may affect the total welfare of society, including, for example, the effect on the environment. It is one of the fundamental weaknesses of multi-criteria analysis that there is no theoretical underpinning to the number or type of attributes to be included. Because there is no conceptual guidance, the selection must necessarily be arbitrary, random or highly subjective. In effect, any number of different decisions could be taken, with no unambiguous rule on which is to be preferred from a social perspective (Arrow's Impossibility Theorem).

Because the analyst is forced institutionally to select a combination of impacts that will be acceptable to political decision-makers, it is highly likely that the selection will, consciously or unconsciously, reflect the concerns of key 'stakeholders'. The nature of relevant stakeholders is rarely defined, but, again, it would hardly be surprising if the focus were on vocal or politically influential groups or individuals. If an analyst wishes to avoid such obvious selection bias, a focus group may be used. However, even if the focus group were somehow selected to be perfectly representative of society as a whole, dominant individuals within the group, or even the facilitator, are still likely to introduce special interest biases.

Table 1: Illustrative example of simplified multi-criteria analysis: 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

Because the selected impacts are expressed in non-commensurable units of measurement, the analyst is forced to impose quantification through attribution of scores that reflect the degree of impact of each attribute. In the absence of any unambiguous theoretical underpinning, various scoring scales can be selected, but table 1 shows a commonly used range from -4 (most undesirable level) to +4 (most desirable level). However, desirability is obviously a subjective concept. Except by pure coincidence, any scores attached to individual impacts are unlikely to reflect the preferences of other analysts or society as a whole.

The arbitrary nature of the selection of impacts and attachment of scores is further compounded in the next stage of the analysis; the selection of weights (fifth column of table 1) as a means of specifying the relative importance of each of the impacts. Again, choice of weights can only be arbitrary, or at worst, seriously biased towards ensuring a 'desirable' result. Evidence of such bias is naturally difficult to find, but Luskin and Dobes (1999, p. 203) cite an article by Dunning (1997) of a traffic restraint project in England. The article indicates fairly clearly that cost-benefit analysis was deliberately not used because it would have produced a negative (i.e. undesirable to the analysts) result, so multi-criteria

analysis was used instead. Given this philosophy, one could further speculate that the impacts and weights would also have been chosen with due deliberation.

Because of the number of aspects that are involved in undertaking a multi-criteria analysis, and because of the inherent subjectivity, it is unlikely that any two analysts would produce the same answer. Although absolute precision cannot be expected in either multi-criteria analysis or cost-benefit analysis, it is not an exaggeration to say that, as a technique, multi-criteria analysis suffers from being non-replicable. In other words, it is unscientific in nature.

4.2 Society versus special interests

The starting point for cost-benefit analysis is to estimate, as well as possible, the effect of a policy measure on society as a whole. To ensure that this is done objectively and comprehensively, the analyst is required to aggregate the costs and benefits that accrue to all individuals in society, be it Australia as a whole, one of the states or territories, or a local area.

In contrast, the analyst who employs multi-criteria analysis starts implicitly from a position of 'client advocate' or 'issue advocate', in the typology identified by Weimer & Vining (1998): see above. The reason for this difference in approach between cost-benefit and multi-criteria analysis is that analysts themselves are able to select the criteria (impacts) that they personally consider should be emphasised in the evaluation or analysis.

An analyst may wish to take into account the general ideology or predilection of a client such as the Minister. It is only to be expected in that case that the criteria used in the analysis will reflect a very specific perspective. For example, a 'petrol-head' Minister may wish to favour road congestion measures that allow access to bus lanes for Sports Utility Vehicles during peak periods. Conversely, an analyst who approaches a road issue from a predominantly environmental perspective may decide to favour more fuel-efficient cars, either in the selection of criteria, or the assignment of weights.

In neither case is there a balanced appraisal of the effects on all car users in society, but both approaches would be valid in terms of a multi-criteria analysis. Apart from illustrating the potential for a significant degree of subjectivity and potential bias in the provision of policy advice, this point also raises the question of how a Minister or Cabinet could validly make decisions about competing projects (e.g. road versus rail) where each has been analysed from an entirely different perspective.

In case it might be thought that the issue of bias is an academic one, it is instructive to consider the Sugarloaf Pipeline Project, which proposed the transport of water by pipeline from the Goulburn River to reservoirs that supply water to Melbourne residents. Despite an initially favourable response, access to the actual multi-criteria analysis was subsequently denied to us on the grounds of Cabinet confidentiality.

It should come as no surprise that the scores and weights used for the Sugarloaf project appear to have been largely determined by water authorities, as well as being 'based on advice' in part from the Agency Reference Group that was heavily involved in the study. This reference group consisted largely of state government agencies such as VicRoads, local governments such as the Shire of Yarra Ranges, government departments such as Planning and Community Development, and water and catchment authorities (Sugarloaf Project Alliance 2008, p. 13). Even if representatives of other interest groups were included, they would have been heavily outnumbered.

4.3 The issue of monetization

An oft-cited reason for eschewing cost-benefit analysis, and using multi-criteria analysis instead, is that many impacts cannot be expressed in monetary units. This is a furphy.

Cost-benefit analysis does not *require* that all of the components of an analysis be monetised. Where analysts are unsure of the accuracy or the wisdom of expressing some aspect of the analysis in monetary units, the option always exists of including it in qualitative terms. Ergas (2009, p. 35) gives the example of moral standards or considerations.

And as explained by Dobes and Bennett (2009, p. 21), the critique that money should not be used as a metric:

> ' ... is misplaced, because willingness to pay – albeit expressed in monetary units – in fact represents a consumer's willingness to sacrifice one bundle of goods or resources for another: money simply represents a claim on resources. Money is just a common expression of value, a numeraire, just as a physicist may measure energy in joules (convertible to calories, electron-volts, and so on), even for different physical systems (food, sunlight, fossil fuels, kinetic energy of an electron, and so on). It would be just as valid to express the value of bundles of goods or services in terms of hamburgers, conch shells or Mars bars that would need to be given in exchange to obtain them.'

Further, the techniques for estimating willingness to pay for various attributes such as environmental degradation are well developed in modern cost-benefit analysis. Contingent valuation methods, choice modelling and hedonic pricing are standard techniques that have a wide variety of applications.

Ironically, multi-criteria analysis can itself end up attaching implicit monetary values to attributes and impacts, despite the qualms that many of its adherents have about monetization. In table 1, for example, equal weights have been attached to the attributes of cost and employment in the road widening project. This implies that 23 additional jobs are considered to be of equal importance to a cost of $89,000. The implicit value of a job is therefore about $3,870.

But it is not clear why a job is valued at this amount, or who attaches such a value to it. The worker and the employer will almost certainly have different valuations, based more closely on the actual wages paid. Similar incongruities arise in terms of the value of travel time savings and crashes avoided. The problem arises from the arbitrariness of the methodology and its lack of clear theoretical underpinnings.

4.4 Fatal mathematical flaws

Even if it were possible to ignore the various biases and subjectivity inherent in multi-criteria analysis, the technique suffers from such a fundamental mathematical flaw that no amount of sophisticated modelling or statistical and mathematical refinements can genuinely overcome it. In simple terms, the flaw in question is the attempt to add apples and oranges.

In order to be able to use a mathematical operator like addition or subtraction, the quantities in question must possess the same dimensionality. That is, the units must be identical. It is possible, for example to add 1 kg to 1.5kg, but not 1kg plus 2 pounds. Plausible aggregation requires expression in common units. Cost-benefit analysis solves the problem by converting all costs and benefits to a standard dimension – the quantity of resources that $1 will command.

It is this key mathematical principle of dimensionality that is breached in multi-criteria analysis. Few policy makers would suggest that it is valid to simply add minutes of travel time saved to number of jobs created. It is therefore puzzling why so many of them are prepared to accept a unitless result that relies on first multiplying each quantity by a score and then a weight. Most schoolchildren would be equally puzzled if told that apples and oranges can be added up in this way.

In table 1, the problem of dimensionality is worsened further because attributes expressed in cardinal number units such as minutes are multiplied by an ordinal number scale (-4 to +4) and then an interval scale (weights expressed as a number between 0 and 100), and then treating the result as a cardinal number that can be added to other cardinal numbers to get a total in the fifth column. Even if the Likert[1] scoring scale (-4 to +4) were treated as an interval scale because the distances between numbers were assumed to be equal (e.g. the difference between 1 and 2 were equivalent to the difference between 3 and 4), the basic flaw of incompatible dimensions is sufficient to invalidate the results of a multi-criteria analysis.

A disturbing aside is that the penchant for adding incommensurable apples and oranges now appears to extend even to the decision-maker level. A joint Budget media release by the Minister for Infrastructure, Transport, Regional Development and Local Government and the Minister for Finance and Deregulation (Albanese & Tanner, 11 May 2010) on rail investment refers to the creation of 'more than 1,500 jobs, mostly in regional Australia'.

Just as oils ain't oils, jobs are not necessarily homogenous either. A temporary job during the construction phase of a passing loop is clearly not the same as a permanent increase in employment of an additional maintenance worker to look after the loop in the future. Labelling them both as jobs is equivalent to solving the addition of an apple and an orange as equalling two pieces of fruit. An interesting approach, and great fun, but ultimately trite and meaningless.

5. Apples, oranges, Mandarins and the emperor

Given that many of the policy analysts involved in the transport sector are engineers and economists, most could be considered to be professionally numerate. Most would probably react negatively to an attempt to add a quantity expressed in kilograms to one expressed in kilometres. Yet both they and their decision-making superiors often appear to be prepared to accept the same incommensurable approach in analyses that are labelled 'multi-criteria analysis'.

It is not clear why this should be so. One explanation may be that public servants are simply too busy to reflect more deeply on what has become common practice, or even that they are ignorant of the underlying, atheoretical nature of multi-criteria analysis. If this is so, then their continued use of it can only amount to negligence.

An alternative explanation is that public servants have been aware of the problems of multi-criteria analysis, but have consciously used it because they believe that the results can be better tailored to suit the predilections of political decision-makers. In that case, the gross

---

[1] Likert scales are commonly used in questionnaires to measure attitudes or preferences of respondents. They are generally used to represent choices between 5 alternatives such as 'strongly disagree' – 'disagree' – 'neither agree nor disagree' – 'agree' – 'strongly agree', although the range can be extended or compressed, for example to 7 or 10 or 3 or 4 point scales.

negligence involved probably contravenes the spirit, if not the letter of Public Service values and codes of conduct.

It is also time to stop the practice of secrecy that shrouds the content of policy analysis that employs multi-criteria analysis. Public availability of all analyses (multi-criteria as well as cost-benefit) is essential if the principal-agent problem in government is to be minimised.

We would be happy to review a set of multi-criteria analyses should any jurisdiction be willing to make an appropriate set available, and permit publication of our findings.

Admittedly, cost-benefit analysis can be time-consuming and has its own shortcomings. However, it remains the only credible analytical tool available to public sector analysts and decision-makers. Although there is no set template, the principles and underlying theory are pretty well established after being subjected to intense critique and debate over the greater part of a century. Because it draws on a coherent analytical framework it is capable of peer review and should be used in preference to ostensible shortcuts such as multi-criteria analysis.

Indeed, it is high time for Mandarins to stop trying to add apples and oranges, and to focus on assessing the social costs and benefits of transport projects. The current, populist 'emperor' of multi-criteria analysis simply has no clothes.

References

Albanese, A & Tanner, L 2010, 'Nation building rail investment', 11 May, Budget-Infra 02/2010, Joint Media Statement, viewed 12 May 2010, http://www.minister.infrastructure.gov.au/aa/releases/2010/May/budget-infra_02-2010.htm

Australian Public Service Commission 2009, 'APS values and code of conduct in practice', 6 May, viewed 11 May 2010, http://www.apsc.gov.au/values/conductguidelines4.htm

Banks, G. 2009, 'Evidence-based policy-making: What is it? How do we get it?', ANZSOG/ANU Public Lecture Series, 4 February, Canberra, viewed 11 May 2010, http://www.pc.gov.au/__data/assets/pdf_file/0003/85836/cs20090204.pdf

Coelli, TJ, Rao, DSP, O'Donnell, CJ, & Battese, GE 2005, *An introduction to efficiency and productivity analysis*, 2nd edition, Springer, USA

Dobes, L & Bennett J 2009, 'Multi-Criteria Analysis: "good enough" for government work?', *Agenda*, vol. 16, no. 3, pp. 7-29

Dunning, J 1997, 'New valuation techniques for new policies: can the Goals Achievement Matrix take over from COBA?', *Local Transport Today*, 17 July, pp. 12-13

Ergas, H 2009, 'In defence of Cost-Benefit Analysis', *Agenda*, vol. 16, no. 3, pp. 31-40

Luskin, D & Dobes, L 1999, *Facts and furphies in benefit-cost analysis: transport*, Report 100, Bureau of Transport Economics, Canberra

Productivity Commission 1999, *Progress in rail reform*, Inquiry Report, Report no. 6, 5 August

Sugarloaf Project Alliance 2008, 'sugarloaf Pipeline Project: sustainability framework', February 2008, revision 3, viewed 11 May 2010, http://www.melbournewater.com.au/content/library/current_projects/water_supply/sugarloaf_pipeline_project/project_impact_assessment_report/appx_19_sustainability_framework.pdf

Weimer, DL & Vining AR 1998, *Policy analysis: concepts and practice*, 3rd edition, Prentice Hall, New Jersey