

Appraisal and Evaluation of Travel Demand Management Measures

Geoff Rose

Institute of Transport Studies, Department of Civil Engineering, Monash University,
Victoria, Australia

1 Introduction

Interest in Travel Demand Management (TDM) has grown throughout the world as transport authorities seek to employ a range of solutions to improve transport efficiency while reducing the negative impacts associated with the growing use of the motor vehicle. The Institution of Engineers, Australia (1996) defines TDM as “*intervention (excluding provision of major infrastructure) to modify travel decisions so that more desirable transport, social, economic and/or environmental objectives can be achieved and the adverse impacts of travel can be reduced.*” Austroads, the association of Australian and New Zealand road authorities, has been active in the development of TDM in Australia and was responsible for commissioning work in the early 1990s to study road demand management and determine ‘the principles on which management of demand for use of the road network in major cities could be based and identify specific measures to reduce congestion’ (Wayte, 1991; Austroads, 1991). Travel Demand Management Guidelines were subsequently published (Austroads, 1995) and more recently evolved into a resource book on TDM (Austroads, 2002).

While the references noted above, along with others, provide insight into the range of TDM measures available, less attention has been focussed on the evaluation of TDM measures to support either more informed decisions about their implementation or more insightful understanding of the impacts of measures which have been implemented. Consequently Austroads commissioned a study to establish a nationally consistent approach to evaluating the effectiveness of TDM measures with a particular emphasis on non-pricing measures. The study aimed to provide a basis for more informed choices between non-infrastructure and infrastructure solutions, a better understanding of how and when to use TDM measures and to enable TDM investment decisions to be considered and integrated with other investment choices. This paper draws on the research undertaken for Austroads to outline a framework for the evaluation of TDM measures. As will be explained shortly, there is a distinction between appraisal and evaluation, and since the former has received much less attention in the context of TDM, that is the emphasis of this paper.

The structure of this paper is as follows. TDM evaluation is reviewed in Section 2 to provide the context for the framework presented in Section 3. The appraisal component of the framework is then examined in detail (Section 4) and its application illustrated through an example case study. The conclusions of this study are summarised in Section 5.

2 TDM evaluation: knowledge, practices and gaps

To gain an appreciation of the state of the art in TDM evaluation, a literature review was conducted in combination with a survey Australian jurisdictions (distributed through Austroads TDM contacts) and interviews with representatives of the National Travel Behaviour Change program (TravelSmart). Key issues are summarised here while complete details are provided in Rose and Ringvall (2006).

There are many examples in the TDM and evaluation literature where different terms are used to refer to the same concept. Evaluation can be conducted at different points in the life of a project or initiative. It is possible to distinguish between evaluation conducted before implementation (pre-implementation evaluation also known as ‘a-priori’ or ‘ex-ante’ evaluation and appraisal) from that conducted after implementation (post-implementation evaluation also known as ‘ex-post’ evaluation). The terminology adopted in this paper mirrors that in the *National Guidelines for Transport Systems Management (TSM)* (ATC, 2006), specifically:

- Appraisal is the process of determining the impacts and overall merit of a proposed alternative, including presentation of the relevant information for consideration by the decision maker, while
- Evaluation is the specific process of reviewing the outcomes and performance of an initiative after it has been implemented.

2.1 TDM appraisal

Traditionally appraisal would employ techniques such as benefit-cost analysis, cost-effectiveness analysis, multi-criteria analysis, goals achievement matrix and the planning balance sheet. The Austroads (2002) TDM Resource Book (Chapter 4) establishes initial guidelines for starting a TDM project. It is suggested that more time spent in the pre-project planning stages increases the likelihood that the approach adopted will be the most effective and efficient. The key steps noted are: identifying the root cause of the problem, identifying the stakeholders and the target group, and assessing alternative strategies as initial steps before choosing a TDM measure or set of TDM measures. Once TDM has been identified as the most appropriate strategy to address the problem, the TDM Resource Book suggests determining which type of TDM measures is most suitable. Initially a project description is noted as a useful starting point followed by systematic consideration of the goals/purpose, component objectives, outputs and the activities involved in the initiative.

Apart from the material mentioned above from the Austroads TDM Resource Book, few specific examples of selection tools or approaches were identified in the literature or the review of current Australian practice. In general, most of the literature tends to focus on evaluation rather than appraisal. There is limited experience noted in the USA with models which have been developed to predict the travel impacts of specific Commute Trip Reduction programs, taking into account the type of program and worksite. These include the *CUTR_AVR Model* (www.cutr.usf.edu/tdm/download.htm), the *Business Benefits Calculator* (BBC) (www.commuterchoice.gov) and the *Commuter Choice Decision Support Tool* (www.ops.fhwa.dot.gov/PrimerDSS/index.htm). These models are however limited to a particular type of TDM initiative and would not assist in comparing that with other measures or indeed with establishing whether that is the most appropriate measure in the first place.

The emphasis noted above on quantitative evaluation is contrasted with the developments in the UK where evaluation frameworks are explicitly embracing qualitative dimensions. The UK's 'New Approach to Appraisal' (UK Department of Transport 2004) has been influential in the acceptance of broader evaluation frameworks. An 'Appraisal Summary Table' is used to summarise key information on the outcomes associated with the objectives for each alternative which is appraised. This approach was subsequently developed for use in Australia for appraisal of proposed actions in a Travel Demand Management Action Plan (Ker, 2003; Kerr and Rosalion, 2003) and provides the foundation for the approach outlined later in this paper.

As noted earlier, Benefit Cost Analysis (BCA) is one tool used in appraisal. The National Guidelines on TSM (ATC, 2006) provide additional guidance on BCA for urban projects which may be of benefit in the context of applying BCA to TDM options. Recent reports discussing the evaluation of TravelSmart (the generic name for voluntary travel behaviour change initiatives) commissioned by the Victorian Department of Infrastructure (Manusell Australia, 2006) along with the Land Transport NZ *Travel Behaviour Change Guidance Handbook* (Land Transport NZ, 2004) and the *Travel Behaviour Change Evaluation Procedures: Technical Report* (Maunsell Australia, 2004) contain guidance on quantifying and valuing benefits for travel behaviour change programs. Litman (undated) also provides extensive discussion of the benefits and costs of TDM programs which can be valuable in the context of conducting an appraisal.

2.2 TDM evaluation

Evaluation commonly employs some form of before-after evaluation where measurements are taken before and after an initiative is implemented. A comparison of the before and after

measurements is then used to gain insight into the effectiveness of the initiative. Frequently a quasi-experimental design is employed including a control site or group which has not received the initiative. This approach enables changes in the general environment (e.g. changes in the price of petrol) to be accounted for rather than being attributed erroneously to the impact of the initiative. Finke and Schreffler (2004) take a broader perspective by highlighting that TDM measures can be evaluated at a range of possible levels:

- awareness: measuring the target audiences' (residents, business leaders, public officials, etc.) overall awareness of mobility management strategies and programs
- attitudes: the degree to which the target audience supports mobility management strategies and programs
- participation: the amount that the target audience participates in mobility management programs, such as applying for ride matching services or purchasing discounted transit passes
- satisfaction: the degree to which the target audience is satisfied with mobility management strategies and programs, particularly those that they have used
- utilisation: the degree to which the target audience has changed their travel patterns in response to mobility management strategies and programs
- impact: the degree to which mobility management strategies and programs have changed overall vehicle traffic levels, traffic congestion, road and parking costs, traffic accidents, etc., compared with what would have occurred otherwise.

In the Australian context, attention is often focussed on the last one in this list (impacts) while US and particularly European practice explore measures from throughout this range in TDM evaluation. The European Union MOST-MET (Mobility Management Strategies for the next Decade – Monitoring and Evaluation Toolkit) (2003) project focussed on the development of a monitoring and evaluation toolkit. MOST-MET was designed as a working aid to provide guidance for comprehensive and individual self-assessments of the impacts of Mobility Management (MM). MM is the term used in Europe to refer to 'softer' Travel Demand Management measures such as mobility centres, green travel plans, community-based travel behaviour change etc. Unfortunately the Manual is thin on advice about choosing MM instruments and services other than to say that selection of the measures needs to be done in conjunction with stakeholders. It does however highlight that it is essential to budget in advance for evaluation and comments that it is not uncommon for 10% of a MM project's budget to be earmarked for evaluation. The TAPESTRY project used the MOST-MET framework to assess 18 mobility management campaigns selected from across Europe and 'demonstrated the importance of measuring changes in awareness and attitude, as well as changes in travel behaviour, particularly when it may not be realistic to expect changes in modal shift in the short term' (Tyler and Cook, 2004).

The approaches outlined in the MOST-MET and TAPESTRY are commonly concerned with the evaluation of a package of MM measures. In contrast most of the evaluation experience in the US, as highlighted by Schreffler (2000), is based on evaluation of individual pilot projects that focus on a single TDM measure (such as a new vanpool or public transport user subsidy) or on individual employer sites (such as the development of a carpool system or a transportation management organisation for the site).

The survey of Australian jurisdictions highlighted that while it was recognised that monitoring can be included as part of TDM project briefs, there was reluctance at times to fund such research. The exception relates to voluntary travel behaviour change programs targeting schools, workplaces and communities where there is evolving evaluation experience. Western Australia was a pioneer in this respect, while South Australia and Victoria have initiated major projects to undertake systematic evaluations of community-based TravelSmart initiatives using a before and after design with control groups. In South Australia, use is being made of Global Positioning Systems (GPS) to gather rich information on change at the individual level. In contrast, Victoria explored the use of odometer readings to provide insight into changes in vehicle use. This is very much an area of 'work in progress' although results to date highlight

that sampling is a major issue where surveys provide the basis for the before and after travel data. No definitive evaluation guidelines have been developed although the current projects are expected to provide valuable insight to assist in the evolution of evaluation methodologies.

3 A Framework for Appraisal and Evaluation of TDM measures

It was evident from the review reported in the previous section that little evidence was forthcoming of systematic frameworks for the appraisal of TDM measures. The framework presented here builds explicitly on the National Guidelines for Transport Systems Management in Australia (Australian Transport Council, 2006) and reflects elements of Land Transport New Zealand's funding allocation process (Land Transport NZ, 2005). The Australian national guidelines make use of an Appraisal Summary Table which also forms a key part of the New Approach to Appraisal in the UK (UK Department of Transport, 2005). The framework presented here has evolved from an appraisal framework for proposed actions in a TDM Action Plan (Ker, 2003; Kerr and Rosalion, 2003). That framework drew on the concept of the Appraisal Summary Table. By building on that foundation, with enhancements that closely mirror the National Guidelines, the proposed framework presented here is in harmony with the National Guidelines. It therefore provides a sound basis for evaluating demand management measures alongside traditional supply side measures which are the primary focus of the National Guidelines.

The framework was developed in draft form and then subjected to extensive peer review and testing through a series of workshops held in Melbourne, Brisbane, Sydney and Wellington (NZ). Drawing on the input from the nearly 60 TDM practitioners, policy makers and academics who participated in those workshops, the framework was refined and its application tested in a series of hypothetical case studies. In this paper the emphasis is on the appraisal component of the framework since the earlier review highlighted that as a major gap. Rose (2007) presents a more detailed explanation of the framework.

Figure 1 summarises the overall framework for selection and evaluation of TDM measures. This process is framed by two key inputs – the objectives and stakeholder consultation. The objectives play a key role as inputs to a number of components of the process. Stakeholder consultation can be viewed as a continuous part of the process, whether it is conducted formally or informally, as the process proceeds.

The evaluation framework has three central components (shown shaded in Figure 1):

1. Shortlist Appraisal
2. Rapid Appraisal
3. Evaluation.

While a broad range of candidate TDM measures could be considered, it is desirable from an efficiency point of view, to target a smaller set of candidate options for appraisal. For this task a selection toolkit has been developed which encompasses a selection checklist and a TDM measure selection table. That selection toolkit is outlined in the following section and is designed to assist in identifying a candidate set of TDM measures, or package of measures, which are relevant to the particular problem context.

Appraisal is not a single step in the process but can be likened to a two stage sieve. The first coarser sieve (Shortlist Appraisal) is intended to identify options which are unlikely to survive the more detailed appraisal stage which follows. The second stage sieve (Rapid Appraisal) prunes the list of candidates so that the strongest would proceed to the development of a business case as a basis for a final decision to implement. Rapid appraisal is based on a strategic merit test and rapid benefit cost analysis (BCA) as explained in the National Guidelines on Transport Systems Management (ATC, 2006).

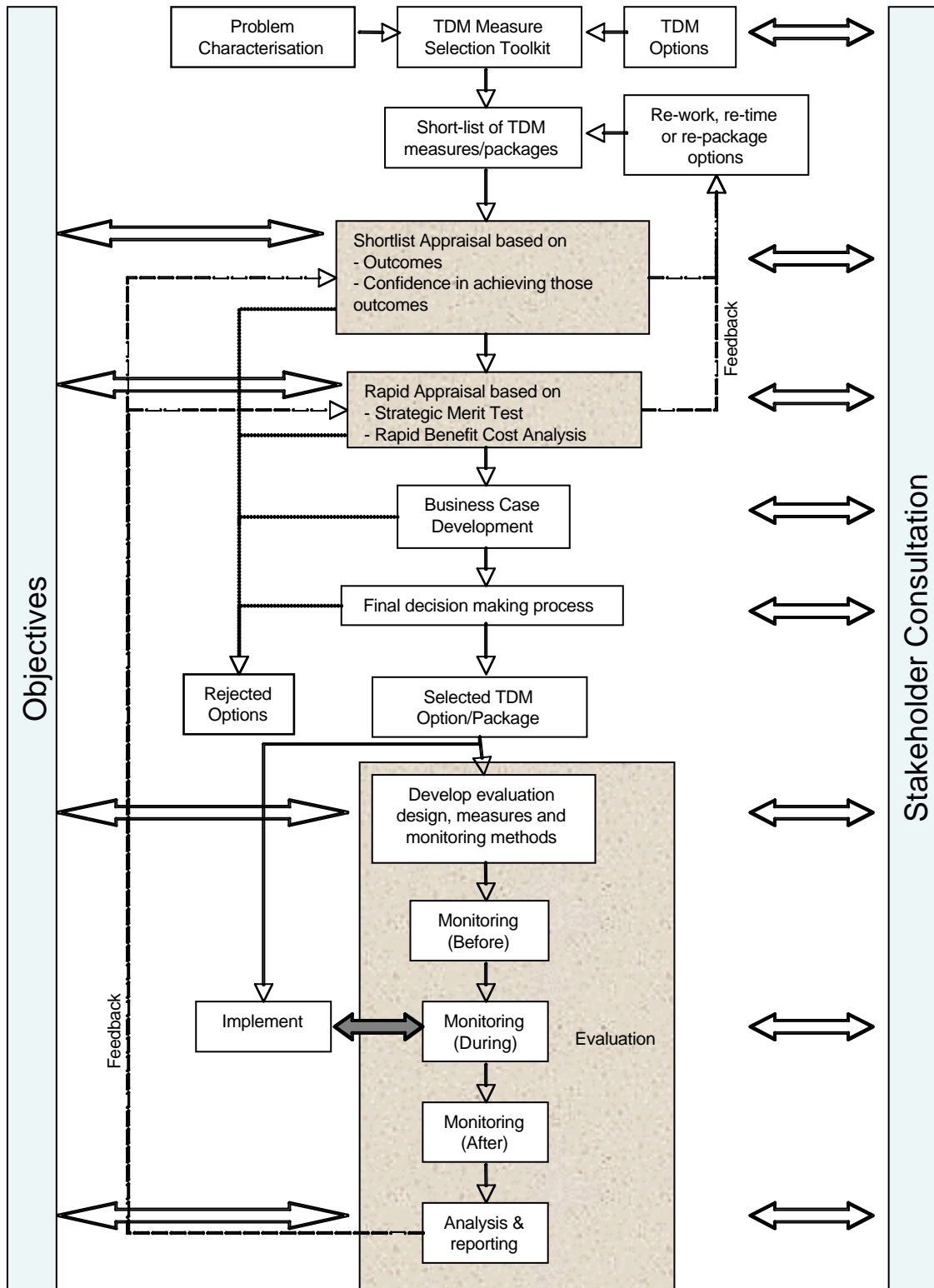


Figure 1: Overall appraisal and evaluation framework

Candidate TDM options are first assessed using a Shortlist Appraisal process which is based on an assessment of the anticipated outcomes and the confidence of achieving those outcomes. The Shortlist Appraisal process relies on scoring the alternative against a range of criteria. The scores on the 'outcomes' and 'confidence' dimensions then provide a basis for identifying options/packages worthy of subsequent more detailed appraisal and business case development. Appraisal is often an iterative process where options may be refined on the basis of the understanding developed through the process of conducting the appraisal. The iterative nature of that process is reflected in the feedback links shown towards the top of Figure 1.

It is essential that consideration be given to the design of the evaluation prior to implementation. The design of the evaluation includes specification of the measures to be used to assess whether the objectives have been achieved and the monitoring methods to be employed to collect the necessary data. Monitoring needs to be conducted before, during and after implementation. This ensures that appropriate data are collected to enable an informed decision to be made about the impact of the TDM measure. It is also critical for data to be collected prior to implementation so that measures can be compared 'before' and 'after' the TDM measure is implemented. The underlying objectives are an important input to the establishment of the evaluation measures and monitoring system and they also provide the basis on which the performance of the initiative is judged. The data collected before, during and after implementation are subsequently analysed and provide the basis for preparing a final evaluation report. The insight gained from evaluation can be fed back to the appraisal stage for future projects. The depository developed as part of this project (Pattinson, 2006) provides a mechanism for archiving and sharing the results of TDM evaluations.

3.1 TDM Selection Toolkit

An important first step in the overall framework is the selection of candidate TDM measures. There is a need to ensure that an appropriate range of TDM measures are considered. In this context 'appropriate' could be considered to mean measures which will not only address the underlying problem but do so in a way which is consistent with progressing the relevant objectives for the transport system. A selection toolkit has been developed to assist in identifying potentially 'appropriate' TDM measures. On the basis of a characterisation of the underlying problem, and the full range of candidate TDM measures, a selection checklist (Figure 2) and TDM measure selection table (Table 1) are used to assist with the short-listing process.

The selection checklist (Figure 2) identifies the sequence of steps to be followed in selecting an appropriate TDM measure. Two versions of the checklist are shown: one with a strategic emphasis, where it is consideration of the underlying objectives which starts the process, and the other with a tactical emphasis, where an existing problem motivates the search for a TDM measure. The steps in the two versions are similar, the difference is primarily in the sequence of those steps. TDM measures can have a potentially valuable role to play in progressing strategic objectives such as reducing greenhouse gas emissions, improving levels of physical activity (to respond to concerns over obesity) or reducing fossil fuel consumption (to reduce vulnerability to changes in fuel price or availability). Here most emphasis is placed on the steps in the tactical version since that is the one which is most likely to be applied in practice. The tactical version of the checklist indicates the first step is to develop an understanding of the problem which TDM measures are intended to solve. This can include identifying the geographic scale of the problem, for example, whether it relates to an individual building or group of buildings (e.g. an office park development), a location on the road network, a route on the road network or a corridor or region of an urban area. The location within the urban area (inner or outer suburbs) could also have a bearing on the characteristics of the problem and the availability of travel options. The underlying problem may be characterised in terms of the time period over which unsatisfactory system performance is noticeable.

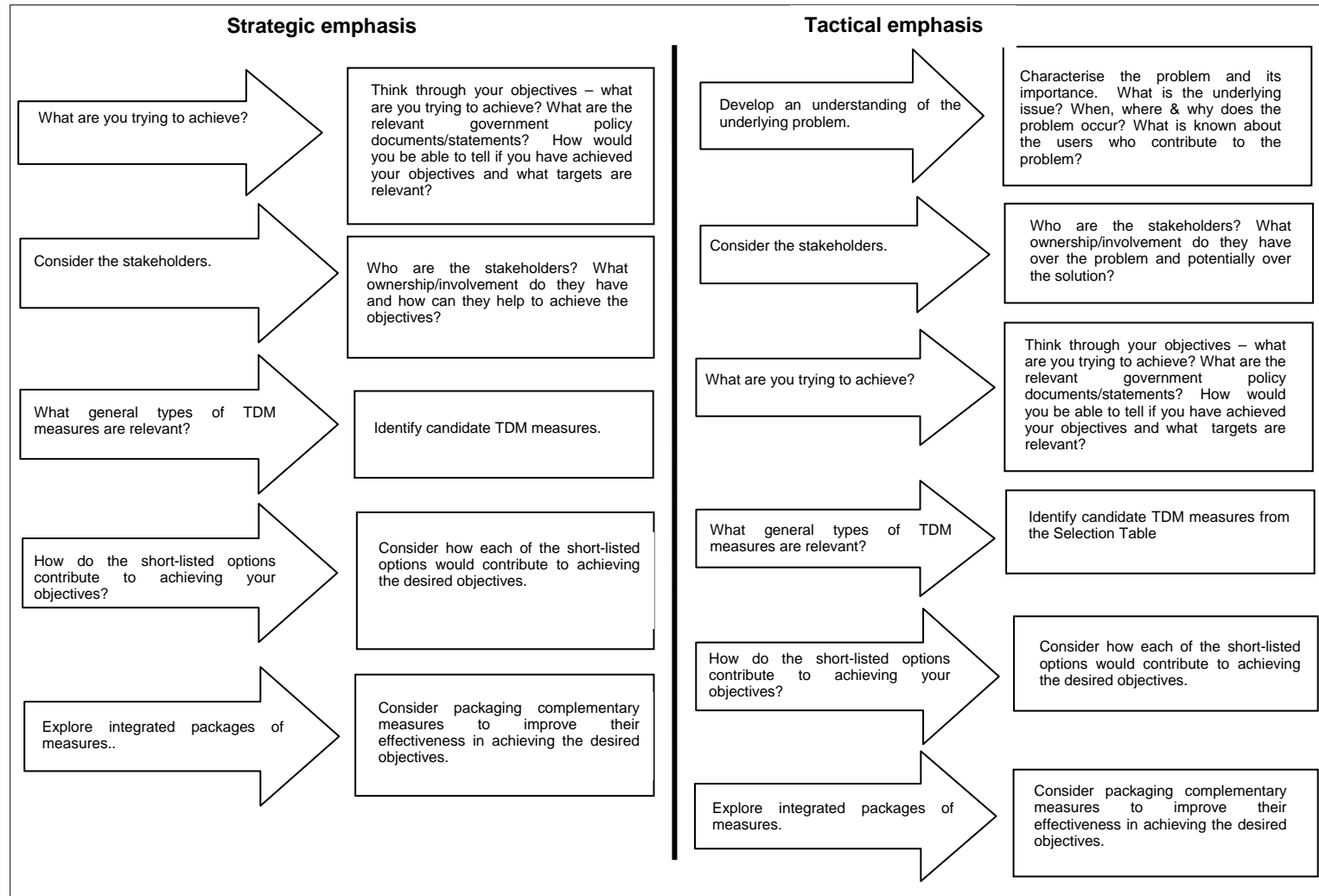


Figure 2: Strategic and tactical views of the selection checklist

Table 1: TDM measure selection table

| | | Where does the problem occur or where could a solution be targeted? | | | | | |
|------------------------------|---|---|--|---|--|--|--|
| | | Individual building or site | Group of sites | Link | Route | Corridor | Area/Region |
| When does the problem occur? | Weekday peak | <ul style="list-style-type: none"> ▪ Parking provision & management ▪ Travel plan ▪ Multi-modal access guides ▪ Changing cost of car travel ▪ Raising travel/environmental awareness ▪ Improved ped & bike facilities ▪ Promoting walking & cycling for health ▪ Ride-sharing, carpooling or car-sharing ▪ Teleworking, teleconferencing ▪ Alternative hours ▪ Smart growth or transit oriented development ▪ Travel coordinator ▪ Events and challenges | <ul style="list-style-type: none"> ▪ Parking provision & management ▪ Travel plan ▪ Multi-modal access guides ▪ Changing cost of car travel ▪ Raising travel/environmental awareness ▪ Improved ped & bike facilities ▪ Promoting walking & cycling for health ▪ Ride-sharing, carpooling or car-sharing ▪ Teleworking, teleconferencing ▪ Alternative hours ▪ Smart growth or transit oriented development ▪ Transportation management association ▪ Travel coordinator ▪ Events and challenges | <ul style="list-style-type: none"> ▪ ATMS – signal priority, access metering, lane restrictions ▪ PT and HOV priority lanes ▪ Improved ped & bike facilities ▪ LATM/traffic calming | <ul style="list-style-type: none"> ▪ ATMS ▪ ATIS ▪ Changing capacity ▪ PT and HOV priority lanes ▪ Improved ped & bike facilities ▪ LATM/traffic calming | <ul style="list-style-type: none"> ▪ ATMS ▪ ATIS ▪ AUPS ▪ Changing capacity across routes ▪ PT and HOV priority lanes ▪ Improved ped & bike facilities ▪ LATM/traffic calming ▪ Community-based travel behaviour change program (e.g. TravelSmart) | <ul style="list-style-type: none"> ▪ ATMS ▪ ATIS ▪ AUPS ▪ Physical restraint through area limitations (traffic cells/mazes, area licences) ▪ Parking provision or restraint, control & management ▪ Changing cost of car travel ▪ Vehicle registration and purchase taxes ▪ Campaigns to raise environmental awareness, reduce GHG or promote PT ▪ Community-based travel behaviour change program (e.g. TravelSmart) ▪ Raising environmental awareness ▪ Promoting walking & cycling for health ▪ Ride-sharing, carpooling or car-sharing ▪ Smart growth or transit oriented development |
| | Weekday off-peak or weekend | <ul style="list-style-type: none"> ▪ Parking control & mgt ▪ Travel plan ▪ Teleconferencing | <ul style="list-style-type: none"> ▪ Parking control & mgt ▪ Travel plan ▪ LATM/traffic calming ▪ Changing cost of car travel ▪ Campaigns to reduce GHG or promote PT ▪ Transportation management association | <ul style="list-style-type: none"> ▪ ATMS ▪ PT and HOV priority lanes | <ul style="list-style-type: none"> ▪ ATMS ▪ ATIS | <ul style="list-style-type: none"> ▪ ATMS ▪ ATIS | <ul style="list-style-type: none"> ▪ As above |
| | Variable – linked to special event timing or seasonal factors | <ul style="list-style-type: none"> ▪ Public transport to special events ▪ Subscription buses or shuttle buses ▪ Alternative hours | <ul style="list-style-type: none"> ▪ Public transport to special events ▪ Subscription buses or shuttle buses ▪ Alternative hours ▪ Transportation management association | <ul style="list-style-type: none"> ▪ ATMS ▪ PT and HOV priority lanes | <ul style="list-style-type: none"> ▪ ATMS ▪ ATIS ▪ Changing capacity ▪ PT and HOV priority lanes ▪ Improved ped & bike facilities | <ul style="list-style-type: none"> ▪ ATMS ▪ ATIS ▪ AUPS ▪ PT and HOV priority lanes | <ul style="list-style-type: none"> ▪ As above |

Acronyms used above: ATMS (Advanced Traffic Management Systems) includes signal priority and linking, access metering, lane restrictions to encourage high occupancy vehicles, PT and/or freight vehicles and discourage low occupancy vehicles; ATIS (Advanced Traveller Information Systems) involves information provision to influence departure time, mode or route choices; AUPS (Advanced User Payment Systems) includes integrated payment and smart charging across modes and/or with parking & tolls along with broader pricing initiatives such as congestion pricing; PT = Public Transport; HOV = High Occupancy Vehicle Lane; LATM = Local Area Traffic Management; GHG = Greenhouse Gas

A distinction could be drawn here between a problem which primarily manifests itself during weekday peak periods as opposed to being associated with special events such as a festival or sporting match. Detailed consideration needs to be given to the relevant user groups since TDM measures, by their very nature, are aimed at modifying travel behaviour and so need to be developed with due regard to the underlying users' travel behaviour. It is useful to identify key user groups relevant to the problem along with factors motivating their travel and their sensitivity to various changes in the transport system. Consideration also needs to be given to the scope to change aspects of their travel behaviour such as the timing or frequency of trips, the destination, mode or choice of route taken for those trips. TDM measures may then be selected which would have greatest impact on the travel decisions which are the targets for change.

Stakeholder analysis may also provide valuable insight at this time. This includes identifying the relevant stakeholders and their level of involvement in, or ownership of, the underlying problems. Stakeholders can play a valuable role in helping to generate options as well as giving feedback on a range of options. It is also worth considering their potential role in assisting with the implementation of solutions. Many TDM measures rely on active engagement by key stakeholders and there may be opportunities to build that involvement at an early stage.

An important next step is to consider relevant objectives and the extent to which it is possible to measure how a particular initiative progresses those objectives. This is very relevant to the ultimate development of an evaluation design which follows later in the process. Relevant targets may be sourced from government policy documents or statements and assessed for appropriateness in the context of the problem at hand. Targets need not always be framed in terms of an increase in say mode use since arresting a decline in use of a particular mode may be worthy achievement.

On the basis of the appreciation of the underlying problem, and who it concerns, candidate TDM measures can then be identified. To assist in this task, a selection table has been developed to highlight the range of measures which are likely to be relevant in particular situations. That selection table is shown in Table 1. The rows in the table correspond to the time period over which the problem is apparent while the columns relate to the location where the problem occurs or where a solution could be targeted. This table provides a basis for identifying a range of TDM measures which may be worthy of consideration in a particular context.

Depending on the temporal and spatial attributes of a particular problem, it may be necessary to consider more than one cell in Table 1 when identifying potential TDM measures. The dividing lines in the table are dashed to highlight that there are no rigid boundaries on the cells in the table. When seeking TDM measures to deploy in a strategic setting, entire rows or columns may need to be considered to identify appropriate candidates. To illustrate the application of the table in a tactical context, consider an example where a problem may relate to a particular corridor. In addition to considering the TDM measures listed in the 'Corridor' column in the table, there may also be scope to consider measures targeted on the 'Areas' at either end of the corridor, that is, considering a column to the right of where the problem occurs. Likewise, options to the left may also be relevant. In the corridor context, individual sites or groups of sites within, or at either end of the corridor, could be targeted with the measures in the left hand side columns of the table.

The final step in the short-listing checklist is to consider integrated strategies or measures. This could be a combination of different TDM measures or through combinations of TDM and more traditional supply side measures including infrastructure and land use planning. The traditional supply side measures include capacity expansion through either physical construction or application of advanced technology in the case of Intelligent Transport Systems (ITS). Options may be refined and packages developed by considering how

effective they are likely to be in achieving the desired objectives. When exploring the potential for integrated strategies or measures there may be merit in considering 'packages' of the following types:

- 'Push' and 'Pull' measures such as a combination of disincentives to discourage status quo travel choices and incentives to encourage new travel behaviour: for example, changes to parking availability for single occupant vehicles and increased availability of premium location carpool parking implemented at the same time as High Occupancy Vehicle (HOV) lanes are introduced in a corridor.
- Information strategies to reinforce new or improved travel options: for example, multi-modal access guides or broader community-based travel behaviour change programs (e.g. dialogue marketing initiatives such as TravelSmart Community or Household programs) delivered at the same time that pedestrian and bicycle facilities are improved, when enhancements are made to public transport services or a new ride-sharing, carpooling or car-sharing scheme is introduced; development of an Advanced Traveller Information System (ATIS) to provide information on travel times by car in conventional versus HOV lanes.
- Activity changes to reduce the impact of 'Push' measures: Such as encouragement of teleworking or alternative (work) hour arrangements along with changes in parking provision.

4 Shortlist Appraisal

The short-listed set of TDM measures are next subjected to a Shortlist Appraisal process as illustrated in Figure 3. Shortlist appraisal focuses on two key dimensions: Outcomes and Confidence (that those outcomes can be achieved). The confidence dimension reflects a similar consideration which is imbedded in the Land Transport NZ's funding allocation process (Land Transport NZ, 2005). The assessment of both the 'outcomes' and the 'confidence' is achieved by scoring each TDM option against a range of criteria. The National TSM Guidelines (ATC, 2006) explicitly recognise the subjectivity associated with assigning the scores or ratings. While a project team could internally undertake the scoring for shortlist appraisal, the subsequent rapid appraisal stage would usually involve scoring by government agency staff assessing proposals for funding (ATC, 2006).

Multiple outcomes are considered in the short-list appraisal by including a range of criteria covering two broad categories:

- TDM effectiveness, i.e. how effective is the measure in managing demand
- economic, environmental and social impacts.

Figure 3 highlights that the mean scores on the 'outcome' and 'confidence' dimensions feed into a category analysis (See Figure 4) to identify options which show sufficient promise to proceed to the rapid appraisal step. Shortlist Appraisal involves outcome and confidence assessment, as described in Section 4.1, and the selection of options for further appraisal, described in Section 4.2.

4.1 Outcome and Confidence Assessment

Outcome assessment focuses on two areas: TDM effectiveness and impacts. In each area, a series of assessment criteria can be established and a rating or score assigned against each criteria.

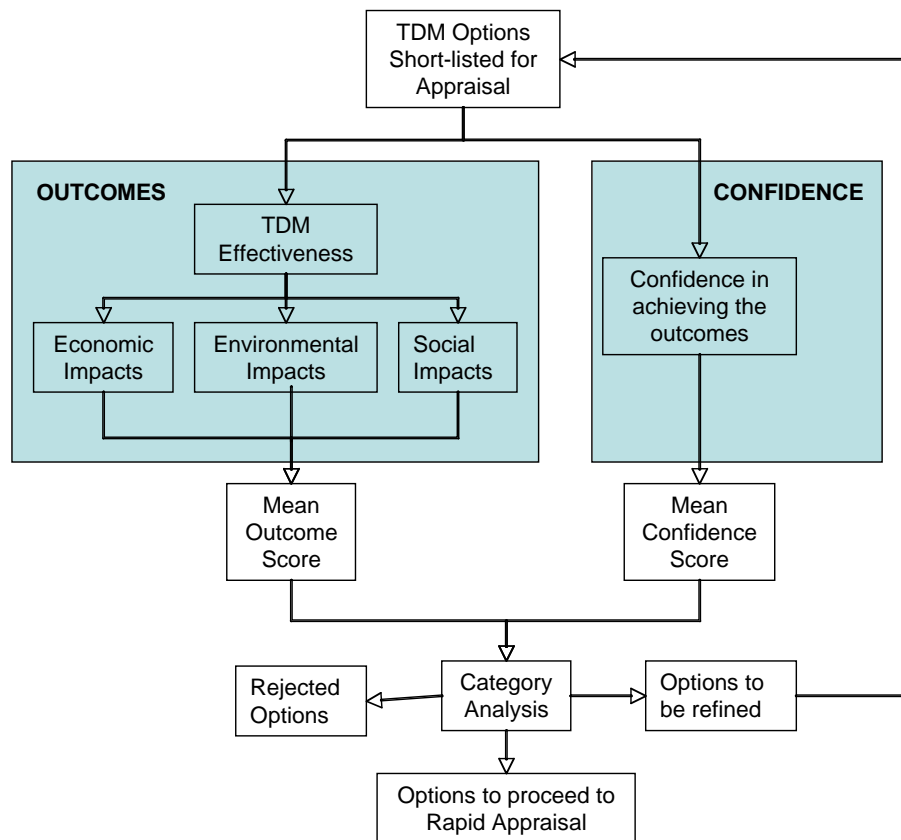


Figure 3: Shortlist appraisal of options

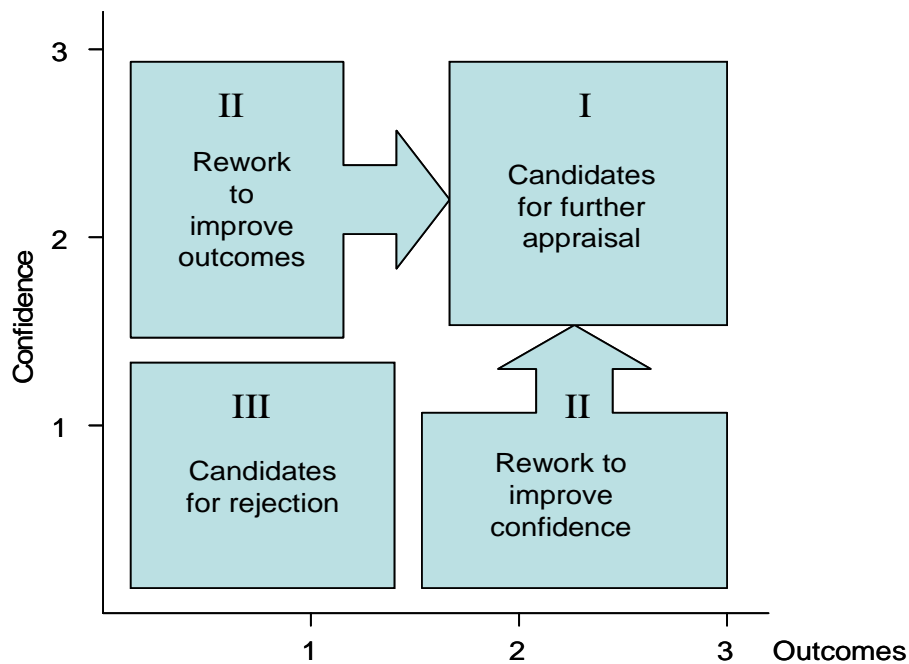


Figure 4: Classification of options following Shortlist Appraisal

Table 2 lists example assessment criteria for the TDM Effectiveness dimension while Table 3 highlights nine criteria for assessing the 'Impacts' dimension. In addition to scoring the outcomes, an assessment is also made of the confidence in achieving those outcomes. Again a range of criteria are established for this dimension as summarised in Table 4. These should be regarded as illustrative rather than prescriptive or comprehensive criteria for the shortlist appraisal. In New Zealand the funding allocation process (Land Transport NZ, 2005) includes explicit objectives which can be incorporated through appropriate choice of criteria for the rating process.

Following the appraisal of actions in a TDM Action Plan undertaken by Ker (2003; Kerr and Rosalion, 2003) a scale from 0 to 3 is suggested including half point ratings (0.5, 1.5 and 2.5). This provides a seven point assessment scale. There will always be an element of subjectivity in assigning scores on each of the criteria. Rather than attempting to score each option in an absolute sense, the aim is to ensure a degree of consistency in the ratings assigned to alternative TDM measures. The emphasis at this stage is on relativities across the measures rather than absolutes for any one measure. The subsequent Rapid Appraisal step has a stronger 'absolute' dimension to the assessment particularly in terms of the benefit cost analysis. In the short-list appraisal, the first of criteria under the economic impact category refers to the ratio of benefits to costs. The National Guidelines for TSM (ATC, 2006) suggest that a BCA be undertaken as part of rapid appraisal although they recognise that, based on the experience of Australian jurisdictions, the error margin could be expected to be $\pm 40\%$. At the shortlist appraisal stage, a rating of the anticipated BCA result would provide the foundation for the appraisal. The one to three scale for this criteria could be regarded as a '1= low', '2=medium', '3=high' scale.

4.2 Selecting Options for More Detailed Appraisal

Interpreting the results of the Shortlist Appraisal provides a basis for selecting options to proceed to the more detailed stage of Rapid Appraisal. Examination of the scores on the different dimensions provides insight into the strengths, weaknesses and degree of confidence in different options.

To facilitate the identification of options likely to be worthy of further more detailed assessment, it is useful to consider each option's mean score on the Outcomes and Confidence scales. Figure 4 shows how a plot of the mean Outcome and Confidence scores can be used to identify categories of options which:

- may be worthy of further, more detailed appraisal (Category I)
- need to be re-worked, packaged or re-timed (Category II)
- perform poorly in terms of both Outcomes and Confidence and should therefore be rejected (Category III).

The phrase 're-timed' used in the context of Category II measures, refers to options which may be capable of delivering solid outcomes but would be unlikely to attract community support for implementation. It may be that through greater stakeholder engagement and education, those options may attract a different level of support at a later point in time. Options which rate highly on the Confidence scale could be used as a 'point of entry' in establishing a TDM initiative. Subsequent emphasis could then be on building the outcomes dimension through complementary measures.

The discussion here implies that it is the raw average scores that are used to identify candidates for rapid appraisal. Scope exists to weight the various criteria if that is regarded as appropriate when seeking to select options to undergo the next stage of appraisal. This is analogous to the Adjusted BCA described in the National TSM Guidelines (ATC, 2006).

Table 2: TDM effectiveness criteria (Modified from Kerr, 2003)

| TDM effectiveness Criterion | Interpretation/assessment/comment |
|--|---|
| How effective is the measure in managing demand? | |
| <ul style="list-style-type: none"> Increased use/share of public transport | Does the measure promote, raise awareness or enhance use of public transport? |
| <ul style="list-style-type: none"> Increased use/share of walking and cycling | Does the measure promote, raise awareness or enhance use of walking/cycling? |
| <ul style="list-style-type: none"> Reduced reliance on car travel | Extent of impact on single-occupant car travel (in the context of commuting) or 'serve-passenger' trips (in the context of school-based travel) |
| <ul style="list-style-type: none"> Optimise use of existing infrastructure | Extent to which the impact is on times/areas of peak demand (high score for reduced car use could be low, or even negative on this criterion where a lack of spare capacity on public transport could undermine mode shift) Targeted and targetable actions (e.g. through choice of locations) would score more highly |
| <ul style="list-style-type: none"> Synergy with existing strategies | Effectiveness of the measure, or other complementary initiatives, is likely to be enhanced, where it is aligned with established transport and/or land use strategies |

Table 3: Impact criteria (Modified from Kerr, 2003)

| Economic impacts | Interpretation/assessment/comment |
|--|--|
| <ul style="list-style-type: none"> What is the scale of the economic impact/benefit relative to the cost? | <ul style="list-style-type: none"> What is the scale of impact related to the cost? What is the likely range of the benefit-cost ratio? |
| <ul style="list-style-type: none"> Reduce costs of travel to the community | <ul style="list-style-type: none"> To what extent does the measure have an impact on critical aspects of the transport system and usage (e.g. congestion)? A focus on reducing peak-period arterial trips by road would increase rating, but to a smaller extent if change is only to encourage public transport where there is no spare capacity |
| <ul style="list-style-type: none"> Improve price signals in the market place | <ul style="list-style-type: none"> Includes improved perceptions of existing pricing signals and broader understanding of overall 'costs' of individual travel decisions Changes from fixed to variable costs for pricing would be a desirable step |
| Environmental impacts | |
| <ul style="list-style-type: none"> Improve air quality | <ul style="list-style-type: none"> Regionally, proportional to changes in car use, with allowance for short journeys (cold start conditions for higher proportion of total journey) Locally, lower impact/concentration of pollution in suburban areas Disproportionate local impact (mainly peak period) arterial road journeys |
| <ul style="list-style-type: none"> Reduce greenhouse gas emissions | <ul style="list-style-type: none"> Regionally, proportionate to change in car use, with allowance for short journeys (cold-starts) |
| <ul style="list-style-type: none"> Reduce noise pollution | <ul style="list-style-type: none"> Focus on times and areas of high car use. Rating would be higher where the target is peak period commuting on arterial roads and lower for more dispersed (in time and space) impacts |
| Social impacts | |
| <ul style="list-style-type: none"> Improve equity of access to employment or other activity opportunities | <ul style="list-style-type: none"> Rating proportional to the impact on alternatives to the car, representing improved perception or greater use of lower cost modes |
| <ul style="list-style-type: none"> Increase health and well being | <ul style="list-style-type: none"> Rating generally in line with increase in walk/cycle use, less so for public transport and also related to impact on air pollution Health and fitness benefits from active transport (walking, cycling and accessing public transport) depend on the existing fitness levels of those who change with people who are inactive or sedentary reaping a higher benefit. Physical activity can also be accumulated over the day e.g. walking for short distances to/from public transport will deliver a benefit where it contributes to accumulating at least 30 mins of physical activity each day for adults and at least 60 mins of moderate to vigorous activity for children and young people. Disproportionate local air pollution impact for (mainly peak period) arterial road journeys |
| <ul style="list-style-type: none"> Increase public safety and security | <ul style="list-style-type: none"> Related to increased people activity ('eyes on the street'), particularly walking and cycling and at public transport stops/stations and reduction in car use (net road trauma reduction). Children, women and the elderly benefit particularly from a safer environment. May depend on area of impact with UK research indicating children are up to four times more likely to be injured in a traffic crash in poor socio-economic areas. |

Table 4: Confidence criteria

| Criterion | Interpretation/assessment/comment |
|--|---|
| <ul style="list-style-type: none"> ▪ Certainty of an ongoing outcome | <ul style="list-style-type: none"> ▪ To what extent are the benefits 'guaranteed' versus uncertain? How good is the evidence that the program will achieve the effect? |
| <ul style="list-style-type: none"> ▪ Time frame for benefit realisation | <ul style="list-style-type: none"> ▪ How soon will the benefits be realised? Short-term (0-2 years) 3pts; medium-term (2-5 years) 2pts; long-term (more than 5 years) 1pt. |
| <ul style="list-style-type: none"> ▪ Durability of the impacts | <ul style="list-style-type: none"> ▪ Are the impacts durable without continued resourcing of the intervention? |
| <ul style="list-style-type: none"> ▪ Degree of social acceptability | <ul style="list-style-type: none"> ▪ What is the ease with which the intervention can be implemented given the extent to which the intervention will be acceptable to the community? |
| <ul style="list-style-type: none"> ▪ Feasibility | <ul style="list-style-type: none"> ▪ To what degree are the necessary skills, expertise and other resources available? |
| <ul style="list-style-type: none"> ▪ Robustness | <ul style="list-style-type: none"> ▪ How robust is the measure? How sensitive are the outcomes to key assumptions about the broad environment (exogenous factors) or internal aspects of the option? Will the measure still deliver benefits across a range of potential future scenarios? |
| <ul style="list-style-type: none"> ▪ Flexibility | <ul style="list-style-type: none"> ▪ Can the delivery be modified to accommodate changed needs? |

4.3 An Example Appraisal

This section sets out an example illustrating the application of the framework. The underlying problem is described and then the TDM Measure Selection Toolkit is used to identify candidate TDM measures. Those measures are then subjected to short-listing appraisal to identify a set of measures to proceed to the more detailed rapid appraisal phase.

In this example, an inner city municipality is home to five primary and secondary schools, located in close proximity, which cater for a total of 4000 students. The common start and finish times of the schools creates challenges for students, parents, residents and other users of the transport system. Initial consultation with the school principals, crossing supervisors and the local municipality has highlighted a variety of concerns:

- Students and their parents complain that the local traffic congestion makes them late for school.
- Road safety concerns have been raised because of the difficulties for children who are walking or riding to school. Pedestrian crossing supervisors have also reported cases of road rage where parents driving children to school have ignored parking signs and created tensions with other road users.
- Residents complain about access problems they experience because of the local traffic congestion as well as noise and local air pollution.
- Spill-over effects are being experienced at the broader network level where high right turn volumes at some unsignalised intersections create congestion on the main roads. This not only affects private motor vehicles but is also impacting the reliability of public transport services on routes which serve the area. Ironically, students accessing the schools on public transport are also being impacted by the traffic congestion.

These problems are most pronounced in the morning peak period particularly in relation to the impacts on the broader network. In the afternoon peak the problems tend to be more localised in the immediate vicinity of the schools. Anecdotal evidence from the school principals suggests that between one third and a half of the trips to the school are home based. Enrolment data suggests that the catchments of each school do vary with the

proportion of students living within 3 km of the school varying between 20 % and 75%. Two of the schools are within walking distance of a railway station while the other three are within 100 m of a bus route and one of those bus routes connects with a railway station.

The government has a policy to increase the share of trips on public transport and wishes to increase walking and cycling. Road safety is a major government priority. Congestion reduction itself is not identified as an objective in its own right except where traffic congestion is impacting on public transport services and therefore affecting ridership. The problem characterisation suggests that the problem is primarily a ‘weekday peak’ problem. In terms of where the problem occurs the ‘Group of sites’ category is the best fit. Table 1 provides a basis for identifying a range of potential measures. Consultation with the key stakeholders (refer to the overall framework in Figure 1) would be an important part of developing a shortlist of measures. Some of the measures may not be appropriate for a schools context or may have less application (e.g. telecommuting). In addition to the best fit box in Table 1, it is worth considering the columns on either side. No new measures are suggested by the ‘Individual building or site’ column but stepping up to the ‘Link’ column would suggest some additional measures. These include Advanced Traffic management Systems (ATMS), Public Transport or High Occupancy Vehicle priority lanes and Local Area Traffic Management (LATM).

Each of the options identified using the Selection Toolkit would then be subjected to Short-listing Appraisal. That involves scoring each alternative on a one to three scale against a series of criteria covering the ‘Outcomes’ which could be expected for that alternative and the ‘Confidence’ that those outcomes could be achieved. The results of Short-listing Appraisal can be presented in a variety of ways. Figure 5 illustrates the average scores for the options on the four outcome dimensions of TDM effectiveness as well as economic, social and environmental impacts. When the scores are illustrated in this side-stacked bar graph the relative performance of the alternatives in each of those dimensions is highlighted as well as each options’ combined performance on all the outcomes criteria. The selection of options which could proceed to Rapid Appraisal is facilitated through a plot of the average scores on the ‘Outcomes’ and ‘Confidence’ dimensions as shown in Figure 6. Alternatives which perform well in terms of both outcomes and confidence are then candidates for taking onto Rapid Appraisal.

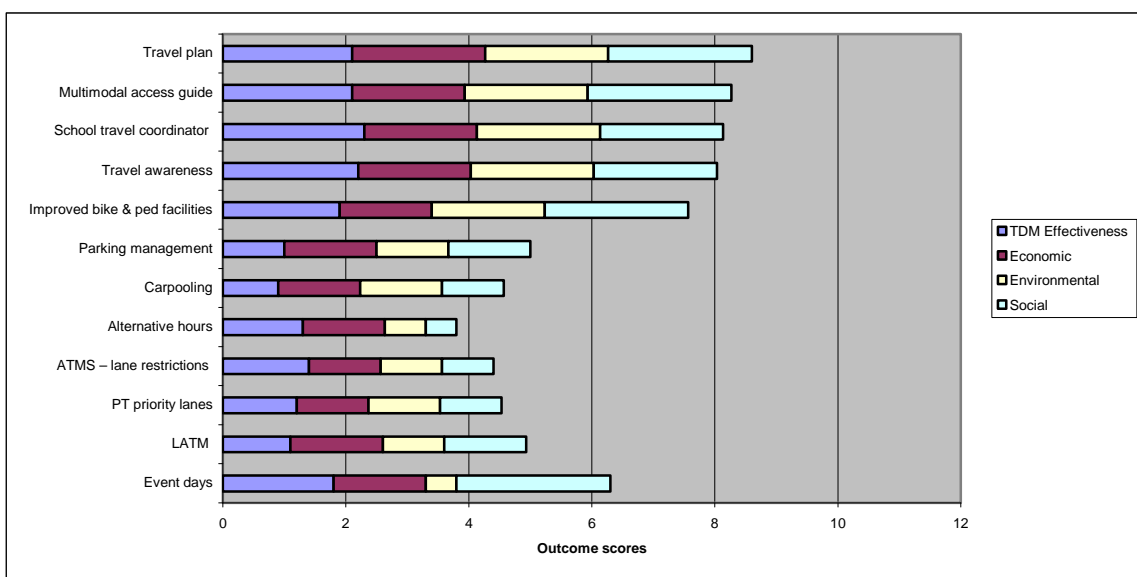


Figure 5: Outcomes scores for options in the Schools sample appraisal

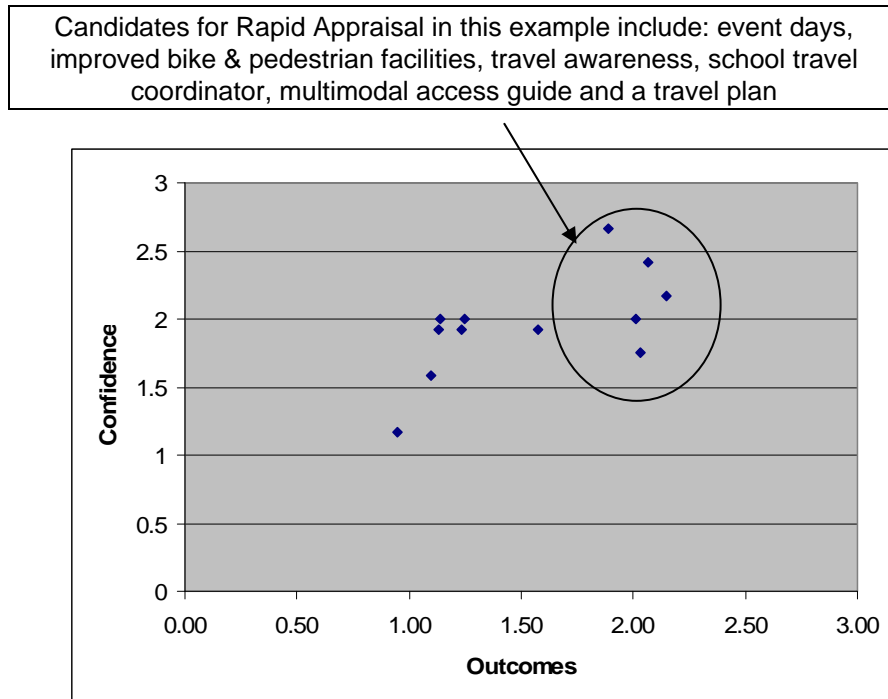


Figure 6: Use of category analysis plot to identify candidates for Rapid Appraisal (Schools)

5 Conclusions

This paper has outlined a framework for the appraisal and evaluation of TDM measures. By building on the National *Guidelines for Transport Systems Management in Australia*, it provides a nationally consistent approach for appraisal and evaluation of TDM measures and will provide a basis for more informed choices between non-infrastructure and infrastructure solutions, a better understanding of how and when to use TDM measures and will also enable TDM investment decisions to be considered and integrated with other investment choices.

Ultimately the success of the appraisal and evaluation will depend on the extent to which the process is driven by the underlying objectives and the extent to which stakeholders have been engaged through consultation conducted as an integral part of the whole process. The appraisal process proposed here can be likened to a two stage sieve. In the first stage, an initial 'shortlist appraisal' focuses on the anticipated outcomes and confidence those outcomes will be achieved. Options passing through that sieve are then subjected to more detailed rapid appraisal which comprises a strategic merit test and rapid benefit cost analysis.

Evaluation is not an easy task and there is much to be learned from the evolving national and international experience with TDM evaluations. Effective sharing of evaluation experience is very important in that context and can be facilitated through ongoing sharing of case study details through a repository for data and reference information such as the one developed as part of the Austroads project on which this paper is based.

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