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Paper title: **Measuring the economic benefits of travel behavioural change programs**

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Abstract (200 words):
The last few years have seen the application of programs promoting behavioural change to more sustainable modes in Western Australia, South Australia and now Victoria. The economic appraisals of these projects have shown impressive results with double digit ratios of benefits to costs. These results, and in some cases, the absence of clarity in the benefit calculations have been greeted with scepticism by some. The development of a Travelsmart program for Melbourne has focused attention on the value for money of these programs and this paper examines their appraisal. The aims of the paper are to describe the theoretical basis underlying the valuation of program benefits and to apply a valuation methodology to a Melbourne based case study. The paper is concerned with community based programs applied to residents of the target area. It specifically highlights the problems with current approaches to the appraisal of the benefits accruing directly to program participants and proposes an alternative methodology consistent with the underlying economic theory. The issues raised are illustrated in the case study and conclusions drawn on the range of economic outcomes likely to arise from the implementation of a community based behavioural change program.

Introduction

Over the last decade there has been a growing concern over the environmental, social equity and economic impacts of an increasing reliance on the motor car for personal travel needs. Traditionally government has taken a supply side approach to influencing this trend investing in improved road capacity and public transport services. In recent years there has been an increasing focus on demand side programs designed to influence the behaviour of travellers.

Programs have mostly been applied to influence participants' travel behaviour by raising awareness about the travel choices available. These programs have been applied to influence behaviour at workplaces, educational institutions and through direct contact with the community through their place of residence. The focus of this paper is on the application of these programs in the residential community setting.

Cost Benefit Analysis (CBA) has been applied to appraise a wide range of transport initiatives. The theory underlying CBA in the transport sector is clearly established although most application experience relates to the appraisal of supply side initiatives. The appraisal of behavioural change initiatives requires the clear and careful application of CBA principles because these programs have some unique attributes distinguishing them from traditional supply side measures.

Initiatives have been appraised in Adelaide by Tisato and Robinson (1999) and Perth by Ker and James (1999) using Cost Benefit Analysis (CBA) and been found to offer excellent value for money, with Benefit Cost Ratios ranging between 3 and 20. These papers identify a range of benefits including those accruing to program participants (user benefits) and a range of external impacts affecting other road users, those affected by transport emissions and the government in terms of the costs of providing health care.

There are some significant challenges with respect to the appraisal of both the user and non-user benefits. In relation to the user benefits the comparison of participants' generalised costs of travel before and after any behavioural change is an inadequate and potentially misleading basis for the calculation of user benefits.

This issue was raised in Ker and James (1999) where a disbenefit in terms of travel time was calculated by applying the value of time used in road appraisals (page 709). This counterintuitive result led Ker and James (1999) to conclude that, either the value of time did not accord with participants' valuation, or 'there are benefits to the individual over and above those that have been quantified here' (page 709). The base case used in the subsequent appraisal assumed a time value of zero effectively excluding these travel time impacts.

This paper seeks to address the issue of the appraisal of user benefits by applying clearly defined CBA principles travel behavioural change programs and suggesting practical measures for their implementation. Accordingly, the paper firstly defines the range of impacts attributable to this type of behavioural change application before describing how the principles of CBA may be practically applied to their monetary measurement. The paper then illustrates the range of likely outcomes with an example application and sensitivity testing. The final section reports the paper's conclusions.

The benefits of a community based behavioural change program

Behavioural impacts

A community based program in essence involves a dialogue between a program representative and persons in the community. The aims of this dialogue are:

- to understand the participants' current travel requirements and behaviour, and
- to provide information on available travel choices and more sustainable alternatives, with the availability of some initial inducements to try these alternatives (for example free public transport tickets).

Table 1 below summarises the changes in behaviour which are likely to result from community based programs. These behavioural impacts may be summarised as follows:

- changes in mode of travel from motor vehicle to public transport, walk or cycle (or some combination of these);
- changes in trip attributes with:
    - the linking of trips to complete more activities within a single travel chain typically starting from and ending at a residential location;
    - the suppression of some trips which are perceived as of marginal importance;
    - the redirection of trips to different destinations with, for example, the substitution of a car trip to a larger supermarket with a car trip to a more local retail destination, and
- changes involving both altered mode of travel and altered trip attributes, for example where a participant substitutes a car based shopping trip to a more distant destination with a walk based trip to a local shop.

The evaluation of behavioural change programs to date has focussed on the quantifiable outputs in terms of changes in mode split and kilometrage travelled by mode. Hence information is available to show that these programs do work but there is very little information to understand how and why these outcomes occur. A more detailed understanding of how changed behaviours are distributed across the categories in Table 1 would be useful in this respect.

Table 1 Behavioural impacts of community based programs

	AFTER					
	MODE			**TRIP ATTRIBUTES**		
	PT	**Walk**	**Cycle**	**Link**	**Suppress**	**Re-direct**
BEFORE						
Car D	✓	✓	✓	✓	✓	✓
PT	×	×	×	✓	✓	✓
Walk	×	×	×	✓	✓	✓
Cycle	×	×	×	✓	✓	✓

KEY	✓	Important impacts
	×	Unlikely to be relevant

Benefit impacts

Table 2 Benefit impacts of community based programs

	BEHAVIOURAL CHANGES					
	CHANGE IN MODE			TRIP ATTRIBUTES		
	PT	Walk	Cycle	Link	Suppress	Re-direct
USER BENEFITS						
Journey time	-	-	-	+	+	+
Monetary expenses	+	+	+	+	+	+
Other sources of benefit	+	+	+	-	-	-
Net User Impact	+	+	+	+	+	+
NON USER BENEFITS						
Road decongestion	+	+	+	+	+	+
Accidents	+	+	+	+	+	+
Emissions	+	+	+	+	+	+
Health care costs	x	+	+	+	+	+
PT revenues	+	x	x	x	x	x
Net Non User Impact	+	+	+	+	+	+

KEY	+	Benefits
	-	Disbenefits
	x	Neutral

Table 2 above summarises the economic benefits and disbenefits associated with the behavioural impacts identified in the previous section. The table does not include the situation where modified behaviour results in both mode and trip attribute changes.

The program impacts for non users are either positive or neutral. However, for the ‘users’, who change their behaviour, the positive, net benefit of the program consists of both positive and negative components. For those who change their behaviour the net, perceived benefit must by definition be positive because a change in behaviour has been induced through the program. The remainder of this section considers the benefit impacts in more detail.

Impacts for users changing mode

Consider first those who decide to change mode from car (driver) to public transport, walking or cycling. It is likely that the same journey will to take longer compared to car, with lower journey speeds and, for public transport, time required to wait for services to arrive and to walk to and from the public transport stops.

Actual monetary expenses are likely to fall in most cases with a shift from car to these other modes because the full costs of operating and parking a car are likely to outweigh the public transport fare or the costs associated with operating a bicycle. A caveat on this assertion concerns the participants’ perception of car operating costs. Most drivers will have a clear appreciation of the fuel costs of a single trip, but their perception of the non fuel cost savings associated with a change in mode will vary considerably. It is conceivable that for some drivers this change will be perceived as increasing their out of pocket expenses.

While the issue of the perception of vehicle operating costs is important and misperception implies an underestimate of the benefits, we proceed on the assumption that the program provides sufficient information for participants to understand the full costs of the car alternative.

In all transport decisions that involve a change in behaviour there are other sources of benefit and cost not captured by the calculation of the generalised journey costs typically used in the appraisal of transport projects. These other sources include the attributes of the particular mode of travel which distinguish it from other modes such as journey comfort and convenience, a sense of wellbeing associated with taking more physical exercise and a sense of 'doing the right thing for the environment' by using a less polluting mode of travel.

Program participants have a perception of the costs and benefits associated with all the issues described above and their behavioural decision reflects their assessment of the perceived net benefit. We can confidently say that a change in behaviour indicates a positive user benefit.

It is clear that a comparison of generalised journey costs provides a partial and possibly misleading picture of the user benefits. Indeed some behavioural change will be associated with an increase in these costs. The challenge in terms of the appraisal is measuring the net benefit perceived by the user and the latter sections of the paper propose an approach for estimating this benefit.

Impacts for users changing their trip making behaviour

In principle a set of similar issues arise where program participants change their trip making behaviour through the linking, suppression or redirection of trips (assuming no change in travel mode). Again observed behaviour change is based on the user perception of a net, positive benefit as a result of making the change.

In contrast to the situation where a different mode is selected for the same trip, here there are likely to be benefits in terms of reduced travel time and lower monetary expenses. Participants are being encouraged to link trips to reduce the time and cost of travel, to avoid making presumably marginal trips or changing to a nearer (and less costly) destination for a particular trip purpose.

However, there are likely to be other impacts not captured by these journey cost calculations. For example, linking previously separate trips might introduce timing constraints in completing some activities and switching to a nearer shopping destination may involve using a less pleasant or well stocked outlet. Conversely if the previous trip pattern was based on a deficiency in information addressed by behavioural change program then these negatives may well be negligible. This would be the case where the participant did not know about the feasibility of linking several trips by public transport or where the participant was unaware of the existence of a local retailer with similar attributes to a more distant shop.

Non user impacts

The direction of the benefit change with respect to the non user benefit components is less ambiguous. The expected behavioural changes are likely to have either positive or neutral outcomes with respect to this class of benefits.

The decongestion benefits arise from a reduction in vehicle kilometres as a result of the program. Those travellers who remain road users therefore benefit from the reduced congestion levels in terms of lower journey times and vehicle operating costs.

The number of accidents affecting road users is likely to change in line with the number of private motor vehicle kilometres. A mode switch to walking and particularly cycling will mitigate this effect, with a higher per kilometre accident rate for cycling than for car based travel.

Fewer vehicle kilometres will lead to reduced motor vehicle emissions thus benefiting those on the road and in the immediate vicinity in terms of toxic emissions, with a wider impact in terms of reduced CO_2 emissions and climate change.

Increased physical exercise in terms of walking and cycling are likely to lead for some to greater life expectancy and better health. These are of value to those experiencing the change and will reduce the resource costs of health care provision.

Finally, increased public transport use will raise public transport fare revenues and an average fare per trip of $1.10 has been assumed. Existing evidence suggests that over 80% of the behavioural change induced by these programs takes place in the off-peak. Increasingly these programs are being designed to avoid increasing demand for congested peak period public transport services. Accordingly it has been assumed that no increase in public transport services are required to accommodate increased demand.

CBA principles and their application to calculating user benefits

The purpose of CBA is to measure the impacts of a project on 'society' compared to a situation without the project. The CBA represents these impacts in monetary terms by valuing the resources consumed at their market value and the impacts on those affected according to their willingness to pay to avoid the negative and to receive the positive project outcomes. These calculations are usually completed using inputs excluding taxation.

Calculating user benefits for a supply side improvement

Figures 1 and 2 on the next page illustrate the calculation of benefits when improvements are made to one public transport mode of travel (Figure 1) and demand falls for a competitive mode (Figure 2). This example represents typical 'supply side' initiatives such as improved journey times or increased service frequencies. Note the simplifying assumption that costs on the competitive mode remain constant. This would not be the case if mode 2 represented congested road travel.

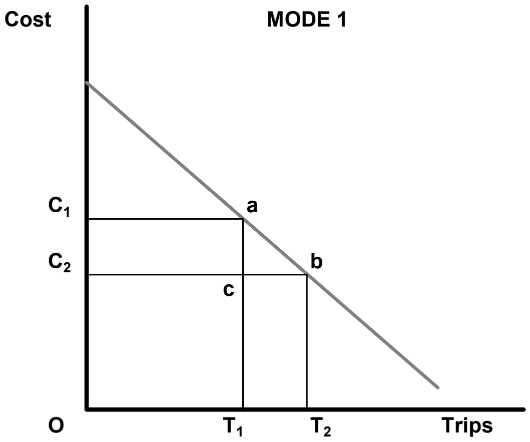

Figure 1 Mode 1 cost and demand changes

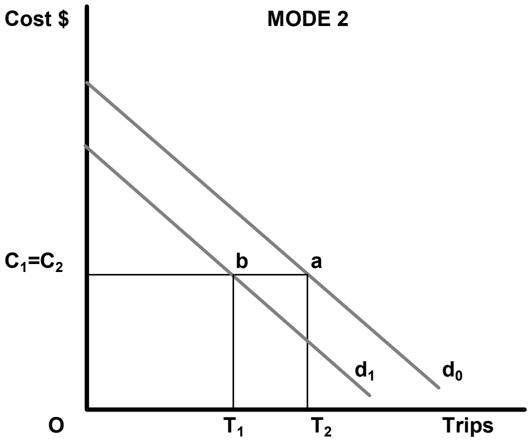

Figure 2: Mode 2 demand changes

In Figure 1 the improvement reduces the generalised cost of travel from C_1 to C_2 leading to an increase in demand from T_1 to T_2. The change in consumer surplus for those using the improved mode is calculated as follows:

- Existing Users = area C_1,a,c,C_2 $((T_1 * C_1) – (T_2 * C_2))$.
- New Users = area a,b,c $(0.5 * (T_2 – T_1) * (C_1 – C_2))$.

Note that the benefits to new users are calculated with reference to the change in costs of the destination mode. There is no change in consumer surplus for mode 2 because the costs of travel remain unchanged.

In this example the ‘costs’ of public transport travel refer to the generalised costs of travel including:

- in-vehicle time valued using an average ‘leisure’ or ‘business’ value of time;
- walking and waiting time (including interchange) valued at twice the in-vehicle time value;
- an additional interchange penalty equivalent to a set number of in-vehicle minutes and valued using the in-vehicle value of time, and
- the fare payable exclusive of GST.

These resource costs are appropriate for calculating the change in consumer surplus for those (existing users) whose modal choice behaviour has not changed. However, changes in these resource costs do not fully explain traveller choices because, either the resource costs are misperceived by users, or there exist in the participants’ perceptions a range of additional factors influencing behaviour.

Normally it is assumed that the various cost components of the public transport journey are correctly perceived. However, perception is likely to vary from the resource costs due to modal attributes (like comfort) perceived by users but not captured within the generalised cost formulation. The consumer surplus for new users is correctly calculated using the change in perceived costs.

Calculating user benefits for a behavioural change program

Theory: Where an existing public transport service is improved the majority of the user benefits will accrue to existing users who gain the full benefit of the cost reduction. Behavioural change programs have the following distinguishing attributes with respect to the user benefits:

- firstly, there is usually no change in the generalised cost of travel for the modes to which participants are attracted, and
- secondly, as a consequence of the constant travel costs, all benefits accrue to those changing their travel behaviour.

As shown above and as is clear from the literature, consumer surplus should be measured in terms of the change in the perceived costs by mode. This calculation takes account of the change in generalised journey costs and the changes in other journey related attributes perceived by participants (including the benefits associated with health and well- being and making a positive contribution to the environment).

The challenge with this approach is placing values on the perceived attributes not incorporated in the generalised cost function.

Application: The approach described below recommends a methodology for estimating consumer surplus where program participants:

- change their mode of travel while undertaking the same trip, and
- link trips or change their destination while using the same mode of travel.

For the valuation of the user benefits associated with changes in the mode of travel it is proposed to use a logit based mode split model. This model form is commonly used in four stage strategic transport models to allocate trips between motorised and non motorised modes and between public transport and motor car within the motorised category. The market share of one mode compared to another is a function of the difference in generalised cost, with a slope parameter governing the rate of change and a shift parameter included to take account of the attributes not included in the generalised cost formulation.

Figure 3 on the next page illustrates the public transport share of motorised transport using typical parameters found in the Melbourne Integrated Transport Model (2000). Notice that where there is no difference in generalised costs public transport accounts for 35% (not 50%) of trips. This reflects the inherently superior comfort and convenience attributes of car based travel.

As a further illustration; if the current public transport mode share of motorised travel was 10% (a $10 difference between car and public transport costs), then a reduction in public transport costs relative to car of about $5 (500 cents) would be required to raise the public transport mode share to 20%.

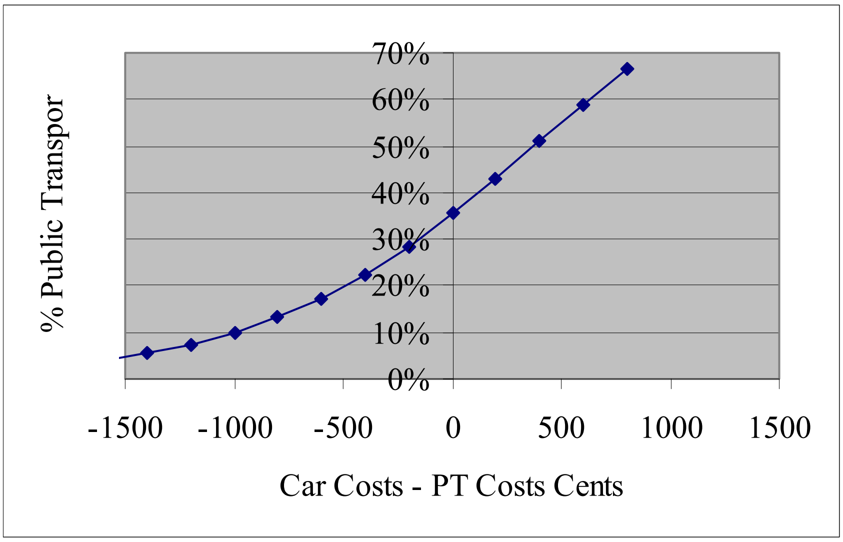

Figure 3 Public transport mode share of motorised travel

This information can be used in the following way to value the user benefits for those who switch from car to public transport for the same type of journey:

- in the example application in the next section a 15% increase in public transport trips and a consequent increase in the PT share of motorised trips from 13% to 17% has been assumed; this is consistent with experience in Australia and internationally;
- applying the relationship shown in Figure 3 suggests a change in the generalised costs of public transport compared to car of around \$2 would be required to effect this shift, and
- the rule of a half should be applied to set the average benefit per user at half the full benefit (a downward sloping demand curve implies that some (marginal) car users would require only a small change in cost to switch while some would require the full \$2 shift to move).

A similar approach may be followed to value the benefits for those switching from car travel to walking and cycling. The example used in the next section assumes a 10% increase in walk trips and a 75% increase in cycling (from a low base) raising the walk/cycle share of all trips from 25% to 29%. The MITM parameters suggest a change in relative generalised cost of about \$1.50 is required to effect this change with an average benefit for those switching of \$0.75.

For the situation where participants change their trip making behaviour by linking trips or changing destinations there is no obvious source of information to estimate the net user benefits. It is recommended that these benefits are estimated as an effective cost reduction assuming that the trip or set of trips are identical in all other ways.

These approaches imply the need to categorise the behavioural responses to a program in more detail than is usual. This knowledge will also be important in more efficiently targeting behavioural change programs and sustaining their effectiveness.

An economic appraisal application

Introduction

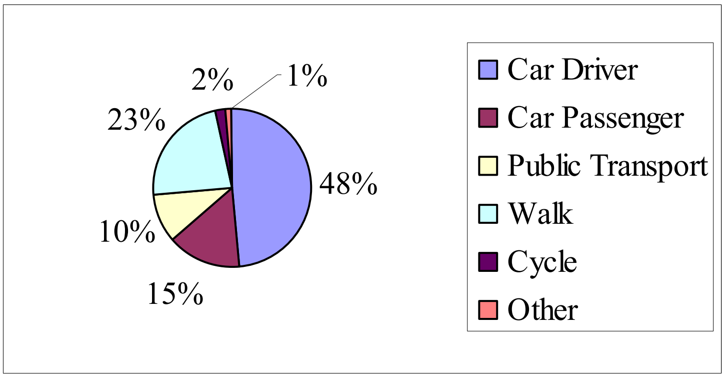

Figure 4 Case study area modal shares

This appraisal concerns the application of a behavioural change program to the residents of a Local Government Area within 4 kilometres of the Melbourne CBD. The appraisal presented has been simplified to allow the clear illustration of the key benefit drivers.

The key characteristics of this area are as follows:

- a residential population of 78,000;
- a total of 48,000 households;
- 322,000 weekday trips or just over 4 trips per person, and
- modal shares are shown in the Figure 4 above, with 63% of trips by car, 10% using public transport and 25% walk and cycle.

Behavioural change assumptions

Australian and international evidence: In the last few years the impacts of behavioural change programs in Australia and overseas have been subjected to considerable scrutiny. As part of the development of a Business Case for the Travelsmart program in Victoria, a report by Ker (2003) was commissioned by the Department of Infrastructure and this reviewed 46 international and Australian community based behavioural change projects. Table 3 shows the results for the Australian pilots and the counter-intuitive 'least' impacts came from a single, small pilot study.

Table 3 Comparative impacts of Australian pilot projects

	Impact		
Travel Mode	**Least**	**Greatest**	**Average**
Car Driver Trips	- 9.6%	-18.7%	-13.0%
Car Passenger Trips	+ 3.9%	- 6.5%	- 1.3%
Walking Trips	- 2.1%	+43.4%	+15.6%
Public Transport Trips	-15.3%	+50.7%	+15.7%
Bicycle Trips	-59.5	+221.4%	+49.5%

Note: figures derived from Ker (2003), Table 1

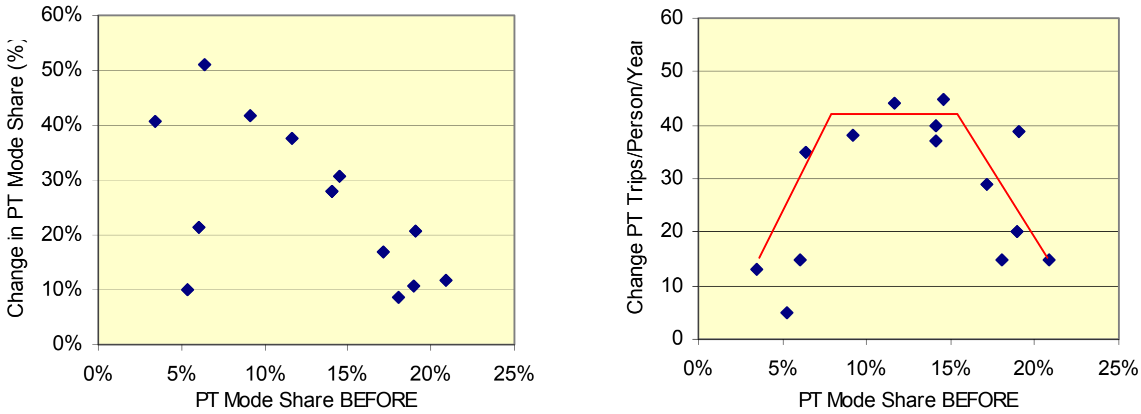

Figure 5 and Figure 6 Percentage and absolute increase in PT trips by existing mode share for the international and Australian studies reviewed

Figures 5 and 6 show that the percentage increase in public transport trips ranged between 10% and 50%, with projects consistently delivering between 15 and 40 additional public transport trips per person contacted including those who chose not to participate.

The red line in Figure 6 illustrates the relationship between existing mode share and the effectiveness of these programs. The program effectiveness in terms of the absolute increase in public transport trips where there is an existing PT mode share of between 8% and 18% (Figure 6). A very low share is indicative of poor PT service levels with a limited ability to retain those passengers attracted. A very high existing share indicates high public transport service levels which probably captures most of the existing choice market. The middle ground therefore provides the greatest potential and the case study area sits within this middle ground.

Case study assumptions: Table 4 shows the modal change assumptions applied. These are considered to be conservative given the results observed for Australian and international applications. These increases result in an additional 18 trips per person for households contacted during the program, assuming a household contact rate of 95% and a weekday to annual expansion factor of 280. This absolute increase is at the lower end of range of 15 to 40 trips per contacted person observed in previous programs.

Table 4 Case study modal change assumptions

	Modal Share			Weekday Trips	
	Before	**Change**	**After**	**Before**	**After**
Car Driver	48.4%	-8%	44.5%	155,788	143,325
Car Passenger	15.1%	-8%	13.9%	48,551	44,667
Public Transport	9.9%	15%	11.4%	32,018	36,821
Walk	23.4%	10%	25.7%	75,303	82,833
Cycle	2.0%	75%	3.5%	6,497	11,370
Other	1.2%	0%	1.0%	3,959	3,959
Total	100%	NA	100%	322,115	322,974

The case study represented the program's impact in terms of changes in travel mode (implicitly for the same journey). The impacts of changing trip attributes are considered in the sensitivity testing below.

Appraisal overview

The appraisal is a simplified application designed to illustrate the main issues raised in this paper. Although it uses average trip characteristics by mode (such as trip lengths and costs), the main findings are sufficiently clear that they hold despite the simplifications.

The appraisal assumes a 15 year appraisal period and a real discount rate of 6%. It is further assumed that the project benefits come on line after the initial application in year 2.

The sub-sections below review the cost and benefit assumptions before describing the economic outcomes of the central case and their sensitivity to changing key assumptions.

Cost assumptions

Of the 48,000 households in the target population it is assumed that 95% will be successfully contacted, with 50% of those contacted fully participating in the program. The cost of the initial application of the program including the evaluation of the impacts has been set at $150 per contacted household or $6.8 million. In Victoria the latest applications suggest the cost per contacted household may turn out to be considerably less than this assumption. A lower cost per household is sensitivity tested below.

The durability of the program is a key issue and for the base case it has been assumed that 10% of the initial cost will be allocated on an annual basis for reinforcement with a major reapplication every 5 years to half the households.

Benefit assumptions

The treatment of the following benefit sources is described below:

- user benefits for those whose behaviour changes as a result of the program, and
- non user benefits including road decongestion, road safety, vehicle emissions, the health benefits from increased exercise, and increased public transport revenues.

User benefits: For the user benefits the central case is appraised by assuming that the only response of participants to the behavioural change program is to change their mode of travel from car to either walk, cycle or public transport. The benefits associated with this mode change are estimated by applying the average benefit per trip as derived from the logit mode split model (see the CBA Principles section above).

The implications of assuming that some of the reduction in car travel is the result of trip linking and altered trip destination is tested as a sensitivity. In this test 20% of the reduction in car trips are assumed to be the result of trip rationalisation and the benefit is valued as a reduction in the resource costs of these trips. For car drivers it is assumed that 80% of the resource cost reduction makes up their net perceived benefit because the change in behaviour may have some negative impacts. For car passengers the net benefit is set to zero reflecting the assumption that the passenger is unlikely to be the cause of the behavioural change. The calculation of average resource cost per trip is shown in Table 5 over the page.

Table 5 Calculation of generalised trip costs by mode

	KM Dist	KPH Speed	Hours IVT	VOC Cost/km	Parking	Walk & Wait Hours	$ Fare	$ Gen Cost
Car Driver	11.3	40	0.28	$ 0.30	$ 5.00	0.00	$ -	$ 10.81
Car Passenger	9.5	40	0.24	$ -	$ -	0.00	$ -	$ 2.02
Public Transport	15.1	25	0.60		$ -	0.25	$ 1.00	$ 10.39
Walk	1.3	5	0.26	$ -	$ -	0.00	$ -	$ 4.44
Cycle	4.5	15	0.30	$ 0.03	$ -	0.00	$ -	$ 5.24

Notes:
1. Non business value of time (VOT) = $8.50 (source: DOI Evaluation Guidelines, 2002)
2. A weighting of 2 has been applied to walking, cycling and waiting time
3. Generalised (Gen) Cost = In Vehicle Time * VOT +VOC*Dist + Parking + Walk / Wait * VOT + Fare

Road decongestion impacts: The Department of Infrastructure (2003) evaluation guidelines provide a range of costs per vehicle kilometre (vkm) removed from or added to the road network. These represent the marginal costs in terms of time and vehicle operating cost savings for remaining road users. These costs range from $0.16 for lightly used roads in the off peak to values of $0.60 to $0.90 per vkm for heavily used roads in the peak periods. The focus of these programs is off peak travel and hence the central case decongestion cost has been set to $0.16 per kilometre. This value is at the lower end of the range recommended in the Department of Infrastructure (2003) guidelines and is appropriate for valuing these benefits in the off peak.

Road safety: Road safety in terms of reduced accident risk will improve with a lower number of car kilometres. However, increased walking and cycling will raise the accident risks for those using these modes. The changes in the distances travelled are multiplied by a per kilometre valuation of these risks. Accident costs per car kilometre of $0.02 and $0.06 per walk/bicycle kilometre have been used.

Vehicle emissions: These impacts have been valued using parameters taken from the Department of Infrastructure Guidelines (2003). A value of $0.02 per kilometre has been applied to the reduction in vehicle kilometres.

Health benefits: The health related benefits have not been quantified here. The linkages between behavioural change programs and the achievement of a threshold activity level likely to reduce the illness and premature deaths associated with a lack of exercise are not well enough established for their inclusion.

Clearly this is an area where detailed before and after studies would shed light on the impact of these programs on those with an unhealthily low level of exercise.

Public transport revenue: Public transport revenue will rise with the shift from car travel and we have assumed an average fare of $1.10 per trip. The focus of the program impacts in the off peak is the basis for the assumption that no increase in public transport capacity will be required as a result of the program.

Increased crowding for existing public transport users: One potential source of negative benefits involves the imposition of additional crowding on existing public transport users where extra patronage is generated on crowded peak period services. The evidence suggests that the vast majority of patronage change occurs in the off peak and as such the crowding impacts have been assumed to be insignificant. To be consistent with this off peak focus the road decongestion benefits have used values consistent with the off peak.

Findings

Table 6 on the next page reports the key inputs and economic results. The economic outcomes have been calculated for central, lower (pessimistic) and upper (optimistic) cases to illustrate the sensitivity of the results to certain key inputs. These sensitivity variables have been highlighted in the table by being enclosed within dashed lines and may be summarised as follows:

- initial program application costs (Low and Central = $150, Upper = $120);
- road decongestion benefits per km (Low= $0.10, Central = $0.16, Upper = $0.16), and
- mode change user benefit per trip (Low = $0.75/$0.5, Central and Upper = $1.00/$0.75).

The Benefit Cost Ratios (BCRs) range between 2.9 and 10.0 with a central value of 4.3. Under these assumptions, a behavioural change program clearly represents good value for money compared with other transport investments. These BCR's compare with a range of 4 to 33 reported in Ker and James (1999) and a typical BCR of 5.7 as reported in Tisato and Robinson (1999).

The response of the community drives the magnitude of the benefits and the assumptions in this respect are conservative, with the public transport mode change at the lower end of the range found in other Australian and international applications.

The major benefits accrue to those changing their behaviour ('users') and to remaining road users through the road decongestion benefits. These are approximately the same for the lower and central cases. The user benefits are significantly higher (upper case) where a proportion of the reduction in car vehicle kilometres is assumed to be the result of more efficient trip making (and this generates resource cost savings).

Conclusions

The economic value of behavioural change programs

The existing and growing body of evidence suggests that community based travel behavioural change programs are highly effective. The BCR range of 2.9 to 10, with a central value of 4.3 is somewhat lower than the range of 4 to 33 reported by Ker and James (1999) and the typical value of 5.7 reported by Tisato and Robinson (1999).

However, the results confirm that these programs represent extremely good value for money compared to other supply side initiatives which typically generate benefit cost ratios of between 1.0 and 2.0. It should be noted that their performance is dependent on a certain threshold level of public transport service coverage and quality.

Table 6 Inputs and results to the economic appraisal

INPUTS	LOWER	CENTRAL	UPPER
COSTS			
Startup Cost/Household	$ 150	$ 150	$ 120
Reinforcement Cost	$ 15	$ 15	$ 8
Reapplication	$ 75	$ 75	$ 60
MODAL SHIFT - No Change			
Walk	10%	10%	10%
Cycle	75%	75%	75%
Car	-8%	-8%	-8%
Public Transport	15%	15%	15%
DECONGESTION			
Benefit per km	$ 0.10	$ 0.16	$ 0.16
USER BENEFIT - MODE CHANGE			
Car to PT Benefit per Trip	$ 0.75	$ 1.00	$ 1.00
Car to walk/cycle benefit per Trip	$ 0.50	$ 0.75	$ 0.75
USER BENEFIT - TRIP CHANGES			
% Trip Reduction due to Trip Changes	0%	0%	20%
Resource Savings to Car Driver	NA	NA	80%
Resource Savings to Car Passenger	NA	NA	0%
Car Driver Cost per Trip	NA	NA	$ 10.81
Car Passenger Cost per Trip	NA	NA	$ 2.02
ACCIDENTS - No Change			
Cost per Car KM	$ 0.02	$ 0.02	$ 0.02
Cost per Walk/Cycle KM	$ 0.07	$ 0.07	$ 0.07
REVENUE - No Change			
Fare Revenue per Passenger	$ 1.1	$ 1.1	$ 1.1
EMISSIONS - No Change			
Cost per VKM	$ 0.020	$ 0.020	$ 0.020
RESULTS	**LOWER**	**CENTRAL**	**UPPER**
TOTAL COSTS (PV)	**$ 16.7**	**$ 16.7**	**$ 11.5**
BENEFITS (PV)			
Decongestion	$ 20.3	$ 32.5	$ 32.5
User Benefits	$ 24.1	$ 34.6	$ 80.7
Accidents	-$ 12.7	-$ 12.7	-$ 12.7
Emissions	$ 4.0	$ 4.0	$ 4.0
Health	$ -	$ -	$ -
PT Revenue	$ 13.0	$ 13.0	$ 10.4
TOTAL BENEFITS (PV)	**$ 48.8**	**$ 71.5**	**$ 115.0**
NET PRESENT VALUE	**$ 32.1**	**$ 54.9**	**$ 103.4**
BENEFIT COST RATIO	**2.9**	**4.3**	**10.0**

The following example provides some insight as to why these programs perform so well in comparison to supply side initiatives. Under the case study assumptions the behavioural change program produced an additional 1.3 million public transport trips, with an implied trip generation of 18 trips per contacted person per year. This is at the lower end of the range of behaviour observed elsewhere. The present value of the costs of the program (central) is $16.7 million.

Generating a similar level of patronage change through supply side measures would be far more expensive. For example some of the better patronised bus routes in Melbourne carry this level of patronage and the annual costs of provision would be in the region of $3 million to $4 million. The application of a funding stream of $3.5 million over 15 years results in a present value of costs of $34 million. Clearly the travel behavioural change programs are extremely cost effective in generating additional public transport trips.

Measuring program benefits

This paper argues that a before and after comparison of the resource costs incurred by program participants is a partial and misleading way of estimating the user benefits. The application of a benefit value per trip based on the revealed preference relationships implicit in logit based mode split models offers a better indication of the users' willingness to pay. This is a practical approach given that these models exist for most major cities.

The paper also explored the complexity of participants' responses to these programs. The focus to date has been on changes in modal shares and kilometrage travelled by mode. Some portion of the reduced car use probably results from changes in other aspects of trip making behaviour such as trip linking or changes in trip destination. For this type of behaviour it is suggested that the benefits are valued in terms of the overall change in the generalised costs of travel experienced by participants.

The different treatment of these categories requires more detailed information on how participants change their travel behaviour. Indeed a deeper understanding of how and why participants change is required to get the best out of future behavioural change programs.

Finally the appraisal would be enhanced with an improved understanding of the health related exercise impacts of these programs. Specifically, clearer estimates of the proportion of participants who move from being unhealthily inactive to a level of activity consistent with good health.

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References

Abelson, P (2000) *Evaluation of the benefits of generated and diverted traffic: an explanation* (working group paper) Wellington: Transfund New Zealand

Department of Infrastructure (2003) *Investment Guidelines* Melbourne: Department of Infrastructure Victoria

Ker, I and James, B (1999) Evaluating behavioural change in transport – a case study of individualised marketing in South Perth, Western Australia, pp 703-718 of *Papers of the 23rd Australasian Transport Research Forum 23*, Perth: ATRF

Ker, I (2003) Travel *demand management – transport business case*, Victoria: Department of Infrastructure

The MVA Consultancy, Oscar Faber TPA and Institute for Transport Studies, University of Leeds (1994) *Common appraisal framework for urban transport projects*

Tisato, P and Robinson, T (1999) A cost benefit analysis of travel blending, pp 687-702 of *Papers of the 23rd Australasian Transport Research Forum 23*, Perth: ATRF