Travel Behaviour Change Evaluation Procedures and Guidelines

Ted van Geldermalsen[1], Carolyn O'Fallon[2], Ian Wallis[3], Ian Melsom[4]
[1] Maunsell Australia Pty Ltd, Melbourne, Australia
[2] Pinnacle Research, Wellington, New Zealand
[3] Booz Allen & Hamilton (NZ) Ltd, Wellington New Zealand
[4] Land Transport New Zealand, Wellington, New Zealand

1 Introduction

Travel Behaviour Change (TBhC) projects are a relatively new category of transport expenditure that employ education, information and marketing based approaches to achieve voluntary changes in the travel behaviour of individuals. Experience to date in New Zealand has found that existing project appraisal procedures are not well suited to TBhC projects. This is mainly because the required level of appraisal effort is disproportionate to the scale of most TBhC proposals. TBhC projects result in small impacts to a large number of people and the impact tends to be different for each participant whereas with typical transport projects most users tend to be attributed the same benefit.

This paper describes research for Land Transport New Zealand (Land Transport NZ) and the Energy Efficiency and Conservation Authority (EECA), which reviewed New Zealand and international TBhC procedures and experience, and developed an appraisal procedure and guidelines for practitioners in New Zealand.

Both agencies wished to increase the level of consistency within and between appraisals of TBhC projects by considering the framework under which such packages of projects are assessed and the associated benefit values used in the analysis.

An economic appraisal procedure was required that achieved an appropriate balance between the requirement for procedures that are consistent with Land Transport NZ's funding allocation process and are evidence based, yet are simple to understand and apply and involve an analysis effort that is in proportion to the scale of the proposed projects.

A Guidance Handbook (Land Transport NZ (2004)) was also prepared that provides advice on types of projects, components, and preconditions that have been found to be successful or unsuccessful in New Zealand and overseas, in the preparation of evaluations and funding applications, design of before and after monitoring programmes, and a listing of relevant sources of further guidance for developing successful TBhC proposals. The Guidance Handbook and other project related reports are available from Land Transport NZ's website.

2 Evaluation framework

A number of factors influenced the selection of the most appropriate evaluation framework for assessing the economic efficiency of TBhC proposals. These included analysis of issues raised by previous evaluations of TBhC proposals in New Zealand and elsewhere, the need for a theoretically sound evaluation framework that was not inconsistent with other Land Transport NZ evaluation procedures and use of common benefit parameters as far as possible, and the need for a method which estimated the benefits obtained by travel behaviour changers. Consideration was given to social cost benefit analysis and multi-criteria analysis approaches.

A social cost benefit analysis framework was selected because:

- Other Land Transport NZ evaluation procedures are based on cost benefit analysis and it would be easier to undertake combined evaluations of integrated

packages of measures if all packages elements used similar evaluation methods.
- Many of the benefits of TBhC projects are of the same types as those of other types of projects funded by Land Transport NZ. Unit values for these benefits already exist.
- Most previous New Zealand and overseas evaluations to date had adopted a cost benefit analysis framework.
- It was considered that TBhC projects would gain greater credibility if they were analysed on a similar basis to other transport investments.

A conventional theoretical framework for cost benefit analysis of transport projects involving switching between modes (of which TBhC projects are a subset) assesses the benefits as the sum of the following:
- (A) Resource benefits to people already on the mode which is improved (estimated as changes in generalised cost and usually include mainly aspects of cost, time and comfort)
- (B) Perceived benefits to mode changers (valued at half the unit benefits to existing users of the improved mode[1])
- (C) Benefits from avoidance of unperceived costs associated with previous behaviour of mode changers, comprising:
  - (i) resource cost corrections for switchers themselves (including monetary (eg car maintenance and other non-fuel variable vehicle operating costs, parking subsidies) and non monetary (eg accident trauma))
  - (ii) other resource cost impacts (externalities) on other transport system users or of the transport system (eg decongestion, environmental, and accident externalities)
- (D) Unperceived costs associated with new behaviour of mode changers, comprising:
  - (i) resource cost corrections for switchers themselves (including monetary (eg public transport fare payments which are perceived as a cost but in fact are a transfer rather than a resource cost) and non monetary (eg health benefits of cycling and walking which are considered to be under-perceived))
  - (ii) other resource cost impacts (externalities) on other transport system users or of the transport system (eg environmental, accident, and health externalities (to the extent that costs of less health were being incurred by society other than the behaviour changer))

Category (A) benefits are the benefits to existing users of the mode that is improved by the infrastructure project or public transport service improvement. Benefits to existing users are changes in generalised cost and usually include mainly aspects of cost, time and comfort.

If people change mode in response to an infrastructure project or public transport service improvement (ie a “supply side intervention”) their benefits (B) are valued at half the unit benefits to existing users (A). When choosing between modes travellers are assumed to fully perceive relative time and comfort aspects and out of pocket costs such as fuel, parking charges, and public transport fares. These aspects/costs are taken into account in their choice of mode and are assumed to be included in (A) and (B).

However travellers’ perceived benefits usually do not include all of the resource cost changes resulting from a project, which are necessary for transport project evaluation. For the mode changers we therefore also add the resource cost adjustments (C(i) and D(i)). These represent the additional unperceived resource cost savings to the behaviour changers

[1] Referred to as the rule of a half this assumes that mode changers are evenly distributed along a linear demand curve from some who perceive the full net benefit obtained by existing users to some who perceive little net benefit from changing.

themselves resulting from replacing a car trip with a public transport trip (or cycle/walk trip) that are not included in the perceived benefit or rule of a half benefit.

Finally we add the other resource cost impacts on other transport system users or of the transport system (C(ii) and D(ii)), such as decongestion and net environmental externalities.

3 Application of framework to TBhC projects

Figure 1 shows the breakdown of costs associated with a car trip into perceived and unperceived components, including externalities.

Normally car drivers only consider the internal perceived costs described above and shown in the dark shaded lower segments in Figure 1. Other internal costs such as non-fuel variable vehicle operating costs, and accident costs are considered to be unperceived as shown by the medium shaded dimension X in Figure 1. Externality costs such as environmental effects are also generally considered to be unperceived.

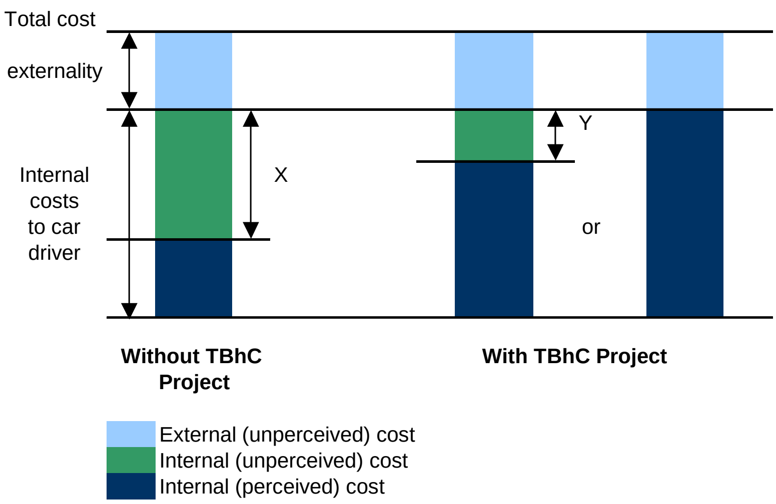

Figure 1: Categories of costs associated with a car trip

One of the effects of a TBhC project is to provide travellers with information that changes their perceptions of costs of different modes. This is illustrated by the two scenarios on the right hand side of Figure 1. The first scenario shows the situation if the TBhC project corrects a proportion of the internal unperceived costs. Dimension Y shows the remaining unperceived internal costs of the car trip following the TBhC project. This is the required resource cost correction that is counted as a benefit in addition to the net perceived benefit if a car trip is removed by the TBhC project. The second scenario shows the situation where all internal costs are perceived as a result of the TBhC project and the required resource correction is reduced to zero.

TBhC projects primarily involve "soft" measures such as marketing and information that aim to change perceptions and knowledge about different travel options and choices rather than changing generalised cost. Therefore category (A) benefits are typically zero for TBhC projects. Some types of TBhC projects may involve some infrastructure improvements that change generalised cost for people already using that infrastructure and this may still need to be quantified in some cases if significant.

Estimating category (B) benefits is therefore difficult with TBhC projects. Normally the benefits to mode switchers can be valued at half of the unit benefits to existing users (ie at half the Category A unit benefits), but as noted above in the case of TBhC projects such benefits are often zero. The benefit to mode switchers ("behaviour changers") cannot be

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zero or people would be indifferent about changing behaviour. The explanation is that TBhC programmes change the information available to households and individuals and, partly as a result, their perceptions about alternative travel modes and choices - even where there are no changes to the system itself.

In the case of TBhC projects, people make changes because the new information:

- corrects an information gap or misperception and they realise that the alternative actually is more attractive on balance than the private car trip that it replaces, or
- changes their attitude so that they are willing to accept the disadvantages of the alternative mode because they feel that it is the right thing to do, eg they are being more environmentally responsible.

The change in perceived benefits/disbenefits resulting from the TBhC project causes people to make the travel behaviour change because they now perceive the cost of making the trip by car as being higher than the alternative. This is shown in Figure 2.

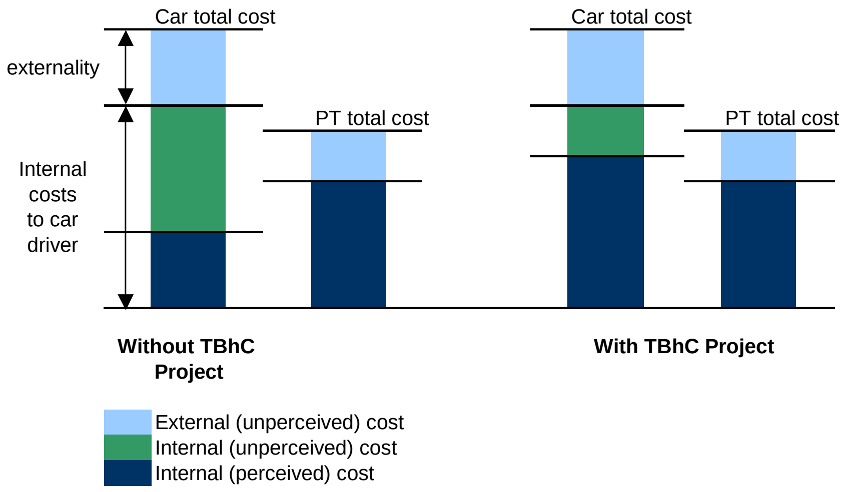

Figure 2: Change in perceived costs resulting from TBhC project

In the situation without the TBhC project Figure 2 shows that for a particular individual the perceived costs of travel by public transport are greater than by car so car is the preferred mode. The TBhC project causes the individual to become aware of a greater proportion of the costs of car travel and as a result the perceived costs of a car trip now exceed those of undertaking the trip by public transport and public transport becomes the preferred mode.

The difference between the car total cost and public transport total cost, which represents the resource cost saving, is the benefit of this mode change. Some of this accrues to the behaviour changer as savings in perceived and unperceived internal costs and some to society due to the lower externality costs associated with a public transport trip compared with a car trip. Note that there is no actual change in the total resource cost of either the car or public transport trip but that the behaviour change and resulting benefits arise solely from the change in perceived costs brought about by the TBhC project.

In summary, the evaluation procedures include three main benefit categories:

- Benefits to travel behaviour changers
- Resource cost corrections
- Externality benefits

4 Benefits to travel behaviour changers

As noted in the previous section, estimating perceived net benefits to behaviour changers (category (B) benefits) in TBhC project appraisals is difficult because the rule of half approach cannot be used. Winn (2004) derived estimates of the benefits perceived by behaviour changers from the mode split relationships incorporated in strategic transport planning models. These relationships reflect the change in mode shares between two modes that will result from changes in the relative perceived generalised costs of the two modes.

The mode split between two modes is a function of the difference in perceived generalised cost between the two modes. The relationship can be used in reverse to determine the change in perceived generalised cost difference that is required to achieve an observed change in mode share. Because the mode share relationships are calibrated to actual behaviour this generalised cost difference can be equated to the perceived benefit associated with a given change in mode share. The Wellington and Auckland strategic transportation models were used to determine relevant values for New Zealand.

Figure 3 shows the mode choice relationship between public transport and car mode share for the morning peak in Wellington Region.

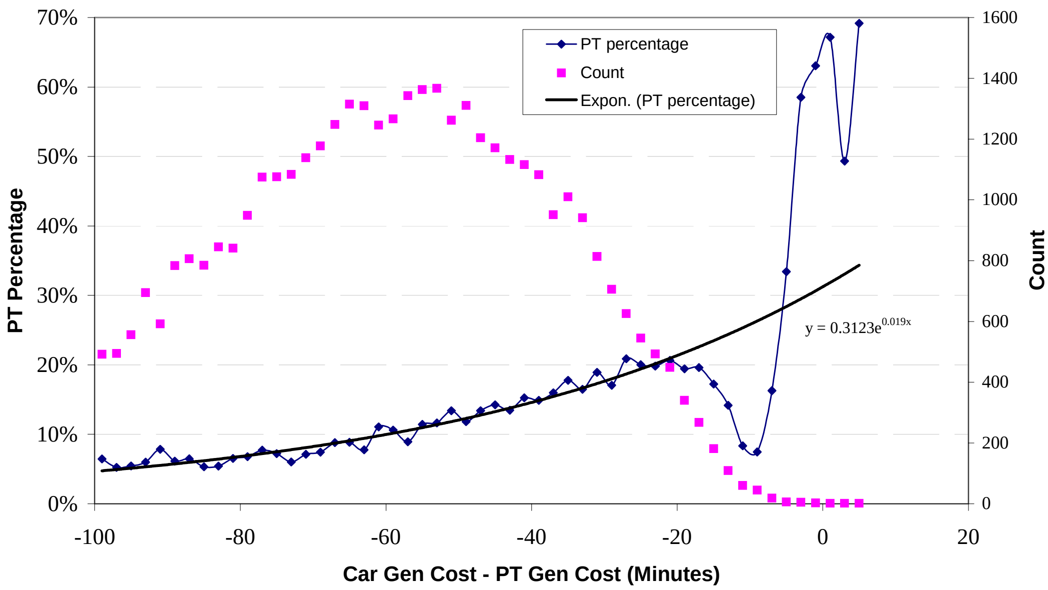

Figure 3: Wellington public transport / car mode choice relationship – morning peak

To produce the graphs the Wellington Regional Council extracted the difference in generalised cost between car and public transport for each origin-destination pair in the network. This determined the point on the horizontal axis. Origin-destination pairs with similar generalised cost difference (car minus public transport generalised cost values) were grouped together within bands of five minutes generalised cost difference. The “count” figure in the graphs represents the number of origin-destination pairs with generalised cost differences within each five minute band.

The public transport share of trips for each origin-destination pair was determined from household travel survey data. The average public transport mode share of all the origin-destination pairs in each band was calculated to determine the point on the vertical axis for that generalised cost difference band. The resulting points form a fairly well defined relationship in the range covered by most of the origin-destination pairs.

From Figure 3, over the range of 8% to 15% public transport mode share (which accounts for the majority of origin-destination pairs), a one percentage point change in mode share corresponds to approximately 4.2 minutes change in generalised cost difference. Based on a $7.96/hour value of time savings for car driver (2004 $) this gives an inferred cost difference of 56 cents, which gives a behaviour changer benefit of 28 cents after applying the rule of half. A four percentage point change in mode share would equate to a behaviour changer benefit of $1.12.

Similar analysis was performed on the Wellington inter-peak relationship and on corresponding data from Auckland Region. Given the approximations in the analysis a benefit value of $1.00 per four percentage point change in mode share was adopted for all locations and for mode changes from car to all environmentally friendly modes.

5 Resource cost corrections for unperceived costs and benefits

No resource cost correction is required for travel time savings (or increases) because travel time changes and related impacts are considered to be fully internalised in the perceived net benefit to behaviour changers estimated in the previous section. This includes effects such as differences in travel time by different modes, differences in the value of that time, other time costs such as waiting, transfers, changing etc, and trip time reliability. All of these tend to be quickly taken into account by users based on their experience and directly influence their mode choice and other travel behaviour decisions.

In the case of car operating costs it is considered that one of the objectives of TBhC projects is to provide information that corrects peoples' misperceptions of the costs of private car use. Therefore it was assumed that TBhC projects will provide sufficient information to make users aware of the resource cost of car operation and that the usual resource cost correction is not required in analysis of TBhC projects.

Similarly it was assumed that people changing to cycling (and walking) are likely to be aware of the probable incremental cycle (and footwear) costs and that no resource cost correction is required.

Car parking costs do require a resource cost correction. When choosing between modes behaviour changers are likely to consider only the parking fee that they actually save. The average parking fee paid by car users is generally less than the resource cost of providing parking. Hence a resource cost correction is required for the difference between the parking fee and the resource cost of parking. As with vehicle operating cost it was assumed that TBhC projects will provide information that reduces the normal misperception of car-parking resource cost and hence the required resource cost correction will be less than without the TBhC project. It was assumed that as a result of the TBhC projects car users will perceive 75% of the resource cost of parking so a resource cost correction of 25% of the resource cost is required.

A resource cost correction is also required for public transport fares. This is because fares are a financial transfer (from behaviour changer to public transport operator) rather than an actual resource cost. This is regardless of whether the public transport provider incurs additional costs to provide additional services. However the fares are perceived as a real cost by the behaviour changer and are therefore reflected in their perceived behaviour changer net benefits. The person changing to public transport perceives fares as a cost but they are not a resource cost so it is necessary to make a resource cost correction by adding back (as a benefit) the (tax inclusive) amount of fare. The tax inclusive fare is used because this is the cost that the behaviour changer sees when choosing between modes.

Little quantitative information was available on the extent to which people perceive accident risks and costs before the event and take this into account in their travel choices. Also research is only beginning to estimate the proportion of accident costs that are internal to an individual as opposed to being externality costs borne by others. It was concluded that accident risk/cost is generally not considered when making travel choices and therefore that the sum of the resource cost correction and externality costs is equal to the resource cost of accidents (for which standard values are available).

The same considerations apply in relation to cycle and walking accident costs as for car accident costs although it was considered that behaviour changers to walking and in particular cycling probably have a fairly clear perception of the associated accident risk (so possibly some of it is included in the net benefits to behaviour changers).

Health benefits of cycling and walking are also likely to be partially included in the net benefit to behaviour changers because TBhC projects promote health benefits as one of the key benefits of changing to cycling or walking. It was assumed that half of the estimated value of health benefits needed to be included as a resource cost correction or externality.

6 Externality benefits

In addition to the internal perceived and unperceived benefits and disbenefits to travel behaviour changers, TBhC projects also result in externality effects on other transport system users and on society.

Decongestion is the reduced congestion costs (time and vehicle operating cost) experienced by remaining road users due to removal of a marginal vehicle - it does not include the saving to the TBhC changers themselves as this is part of their internalised benefit. Estimates of decongestion benefits were obtained from previous research for Land Transport NZ. The average marginal travel time saving to remaining road users per vehicle-km removed is Auckland $1.190/km, Wellington $0.911/km, Christchurch $0.085/km. Decongestion also includes the savings in vehicle operating costs to the remaining road users per vehicle-km removed. The total travel time decongestion benefits are factored up by 7% to account for the vehicle operating cost externality saving. This proportion was derived by research reported in BAH (2003)

The reduction in congestion resulting from TBhC projects is likely to make car travel more appealing for other potential road users, leading to increases in car use by other individuals (induced traffic) which has the effect of partially reducing the first round decongestion benefit. This is valued as a disbenefit equivalent to 50% of the decongestion benefit. The derivation of this proportion is also reported in BAH (2003)

Road system benefits such as reduced road maintenance and deferral of road capacity increases were considered but not included because they are likely to be negligible for the numbers of car trips and/or car vehicle kilometres that are likely to be removed by most TBhC projects.

For peak period trips it is considered that increases in patronage due to TBhC projects may lead to marginal increases in public transport operating costs (given that existing services are at capacity in peak periods and additional services would need to be provided). Similarly the Mohring effect (public transport frequency benefits generated by additional demand) may be a benefit of TBhC projects if the behaviour change was sufficient to require additional more frequent public transport services. It was decided that as Land Transport NZ evaluation procedures already existed for additions to public transport services any additional operating costs or Mohring effect benefits should not be included in the TBhC evaluation procedure.

As noted in the previous section it was concluded that the sum of externality and internalised costs of accidents is equal to the resource cost of accidents. The resource cost can therefore be used for valuing accident saving benefits from TBhC projects. Previous Land Transport NZ research has established a marginal accident cost for car as driver of 1.8 cents/km for peak period travel and 2.9 cents/km for off-peak travel.

Accident externality costs due to additional cycling and walking were valued at zero in the TBhC evaluation procedure notwithstanding that accident resource average costs are 34 – 44 cents/km for cycling and 18 – 19 cents/km for walking. It was considered that people are generally aware of the risks of using these modes, particularly cycling so the internal costs are all reflected in the net benefit to behaviour changers. It was assumed that the externality costs of increased accidents will be offset in the longer term by the accident reductions due to the traffic calming effect of increased numbers of cyclists and pedestrians. These assumptions may be considered slightly optimistic.

Environmental externalities are estimated as a total value of all effects including local air, noise, and water pollution, and greenhouse gas emissions. Some previous evaluations have tended to use an average cost for environmental externalities. For TBhC evaluations it is considered more appropriate to use a marginal cost value and this is estimated to be approximately 10 cents/km. It was assumed that, notwithstanding the information provided by the TBhC project, behaviour changers were unlikely to take much account of environmental costs in their decision to change modes and hence the full value associated with reduced car and passenger km was included as an externality benefit.

As discussed in the previous section it was assumed that half of the estimated unit value of health benefits of cycling and walking needed to be included as a resource cost correction or externality. Previous Land Transport NZ research estimated health benefits at 40 cents/km for walking and 16 cents/km for cycling.

Based on the above considerations appropriate resource cost corrections and externality costs and benefits per kilometre or per trip were estimated for different modes, trip types, times, and locations.

The following other potential benefits were identified in previous studies but were not quantified in the evaluation procedure:

- Reduced community severance
- More sustainable land use/urban form
- Community cohesion
- Improved security/safety to the community
- Less dependence on fossil fuels
- Viability of local shops and businesses
- Synergy with other marketing initiatives

7 Diversion rates

In order to quantify the benefits associated with a TBhC project, estimation is required of the likely impact that the project will have on travel behaviour including changes in mode share. Default diversion rate profiles (mode share changes) were determined for different types of work travel plans, school travel plans and household/ community based projects from the reported results achieved by TBhC projects in New Zealand, Australia, and the United Kingdom in recent years.

For each project that had information on before and after project implementation mode shares the mode share was calculated for each mode. Changes for some projects could only be calculated for one or two modes, consequentially there are different numbers of observations for each mode.

Default diversion rates are presented as an absolute percentage point change in mode share from car-as-driver to other modes including car-as-passenger, public transport, cycling, and walking. This was possible because detailed statistical analysis of the TBhC projects to date indicated that percentage point change in mode share did not appear to be significantly related to the initial mode share. This is illustrated in Figure 4 showing a plot of percentage point change versus initial mode share for car-as-driver in all of the workplace travel plans investigated.

The plots for each of the other modes and TBhC project types also showed no obvious relationship between initial mode share and the percentage point change. The advantage of using percentage point changes is that they can be used without knowledge of existing mode shares, which simplifies the evaluation procedure.

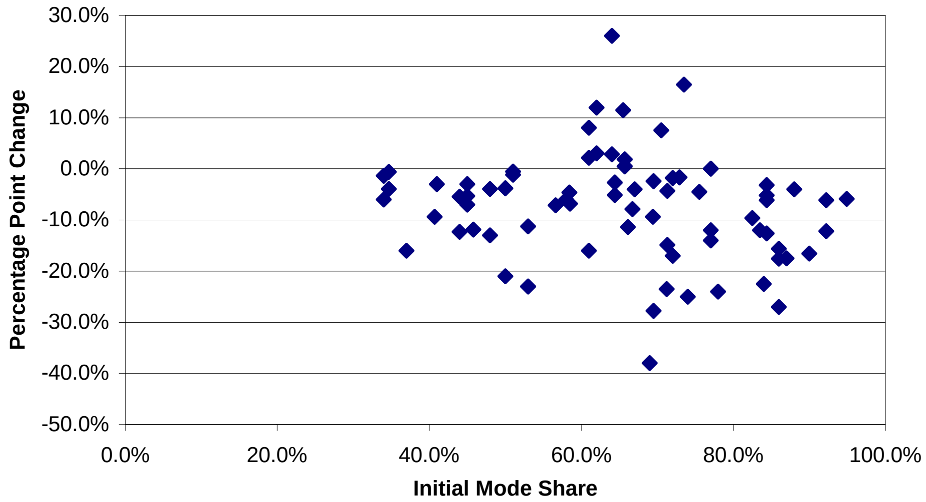

Figure 4: Workplace Travel Plans – Car as Driver Initial Mode Share vs Percentage Point Change

The recommended diversion rates take account of the fact that many case studies only report the observed behaviour changes for a certain subset of the population, such as those who participated in the programme. Where necessary, appropriate adjustments were made for the assumed response of non-participants and the effect of on-going word-of-mouth dissemination of TBhC information.

In the case studies reviewed changes in mode share were reported for car as driver, car as passenger, public transport, walking, cycling and car sharer, although not all modes were measured for every project. Thus the number of observations for each mode varied, with the most observed for car as driver.

Statistical analysis confirmed that on average work travel plans result in a statistically significant reduction in car as driver mode share. Significance tests on changes in car as passenger, public transport, walking and cycling showed that none of these were statistically significant. However the diverted car drivers must have gone somewhere and hence the reduction in car as driver mode share is distributed between the other modes on the basis of observed data even though this is not statistically significant for each individual mode.

The first step in estimating diversion rates was to sort data from the case studies for each type of TBhC project into ascending order of percentage point change for car as driver. The individual observations for work travel plans were then divided into three groups representing low, medium, and high diversion respectively. Effectively the observations in Figure 4 were divided into three groups comprising equal numbers of observations based on their position on the vertical axis. The second step was then to calculate the average percentage point mode change for each mode within each group. Table 1 shows the initial results of this.

Table 1: Workplace travel plans – lower, middle and upper third averages

	Car as Driver	Car as Passenger	PT	Cycling	Walking
Low	1.8%	-0.6%	0.0%	-0.7%	-0.5%
Medium	-6.0%	1.1%	2.2%	0.2%	0.7%
High	-17.7%	2.4%	5.4%	0.7%	0.9%

There are two points to note about Table 1. Firstly, these results do not meet the constraint that the sum of the 'to' modes need to equal the sum of the 'from' modes. Values were adjusted in appropriate proportions to achieve this. The second point is that the "low" group of diversion percentages show a negative result from the work travel plans, with an increase in car use and a decrease in the mode shares of environmentally friendly modes. These results are due to a few outlier cases in which there was a significant increase in car trips. These outliers, which can be seen in Figure 4, were removed for the calculation of default diversion rates.

Table 2 shows the resulting default diversion rates that were adopted for use in the evaluation of workplace travel plans.

Table 2: Workplace travel plans – recommended diversion rates for projects with PT service improvements

	Score	Car as Driver	Car as Passenger	PT	Cycling	Walking
Low	1 or 2	0.0%	0.0%	0.0%	0.0%	0.0%
Medium	3 or 4	-5.0%	1.3%	2.6%	0.3%	0.8%
High	5 or 6	-12.9%	3.3%	7.4%	1.0%	1.2%

A scoring system, based on the components to be included in the workplace travel plan, was developed for determining the relevant diversion rate. These diversion rates are applicable when the TBhC project is accompanied by public transport service Improvements. An alternative table of diversion rates was developed for projects not including public transport measures.

School travel plans and household based projects were only divided into two groups because the number of available case study results did not support further disaggregation.

The results from school travel plans were generally from projects implemented in the UK. The summary statistics showed that the change in car passenger mode share was statistically significant but that walking mode share change was not. Public transport, cycling and car sharing had less than 10 observations each, too small for meaningful statistical analysis. The plots of initial mode share against percentage point change showed them to be independent.

Estimation of different diversion rates for primary and secondary schools could not be determined from the literature, because there were only a small number of observations for secondary schools.

The mean percentage point change in car as passenger is used as the default 'from' diversion rate for both primary and secondary schools.

In the case of primary schools, the 'to' modes are considered to be walking initiatives and cycling. Evidence was that public transport is not an important mode for primary schools, possibly due to the relatively short journey distances and parental concern for safety. The default mode change value for walking was estimated at 80% of the diversion rate of car as passenger, and for cycling it was at estimated at 20%. The reason for the split is that the literature suggests there is a single mode that attracts the majority of the change, and that this is generally associated with walking initiatives.

Default diversion rates for secondary schools are estimated for public transport, cycling and walking initiatives. There is limited evidence on proportions of 'to' mode shares. Based on experience and judgement public transport is considered to receive most diversion and cycling is considered to achieve the least change. Results from future projects will provide evidence on which these assumptions may be refined.

The default diversion rate values for primary and secondary/intermediate schools are shown in Table 3.

Table 3: School travel plans – default diversion rates

	Car as Passenger	PT	Cycling	Walking
Primary	-9.0%	0.0%	1.5%	7.5%
Secondary / Intermediate	-9.0%	5.0%	0.5%	3.5%

The reported results from household based projects generally had a consistent set of modes, being car as driver, car as passenger, public transport, cycling and walking. The number of observations for household based projects was significantly less than for workplace travel plans, although a similar process was used to estimate the default values for the two sets of default diversion rates.

Analysis indicated that the change in mode share for car as driver was not statistically significant. This result is affected by the small sample size of 19 cases. This further supported fewer rather than more sets of default diversion rates.

The two sets of default diversion rates were estimated in a similar method to work travel plans. The data for each mode was sorted into ascending order for the car as driver. A standard set of diversion rates was derived using the average for the whole sample, while the low set of diversion rates was based on the average value for the half of cases that achieved least diversion. It was also necessary to adjust these values to meet the constraint of mode share summing to 100% (using the same process as for work travel plans).

The two sets of default diversion rates adopted for household based programs are shown in Table 4.

Table 4: Household based programs – default diversion rates

	Car as Driver	Car as Passenger	PT	Cycling	Walking
Standard	-3.1%	-0.5%	1.4%	0.9%	1.3%
Low	-1.0%	-0.2%	0.5%	0.3%	0.4%

It is intended that the standard diversion rate profile based on the average of all case studies be used for most household TBhC projects. The low set of default rates, based on the average of the bottom half of diversion rates achieved, should be used for any projects that may not implement the full range of initiatives that have become standard in household based programs such as TravelSMART, or where public transport services or cycle/walk facilities are poor, with the decision to use the low set at the discretion of analysts.

It was initially intended to separate each of the TBhC project types into a larger number of sub-groups with a greater number of diversion rate profiles for different situations. It was expected that characteristics of a workplace, school or household area would determine the applicable diversion rate from within a sub-group (such characteristics were the size of the company, accessibility to services and amenities, quality of public transport services, etc). After considerable analysis this method was discarded, as there was insufficient data to determine statistically significant differences between the diversion rates that were achieved with different combinations of characteristics.

8 Evaluation procedure

TBhC projects tend to result in small impacts to a large number of people. They are much more difficult to evaluate than conventional projects because the impact tends to be different for each participant whereas with typical transport projects most users tend to be attributed the same benefit. This leads to a conflict between procedures that accurately reflect all of the different individual responses to TBhC projects (but which may cost more to actually apply than the cost of the project being evaluated) and procedures that are cost effective to use but that may involve significant approximations and averaging of the effects on different participants. This averaging and approximation is an inevitable consequence of the requirement for simplified procedures and the relative newness of TBhC projects, which means that the database of project impacts is still relatively small and subject to considerable variation.

Nevertheless, in keeping with the project requirement for simplified procedures, an evaluation procedure was developed that covers the main types of TBhC projects and can be extended to other types if necessary. The procedure is considered to meet Land Transport NZ's requirements of being appropriate for the scale of individual TBhC initiatives as well as promoting consistency in the evaluation of these projects.

The evaluation procedure uses a ten-year evaluation period and determines a benefit cost ratio. Required inputs are the type of TBhC project, city/location, target population number (workforce, school roll, or residents, etc), and information about the comprehensiveness of the proposed project. Benefits are assumed to remain constant over the evaluation period – different levels of ongoing "maintenance expenditure" are required to achieve this for different TBhC project types.

The steps in the evaluation procedure are:

- Identify most appropriate default diversion rate profile (refer to Section 7)
- Look up the corresponding composite benefit value
- Multiply composite benefit value by target population to determine benefits per annum
- Multiply benefits per annum by discount factor to determine present value of benefits
- Divide by present value of TBhC implementation costs to determine benefit/cost ratio

A number of composite benefit values were calculated for a range of TBhC project types and situations incorporating the costs and benefits and diversion rates discussed in the previous sections. These are shown in Table 5.

These composite benefit values include benefits to the person changing their travel behaviour as well as benefits to remaining road users and the general community, such as reduced health costs and accident risk, decongestion and environmental benefits. The exact composition depends on the nature of the TBhC project being undertaken. The composite benefits also incorporate the default diversion rate assumptions for each TBhC project type as well as the average trip length for each mode affected by the project. The composite benefit values were calculated using a spreadsheet program that effectively performed a series of cost benefit appraisals for each expected TBhC project type, location, and diversion rate profile (see Maunsell (2004) for more detail).

The composite benefit values are the average annual benefit per person in the workforce, school, or community targeted by the TBhC project (and take account of the proportion that do not participate or change their travel behaviour)

During development of the evaluation procedure a number of sensitivity tests were carried out to determine the sensitivity of the composite benefit values to alternative values for some benefit parameters. The sensitivity tests show that the approach and benefit values are reasonably robust (and consistent with other Land Transport NZ procedures such as passenger transport funding policy) for workplace travel plans and household based projects but that there is somewhat less certainty with school travel plans due to factors such as school mode change being dependent on both student and parent perceptions, and variability in the proportions of change to different modes.

Table 5: Composite benefit values for TBhC projects

Workplace travel plans

Benefit per employee (dollars/annum)

		CBD workplace			Non-CBD workplace		
		Level of Diversion					
		Low	Medium	High	Low	Medium	High
	Distribution						
Auckland	Standard	0.00	160.88		0.00	137.88	
	incl PT improvements	0.00	201.17	588.00	0.00	178.17	528.66
Wellington	Standard	0.00	142.31		0.00	119.31	
	incl PT improvements	0.00	178.21	525.78	0.00	155.21	466.44
Christchurch/ Other	Standard	0.00	40.84		0.00	40.84	
	incl PT improvements	0.00	47.95	173.12	0.00	47.95	173.12

Based on 100% of changed trips being Peak Period

Standard = Without public transport measures
Alternative = With public transport service improvements or subsidies

School travel plans

Benefit per student on school roll (dollars/annum)

	School Type	
	Primary	Secondary/ Intermediate
Auckland	25.87	106.98
Wellington	23.21	92.42
Christchurch/ Other	15.34	43.21

Based on 55% of changed trips being Peak Period

Household/community based initiatives

Benefit per head of target population (dollars/annum)

	Level of Diversion	
	Standard	Low
Auckland	85.06	25.46
Wellington	92.84	28.21
Christchurch/ Other	65.65	18.76

Based on 85% of changed trips being Off Peak

The composite benefit values represent an average benefit per head of target population and allow for the fact that the majority do not make substantial change and that there are also a proportion who do not participate in the programme at all for one reason or another.

The TBhC evaluation also requires an understanding of the likely trend of benefits in future years. Some earlier evaluations assumed that benefits would decay or that maintenance expenditure would be required. More recent papers have found evidence that benefits appeared to be self-sustaining without specific maintenance.

It is intuitively plausible that if TBhC programmes provide information that corrects misperceptions about alternative travel options and modes that people were not aware of, many of the people making changes will find the new option to be an improvement and will not have an incentive to revert.

Further analysis of previous experience indicates that for household/community initiatives there appears to be some reversion to previous travel choices over the first nine months following the TBhC project but that people who have not reverted by this time tend to stay with their new travel choice. Experience from Perth over a four to five year period indicates stable mode shares at the same proportions as they settled at 9 – 12 months after the TBhC project. There is no experience yet over longer periods but it may be assumed that there is little reason for reversion after four or five years. Therefore evaluations of household community projects could generally assume that benefits will be retained in future years with little or no maintenance expenditure, subject to adopting a suitable evaluation period.

Workplace travel plans and particularly school travel plans are more likely to require ongoing maintenance expenditure due to staff and student turnover. In the case of workplace travel plans some of this will become part of the companies' cost of business but in the case of school travel plans this may require ongoing council or Land Transport NZ expenditure which would need to be estimated and included in the evaluation.

A 10-year evaluation period was considered the maximum appropriate length for TBhC projects at this stage, given the recommendation above to assume that benefits are sustainable without maintenance, and the absence of experience of the durability of benefits beyond about five years. This could be reviewed in future in the light of ongoing monitoring of projects undertaken in early years.

Table 6 shows some examples of results using the TBhC project evaluation procedure.

Table 6: Examples of TBhC project evaluation results

	Workplace[1]	School[2]	Household[3]
Target population	500	1,000	5,000
Composite benefit value	$137.9	$92.4	$65.7
Discount factor	5.49	5.49	5.49
PV of benefit	$378,500	$507,500	$1,802,000
PV of cost	$150,000	$150,000	$750,000
Benefit/cost ratio	2.5	3.4	2.4

1 Workplace travel plan: Auckland, medium diversion rate, non-CBD location, without public transport measures
2 School travel plan: Wellington, secondary school diversion rate
3 Household/community project: Christchurch/other, standard diversion rate

These results are towards the lower end of the range of results obtained in ex-ante TBhC project evaluations overseas. For household based programmes Winn (2004) obtained results ranging from 2.9 to 10 (based on a 15 year evaluation period) in Melbourne, The Department of Infrastructure results were 5.0 to 7.5. Ker and James (1999) reported a range of 4 to 33 in Perth and Tisato and Robinson obtained a typical benefit/cost ratio of 5.7 for travel blending in Adelaide. In the case of household programmes most of the differences is considered to be due to higher assumed diversion rates in the other evaluations. Diversion rates recommended for New Zealand are based on averaging and other analysis of post implementation surveys of project results and so avoid the optimism in some overseas evaluations. Some projects will achieve the higher diversion rates but experience shows that many will be less effective than might have been anticipated based on overseas reporting.

9 Monitoring and review

It is expected that the evaluation procedures will be reviewed and refined after one year to improve their ease of use and applicability, if necessary, following initial experience with their application. It was envisaged that a more comprehensive review including default diversion rates might be undertaken after approximately three years when more evidence on effectiveness of different TBhC projects has become available from monitoring of initial projects. The Guidance Handbook prepared as part of this overall project provides advice on the design and timing of appropriate monitoring programmes to measure the effects of TBhC projects.

It was recommended that the costs of monitoring should be excluded from the evaluation even though this might be a significant cost for TBhC projects and is likely to be included as part of funding requests. This is because monitoring is not specifically included in the costs of other types of projects and should not be an additional hurdle for TBhC projects. Rather, it was considered that the additional monitoring costs in early years should possibly be regarded the same as research and development or demonstration project expenditure.

10 Conclusions

An economic evaluation procedure based on social cost benefit analysis was developed that achieves an appropriate balance between Land Transport NZ and EECA's requirements for procedures that are consistent with Land Transport NZ's Allocation Process and are evidence based, yet are simple to understand and apply and involve an analysis effort that is in proportion to the scale of the proposed projects. The evaluation procedure should be regarded as interim and likely to benefit from ongoing review and refinement as further knowledge is gained from evaluation experience and monitoring of actual TBhC projects.

A Guidance Handbook was also prepared that provides advice on types of projects, components, and preconditions that have been found to be successful or unsuccessful in New Zealand and/or overseas, preparation of evaluations and funding applications, design of before and after monitoring programmes, and a listing of relevant sources of further guidance for developing successful TBhC proposals.

Further research could be undertaken to refine some of the benefit values including:

- Behaviour changer benefits
- Congestion (particularly Christchurch)
- Accidents
- Health benefits

The evaluation procedure does not include any benefits from reduction in vehicle kilometres travelled when there is no change in mode, eg from trip chaining, due to a lack of conclusive evidence on which to base forecasts of likely reductions. This could be an area for further research and refinement of the evaluation procedure.

Further research could also be undertaken to confirm/refine the estimates of the extent to which some benefit categories are perceived by behaviour changers or require resource cost corrections.

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