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Estimating the benefits of walking

A cost benefit methodology

Prepared for PCAL and DEECW

Cost benefit methodology

26 November 2010

pwc

What would you like to grow?

This project has been assisted by the New South Wales Government through its Environmental Trust.

Contents

Glossary

Abbreviation	Description
ATC	Australian Transport Council
BCR	Benefit cost ratio
BTS	Bureau of Transport Statistics (NSW)
CB	Colin Buchanan and Partners Ltd
CBA	Cost benefit analysis
CO	Carbon monoxide
CPI	CP
DECCW	Department of Environment, Climate Change and Water (NSW)
DEEWR	Department of Education, Employment and Workplace Relations (Commonwealth)
DfT	Department for Transport (UK)
EEM2	Economic Evaluation Manual 2
EIRR	Economic internal rate of return
GHG	Greenhouse gas
IA	Infrastructure Australia
IVT	In vehicle time
KM	Kilometre
LTNZ	Land Transport New Zealand
NMT	Non motorised transport
NPV	Net present value
NPVI	Net present value: investment ration
NOx	Nitrogen oxides
OVT	Out of vehicle time
PCAL	Premier's Council for Active Living
PT	Public transport
PwC	PricewaterhouseCoopers
RTA	Roads and Traffic Authority (NSW)
SKM	Sinclair Knight Merz
TDC	Transport Development Council
TDM	Transport demand management
VKT	Vehicle kilometres travelled
VTPI	Victorian Transport Policy Institute
WHO	World Health Organisation

1 Introduction

1.1 Background

The NSW Treasury's Guidelines for Economic Appraisal set out a consistent approach to undertaking economic appraisals for the assessment of significant spending proposals, including proposed capital works projects and new programs across all public sector agencies. Economic appraisal is a way of systematically analysing all the costs and benefits associated with the various ways of meeting an objective. In general, a formal economic appraisal is required for all individual projects with costs in excess of $1 million although it can be a useful mechanism for demonstrating the potential impact of a lower value investment for other projects.

Cost benefit analysis (CBA) is the most comprehensive economic appraisal technique available and enables the efficiency of different investment options to be assessed. It is important that any proposed CBA methodology is consistent with the Treasury's Guidelines to ensure it is robust and only factors in those direct impacts that can be directly attributed to an increase in walking.

The NSW Premier's Council for Active Living (PCAL) and NSW Department of Environment, Climate Change and Water (DECCW) have asked PricewaterhouseCoopers (PwC) to assist in developing a robust methodology that would allow walking initiatives to be subject to CBA.

1.2 Aim of the methodology

The aim of this appraisal methodology is to document an easy to adopt set of appraisal parameters that can be applied in a consistent manner to examine the costs and benefits of walking initiatives. This area of CBA is in its infancy, not only in Australia but internationally. Hence, this methodology should be seen as a reflection of current international best practice, adapted to ensure consistency with Australian transport CBA frameworks used by the NSW Treasury and Infrastructure Australia (IA). It is also designed to be consistent with similar work on a methodology for analysing cycling initiatives developed for the NSW RTA and DECCW by PwC.

The aims of the methodology are to:

- develop a CBA framework that provides policy makers with the ability to analyse walking initiatives with the same level of rigour as other transport and health projects when funding decisions are being made;
- develop an initial methodology, and identify opportunities which can build on this methodology, to further the debate and understanding around this emerging field of economic analysis; and
- investigate how walking is currently incorporated into Australian transport appraisal and identify opportunities to improve this incorporation.

This methodology is designed to complement and be read in conjunction with the RTA's *Guidelines for the Economic Evaluation of Pedestrian Facilities (currently in draft)*, which provide very detailed modelling and quantification advice for the appraisal of intersections and walking infrastructure. This methodology should also be understood within the context of the NSW Treasury *Guidelines for Economic Appraisal* and the Australian Transport Council *National Guidelines for Transport System Management in Australia.*

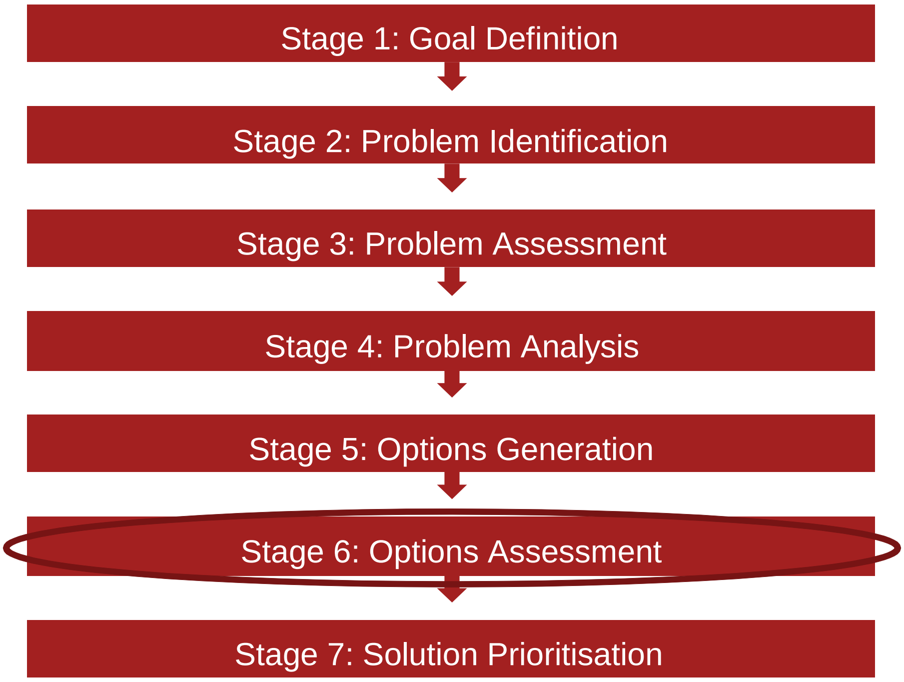
Finally, the methodology should be updated as appropriates as this field of analysis develops and new research is undertaken into the individual and societal costs and benefits of walking.

1.3 Context of the methodology

In *Better Decision Making* (2010), Infrastructure Australia sets out a seven step process to inform decision making and funding choices. It is recommended that this process, or one similar to it such as the Australian Transport Council National Guidelines for Transport System Management, be followed for all walking projects.

The aim of this document is to expand upon a walking specific methodology which can be used in Stage 6 (Options Assessment) of the IA framework. This is shown below in Figure 1.

Figure 1 - Stages in IA investment framework



Source: Infrastructure Australia, 2010, *Better Decision Making*

2 The CBA process

The suggested process for conducting the CBA is outlined below. Steps in the process are elaborated upon below or in subsequent chapters.

2.1 Define objective

Before assessing comparative projects, it is important to be clear about the objectives of any additional investment. For a walking project, this may a specific factor such as improved health outcomes or decongestion or a combination of factors.

2.2 Identify options

Different options for investment in walking should be identified that aim to achieve the outlined objectives. The options should include a base case which is a ‘do minimum’ scenario rather than an unrealistic ‘do nothing’ scenario (i.e. the base case factors in any pre-existing investment plans).

2.3 Identify costs for each scenario

Costs should include both capital and recurrent costs. All costs should be presented in real terms (i.e. excluding inflation) to ensure consistency with a discounted cash flow model.

Chapter 4 elaborates on cost.

2.4 Demand forecasting

In order to estimate the potential benefits, the likely impact of the investment on the number of people walking or the distance people are walking needs to be forecast.

Chapter 5 elaborates upon demand.

2.5 Identify quantifiable benefits for each scenario

A range of quantifiable benefits have been identified as directly attributable to walking schemes. These benefits include:

- Health benefits
- Decongestion
- Reduced vehicle operating costs
- Avoided or deferred infrastructure provision
- Reduced environmental costs

Discussion regarding the quantification of these benefits is outlined in more detail in Chapter 6

2.6 Assess net benefits

An appropriate appraisal length should be determined. Based on NSW Treasury requirements, the appraisal periods should be 20 or 30 years (depending upon the project specifics) from the first full year of benefits. Policies or awareness / behaviour change campaigns should adopt the 20 year appraisal period. It may be justified to use a 30 year appraisal period when pedestrian infrastructure, such as footbridges or overpasses, are being built.

To ensure comparable results, the net present value (NPV) of quantifiable benefits and the NPV of equal annual payments should be calculated. In line with NSW Treasury guidelines, a 7% real discount rate should be used for CBA and results should be sensitivity tested for a 4% rate and a 10% rate.

Using the cost and benefit results, the Benefit Cost Ratio (BCR), which is the ratio of the present value of benefits to the present value of costs, can then be calculated.

A project is considered to be potentially worthwhile if the BCR is greater than 1 i.e. the present value of benefits exceeds the present value of costs.

2.7 Undertake sensitivity testing

BCR results should be sensitivity tested for alternative discount rates (4% and 10%), alternative demand forecasts, alternative capital costs and alternative parameters for the quantification of key benefits.

2.8 Identify qualitative factors

While the BCR result is a key determinant in decision-making, it is only one factor and can helpfully be accompanied by an assessment of the additional benefits that the project might generate, but which are not quantified, for CBA purposes. The BCR result should therefore be accompanied by a discussion of the additional qualitative factors.

The CBA should be accompanied by a qualitative analysis of those social capital benefits that cannot be quantified. These include factors such as:

- Amenity values
- Mobility for all
- Improving access
- Supporting community development
- Sport and recreation
- Community engagement and interaction
- Opening up public spaces
- Increasing liveability

3 Project costs

To complete the CBA, the capital and recurrent costs of each walking investment option will need to be identified. The level of detail into which the costs are investigated should match the level of detail required by the CBA. Project costs can be categorised into two elements, capital costs and recurrent costs.

Capital costs

Capital costs relate to the up-front costs of the project initiative. For walking infrastructure costs should include:

1. design costs
2. construction costs
3. agency costs
4. land acquisition costs
5. contingency costs

For walking policy/behavioural change initiatives costs could include:

6. policy development costs
7. policy implementation costs
8. advertising/marketing costs

All costs used within the CBA should be real costs, i.e. exclude any escalation of costs throughout the appraisal period. In line with Treasury guidelines, the following costs should not be included:

9. escalation
10. sunk costs
11. depreciation
12. interest costs
13. profit margin of construction
14. indirect and corporate tax

A strategic, rapid or preliminary CBA is usually carried out early in the project life to ascertain potential feasibility, test the merits of various options and inform on staging options. This is often undertaken using P50 cost estimates. Projects seeking funding decisions usually require a full CBA which uses a P90 capital cost estimates.[1]

[1] A P value represents a probability, normally expressed as a percentile value that actual cost will be less than or equal to a specified cost value. Such confidence levels are usually expressed as P value to indicate percentage confidence. For example, a P50 value means that there is a 50% probability that the cost estimate of a project will not be exceeded.

3.1 Recurrent costs

Recurrent costs are defined as those costs that recur during the appraisal period, as opposed to fixed capital costs. Recurrent costs for infrastructure development should factor in annual infrastructure maintenance costs as well as major periodic maintenance (MPM) during the lifecycle of the infrastructure. Recurrent costs for policy initiatives may refer to the annual costs of running, monitoring or evaluating the project.

4 Demand

4.1 Discussion around Demand Forecasting Approaches

Forecasting demand for walking is an active research area, in which no consensus on best practice has yet emerged. There are a number of very significant methodological challenges in forecasting demand for walking in addition to the challenges facing motorised travel (which is comparatively mature):

1. There is sparse data on current walking travel and, importantly to develop predictive models, revealed and stated data on perceptions towards walking in different environments
2. A significant proportion of walking trips are discretionary; that is, they occur for their own sake and are not a means to travel to another activity.
3. Walking rates are influenced not just by readily measurable factors such as population density and network connectivity, but by many micro-level factors such as urban form and landscape issues.
4. Walking rates are influenced by attitudes, such as to health and fitness, which are exceptionally difficult to forecast (and then to relate to walking rates).

There is a strong evidence base on the high level factors which contribute to strong levels of demand for walking; mixed land uses and relatively high densities which make walking a competitive and practical alternative, as well as streetscape design such as active street frontages and perceived personal safety. However, the choice to walk is also influenced by many local issues such as the quality of footpaths, presence of street trees, lighting, priority at intersections, presence of pedestrian crossings, road traffic volumes, among others. It is exceptionally challenging, and a time consuming activity, to quantify each of these elements (many of which are subjective).

Traditional four-stage models, incorporating trip generation, distribution, mode choice and route choice are difficult to apply in a walking context. There is very little empirical data available on the number and purpose of trips that would be generated through a walking project, and from what other modes some of these trips would be substituted. What is more readily estimable is the relative attractiveness of various routes to walking, determined either through revealed (i.e. observed) or stated preferences. Experimental methods, combined with observations of real behaviour, can be used to quantify preferences towards walking related variables.

For example, an individual may be observed to travel a further 300 m along a residential street between their home and a shop in order to avoid walking along a busy road. This implies a willingness to trade off time (which may in turn be monetarised to estimate a generalised cost) in order to gain amenity. Using such an approach it is then conceivable to estimate how many **existing** walking trips would re-route onto an upgraded corridor using widely used path assignment methods (either minimum path or discrete choice methods). One technical issue to consider in estimating models of route choice, depending on the assignment method, is the extent of overlapping paths (that is, how extensive the similarity between paths that share some links). While methods exist to handle such issues, there are statistical and software implementation issues that would need be considered.

Having estimated the generalised cost of a route before and after a pedestrian treatment, it is conceivable that standard generalised cost elasticities may be applied to account for mode shift and trip generation. While there is an extensive database for these elasticities from observations of motorised modes, there is a paucity of data for walking. However, in the absence of a strong empirical evidence base sensitivity testing could be used to establish a range of expected demand for any particular project.

Source – Sinclair Knight Merz (SKM), 2010

4.2 Demand segments

There are two distinct user groups which need to be considered in the demand forecasts and the quantification of the costs and benefits of walking programs. These are described below:

- **Walking for transport:** Users who choose walking over an alternate form of private or public transport for the purposes of any given trip. Demand for this segment of users is driven by the user's perception of the benefits of walking over other forms of transport. To more accurately understand the impact of a walking project, it would be important to estimate the distance and travel time walked relative to the mode travelled, distance travelled and travel time in the base case.

- **Walking for recreation:** Those who walk for leisure purposes, i.e. with no specific trip purpose in mind. Demand for this segment is driven by subjective factors such as the degree of amenity, fitness and health.

Within these user groups there are two further categories: existing users and new users. Existing users refer to those who were walking for transport or recreational purposes before the infrastructure or the policy was put in place (i.e. walked in the base case). New users refer to those users who have switched from an alternate form of transport or recreation to walking as a direct result of the infrastructure or policy initiative. It is imperative that the quantification of costs and benefits account for the demand characteristics associated with these different users.

4.3 Demand ramp up

With the opening of new infrastructure, or delivery of a new policy, there will always be a period of time required before the up-take reaches expected demand. This period is referred to as the demand ramp-up period. The period should always be factored into demand forecasts to reflect the time required to enact behavioural change or influence travel patterns.

5 Benefits

5.1 Quantification of benefits: walking for transport

Parameters used in the evaluation are primarily driven by the changes that stem from replacing car or public transport trips with walking trips. A relationship therefore needs to be established between the replacement of car or public transport travel for active travel. The diversion will differ depending upon location; hence guidance should be sought from the NSW Bureau of Transport Statistics (BTS) or other relevant bodies to ascertain local diversion rates. The Sydney wide diversion rate (revealed by the Sydney mode split) is:

- one additional walking KM trip replaces 0.583 car KM trips
- one additional walking KM trip replaces 0.193 bus, train and other forms of motorised transport trips.[2]

These diversion rates relate to new and/or induced walkers and assume there is no suppressed demand for the forms of transport that walking is replacing. This assumption should be tested during the sensitivity analysis of the results.

This replacement relationship is used in calculating the parameters of cost savings that are generated by replacing car and public transport trips with walking trips. These parameters are then multiplied by the aggregate number of new walking kilometres travelled that is a direct result of the project.

The potential to substitute walking trips for short car and bus trips is a major potential source of benefit. This substitution decreases road congestion, reduces vehicle operating costs, avoids infrastructure costs and generates a range of environmental benefits such as improved air quality, and reduced consumption of non-renewable energy sources.

5.1.1 Reduced car use contributing to decongestion cost savings

Calculating a decongestion cost saving is undertaken by analysing the additional journey cost incurred when travelling in congested conditions compared with a hypothetical journey cost in free flow conditions. Congestion costs are therefore a factor of both the volume of vehicles on the road and average traffic speeds. Any reduction in the number of road users which generates increased traffic speeds and reduced traffic volumes will then result in congestion cost savings.

It is important to realise that while the impact of walking initiatives on levels of congestion in specific locations may be significant, the overall impact upon the level of congestion on the wider Sydney network is likely to be minimal. Furthermore, during demand modelling exercises, it is often necessary to assume that there is no suppressed or latent demand for Sydney's road network and public transport. Freed-up road space might in fact be taken up by new road users, leaving congestion levels unchanged in the absence of supply-side measures to control congestion. However, there are presumably benefits in these new road users making their trips,

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[2] Transport Data Centre, 2010 Release *2008/09 Household Travel Survey,* NSW Transport

as they would otherwise not undertake them. Thus, there are either benefits to remaining road and bus users with less congestion or increased benefits to new road or bus users.

The most recent decongestion cost calculations have been undertaken by CityRail and are specific to the Sydney network. They estimate that every one reduction in a car kilometre translates into a road congestion savings of 41 cents in September 2010 prices.[3]

Table 1 Decongestion parameter value

	Parameter value (A)	Replacement value (B)	User cost saving (A*B)
	cents/car VKT	(%)	cents/active transport VKT
Decongestion	41.55	58.3	24.22

Source: CityRail, 2009, September 2010 values

Adopting the replacement value of 58.3% (implying that an increase of 1 walking kilometre reduces car kilometres by 0.583), the congestion cost savings attributable to walkers switching from private cars is 24.2 cents per incremental active transport kilometre.

Caution needs to be taken when examining the impact that walking initiatives can have on bus congestion levels. While short bus trips may be substituted for walking trips, any CBA would need to demonstrate that the decline in bus patronage would exceeds a threshold which would alter total bus service kilometres (the key variable for measuring the decongestion benefits of reduced bus use).

5.1.2 Savings in vehicle operating costs

Savings in car user costs are based on the premise that people substituting short walking trips for car trips avoid vehicle operating costs which include fuel, tyre repair, maintenance and depreciation.

The latest estimates suggest car operating costs are 24.35 c/vkm.[4] The vehicle operating cost savings attributable to walkers switching from private cars to walking is 14.8 cents per incremental active transport kilometre within Sydney.

Table 2 vehicle operating costs parameter value

	Parameter value (A)	Replacement value (B)	User cost saving (A*B)
	cents/car VKT	%	cents/active transport VKT
Vehicle operating costs	24.14	58.3	14.07

Source: RTA, 2009, September 2010 values.

Arguments could be made that an increase in walking also reduces the vehicle operating costs (both short and long run marginal costs) of train and bus services (in this case CityRail and Sydney buses). However, while an increase in walking may reduce bus and rail trips, including the benefits of this within the CBA would require a strong case to be made that the reduction in bus and rail *patronage* translated to a reduction in bus or rail *service kilometres* travelled. This

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3 CityRail 2009, A Compendium of CityRail Travel Statistics, updated 2009. pg 74

4 RTA, 2009, Economic Appraisal Manual, Version 2, Appendix B: Economic Parameters for 2009; updated to September 2010 values

approach would also have to consider the commensurate fall in fare revenue that would be associated with decreased patronage, with quantification focusing on how the reduction in rail or bus demand would influence the magnitude of government subsidies required to run these services.

5.1.3 Reduced noise

While no mode of transport is entirely noise free, walking is generally considered to be a virtually noiseless form of transport compared to the noise levels generated by motor vehicles.

Reduced noise (and all environmental externalities) stemming from reduced demand for buses and rail travel should initially be excluded from the CBA unless a strong case can be made that the reduction in bus and rail *patronage* translated to a reduction in bus or rail *service kilometres* travelled, as set out above.

Table 3 Noise pollution parameter value

	Parameter value (A)	Replacement value (B)	User cost saving (A*B)
	cents/car VKT	%	cents/active transport VKT
Noise pollution	0.81	58.3	0.47

Source: ATC, 2006, September 2010 values.

5.1.4 Reduced air pollution

Walking effectively produces no air pollution, aside from the very small increase in CO_2 emissions associated with an increase in metabolic rate. Even this very small increment is preferable to the form of CO_2 emissions from motorised forms of transport as it is produced from renewable sources (food) rather than from fossil fuels.

This compares to motor vehicles, which are a major contributor of air pollutants, accounting for more than 50% of the emissions of oxides of nitrogen (NOx), carbon monoxide (CO) and almost half the emissions of hydrocarbons in Australia each year.[5]

In urban areas, emissions reductions can be large because walking trips are more likely to replace short, cold-start trips for which internal combustion engines have high emission rates. Hence, each 1% of automobile travel replaced by walking (or cycling) is estimated to decrease motor vehicle emissions by 2% to 4%.[6]

Table 4 Air pollution parameter value

	Parameter value (A)	Replacement value (B)	User cost saving (A*B)
	cents/car VKT	%	cents/active transport VKT
Air pollution	2.53	58.3	1.48

Source: ATC, 2006, September 2010 values.

5 Austroads 2000, *Roadfacts 2000*.

6 Victoria Transport Institute, 2004, Quantifying the benefits of non-motorized transportation for achieving mobility management objectives, p.12

5.1.5 *Reduced greenhouse gas emissions*

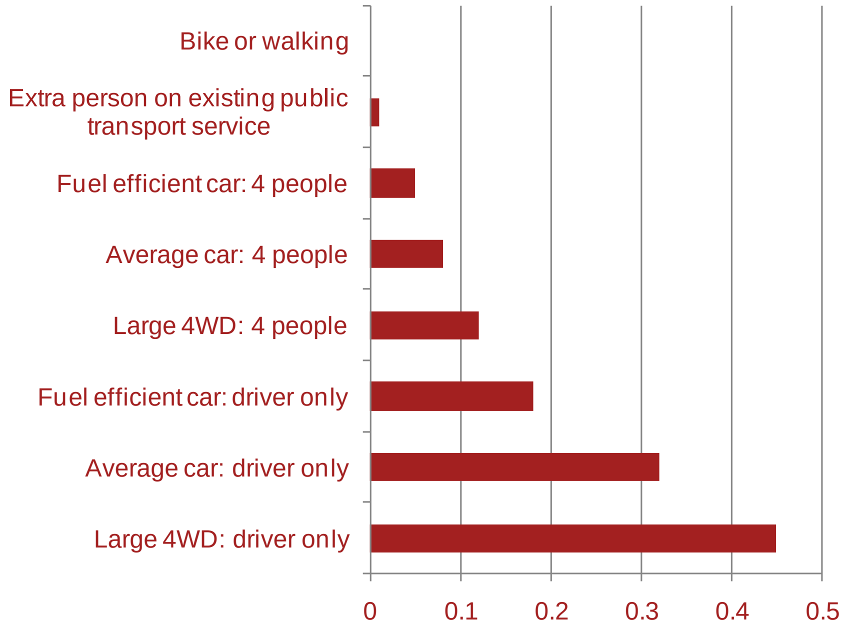
The RTA identified three potential sources of greenhouse gas reduction from promoting and providing for cycling as a mode of active transport.[7] These sources also hold true for walking as a mode of active transport. These include:

- substituting kilometres travelled in motor vehicles with active transport trips;
- reducing reliance upon cars (which have significant embedded emissions); and
- improving traffic flow through reducing congestion or improving space management.

Cycling and walking offer substantial potential to lower emissions in the passenger transport sector.[8] In Australia, cars produce an average of 0.3 kg of CO_2 per km travelled.[9] As a consequence, for each kilometre walked instead of being driven; a saving of approximately 0.3 kg of CO_2 could be achieved.

Figure 2 below shows the greenhouse gas emissions from different forms of transport in Australia.

Figure 2 Kg of greenhouse gas per person per Km from different forms of transport



Source – Australian Greenhouse office

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7 RTA, 2000, The role of Bicycles in Greenhouse Gas Reduction.

8 Cycling Promotion Fund , June 2008, Economic Benefits of Cycling for Australia

9 Department of the Environment and Water Resources, Australian Greenhouse Office, *Transport – How can I save?* Web page, http://www.greenhouse.gov.au/gwci/transport.html

Table 5 Greenhouse gas parameter value

	Parameter value (A)	Replacement value (B)	User cost saving (A*B)
	cents/car VKT	%	cents/active transport VKT
Greenhouse/climate change	1.49	58.3	0.87

Source: Pratt, 2002, *Estimation and valuation of environmental and social externalities for the transport sector*. (assumes $40/tonne cost of carbon), September 2010 values.

5.1.6 Infrastructure (roadway) provision

Depending on the extent of any substitution between car and walking trips, increases in walking has the potential to reduce road maintenance costs, as walking produce insignificant wear and tear on roads and associated infrastructure.

The RTA (2003) assumes that roadway cost savings associated with the provision of new cycle ways are 3.3 cents per bicycle kilometre. This assumption was informed by work undertaken by Austroads (1994) and the Sydney Future Directions Study (1991). Using CPI to inflate to September 2010 dollars produced a value of 3.9 cents per bicycle km. These assumptions hold true for all forms of active transport, including walking.

Table 6 Infrastructure (roadway) parameter value

	User cost saving (A*B)
	cents/active transport VKT
Roadway provision	3.95

Source: RTA (2003), Austroads (1994), PwC (2009) September 2010 values.

Road infrastructure, and the cost of maintaining it, can be linked back to marginal use, or slight changes, in total vehicle kilometres travelled. However, like vehicle operating costs, it could be argued that the reduction in public transport use results in avoided bus and rail infrastructure costs. As set out in relation to decongestion and vehicle operating costs above, For the reasons given when discussing the decongestion and vehicle operating costs, we initially caution against this unless all the issues raised regarding the relationship between patronage and kilometres travelled have been addressed.

5.1.7 Parking cost savings

The RTA (2002) estimates parking user cost savings of 1c per bicycle kilometre. This represents an avoided cost of parking facility infrastructure and maintenance. This estimate would hold true for all forms of active transport, including walking.

This figure has been inflated using CPI to September 2010 prices. This estimate acknowledges that the impact upon parking costs will be low for walkers.

Table 7 Infrastructure (roadway) parameter value

	Parameter value (A)	Replacement value (B)	User cost saving (A*B)
	cents/car VKT	%	cents/active transport VKT
Parking cost savings	4.05	58.3	2.36

Source: RTA (2003), PwC (2009), September 2010 values.

5.1.8 Health benefits

There are two primary ways in which walking can improve health outcomes:

- reduced mortality (death)
- reduced morbidity (ie illnesses or disease burden).

A range of studies have attempted to quantify the health benefits of increased walking. These are summarised below in Table 8

Table 8 Methodologies to quantify health benefits

Author	Methodology	Overall user cost ($/km)
Colin Buchanan Partners (2008) - Thames Pedestrian and Cycle Bridge	These 'per 1 km trip' values have been calculated based on observed walk, cycle and overall physical activity patterns for London as a whole. In each case, the benefit from exceeding the 3 x 30 minutes moderate physical activity threshold is calculated from an annual reduced mortality benefit and an associated annual absenteeism benefit of £32.53	The health benefits from a new A to B walking trip is $0.75 and a new walk to public transport trip is $0.18.
BECA (2007)	Benefits associated with moving a person from inactive to active in terms of willingness-to-pay (WTP) for disability adjusted life years (DALYs), health sector resource costs, and lost output resource costs	The health benefits are $0.96 for walking, with a cap of annual health benefits of $1,000 per year or 30 minutes per day.
Genter et al (2008)	Utilise an average of mortality ratio (costs of mortality associated with insufficient physical activity) and disability adjusted life years (DALYs) compared to prevalence of current activity status in society. This generates a range of per kilometre benefit for either attaining, or maintaining, a level of physical activity which leads to improved health outcomes. This was a study commissioned by LTNZ.	If sedentary: $0.78 to $1.08 If inactive: $2.07 to $2.92
Land Transport NZ (2010)	LTNZ revised the Genter (2008) recommendations downward based on advice from BECA which suggested health benefits would only accrue to sedentary and inactive segments of the populations who increased walking. Those who are already active would receive very little marginal benefit from increased walking. LTNZ also specifies that half the estimated benefits are perceived and internalised by the people who increase their physical activity. The other half are unperceived and accrue to society due to medical cost savings. This implies the 'rule of half' should potentially be applied to new walkers, if the demand has been calculated in such a way that all perceived benefits feed into a person's mode choice (choice to walk). Hence, the appropriate value to adopt for the study will differ depending upon the project and assumptions which have been adopted during the demand modelling process.	$2.05
PwC (2010)	PwC replicated the methodology contained in Genter et al (2008), substituting equivalent Australian values for the value of a statistical life year (VOSL) disability adjusted life years (DALYs). The prevalence of inactivity in society and annual health costs of inactivity on the Australian health system were also used instead of NZ values. The methodology also made the downward adjustment adopted by LTNZ by excluding benefits the physically active segment of the population.	$3.35

* $A 2010, Currency conversion undertaken using RBA time series, www.rba.gov.au

Given the infancy of walking CBA methodology, it is initially recommended that a range of health benefits be tested when undertaking the appraisal. This range should centre on the methodology adopted by Genter and LTNZ, which has been reviewed by a number of sources and deemed appropriate for inclusion within the New Zealand Economic Evaluation Manual (EEM).

The upper bound of this range could be informed by the PwC (2010) value that looks at replicating the Genter methodology using Australian inputs. The lower bound of the range should exclude health benefits from the appraisal (i.e. adopt a value of zero). While this would be a highly conservative assumption, it would seek to demonstrate the transport specific project outcomes.

The quantification of the health impacts within the walking CBA framework is an area where further development and investigation within the Australian context could be undertaken. This could involve undertaking studies specific to NSW transport and health patterns and would ideally include buy in from NSW Health, Transport NSW and NSW Treasury to ensure that the study outcomes are endorsed for widespread use. Specific areas of investigation are discussed below:

1. In addition to reduced mortality and morbidity costs, arguments could be made that an active and healthy population is also more productive due to reduced absenteeism. However, these productivity benefits are still debated within international literature with recent research concluding that "the evidence between active transport modes and reduced sick days and other measures of productivity was simply not robust enough".[10] Issues may also exist around satisfying the criteria that such benefits are a direct result of the walking initiative. Even though it is not initially recommended that these benefits are quantified, qualitative discussion around this would lend weight to adopting a health value towards the upper end of the range.

2. While increasing rates of walking have health benefits, it is important not to over-estimate these benefits. For instance, if increases in walking reflect a switch in the type of physical activity, rather than the generation of additional physical activity, the health benefits of walking can be overstated.[11] Hence a greater understanding of the potential substitution of walking trips for other forms of physical activity in NSW needs to be developed.

3. Substantial care also needs to be taken when deciding upon what constitutes a sufficient increase (step change) in these activities, bearing in mind that the marginal benefit of additional physical activity differs depending upon a person's individual level of fitness (sedentary and less active people benefit more from an increase in activity than very active people). Hence, the overall benefits from improvements in health may be represented on a declining scale, with the greatest benefits accruing to those who were previously inactive and less to those already sufficiently active

All methodologies outlined above are sensitive to the assumptions adopted around the level of physical activity needed to generate a health benefit.

5.1.9 Changes in Travel Time

For short-distance travel, walking may often be faster than other modes such as cars or trains. Figure 3 below shows the estimated average journey time against distance by mode in the urban environment. This indicates that the target market for diverting trips from private vehicles

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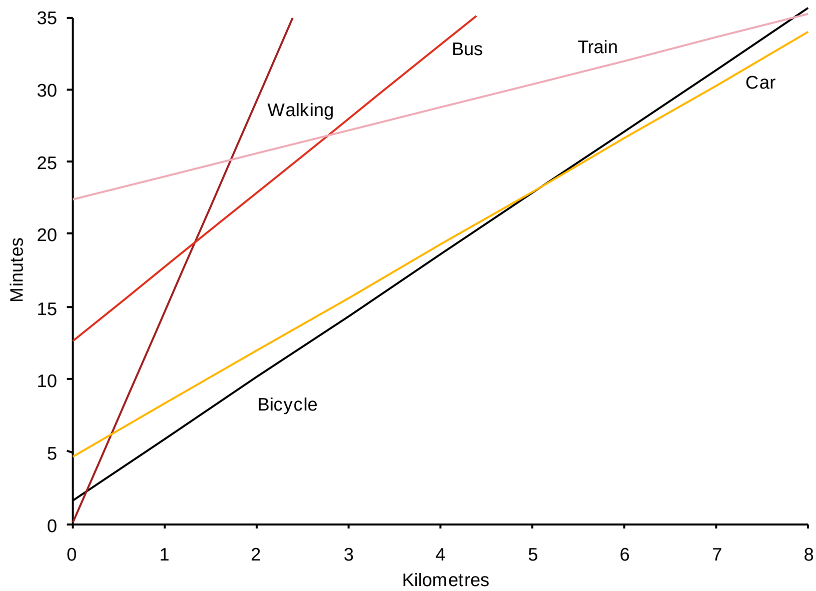
[10] Genter et al, Valuing the health benefits of active transport modes, NZ Transport Agency research report 359, pp 49.

[11] World Health Organisation, 2007, 'Economic assessment of transport infrastructure and policies: Methodological guidance on the economic appraisal of health effects related to walking and cycling'.

to walking is for distances less than 1km, when the time differential between car and walking is lowest.

Figure 3 Comparative journey speeds in the urban environment



Source – Bureau of Transport and Regional Economics, 2007 Estimating urban traffic and congestion cost trends for Australian cities, Working Paper 71, Department of Transport and Regional Services, Canberra, Australia, p.16.

The methodology used to analyse of travel time savings will be heavily influenced by the nature of the individual projects. Any such analysis should be undertaken along-side the guidance provided by the RTA, *Guidelines for the Economic Evaluation of Pedestrian Facilities (currently in draft form)*. While these guidelines don't capture all the benefits specified above, most notably the health benefits, they do elaborate on the specific demand models (such as SIDRA ad SCATES) which can be used to model intersection and access design and the impact this has on traffic and pedestrians.

The development and recommendations contained within this report have assumed that changes in travel time for pedestrians are not quantified. This assumption was made based on the difficulty in providing robust, high level advice, which can be applied in a consistent manner across all project types which may adopt this methodology. If a specific project warrants the investigation of travel time savings then there are a number of further issues which need to be considered:

1. when undertaken as a form of access to a public transport mode, walking is given a weighting to reflect the greater disutility associated with this walking access compared to time spent in vehicle. This is common practice in all public transport and multimodal CBAs and is a fundamental requirement in the calibration of demand models. However, it is debatable whether this weighting is required if walking is a stand-along journey and not an access requirement, or component, of a longer journey.

2. the purpose of the walking trip will determine the correct monetary value to apply in the quantification of travel time savings. Walking for commute purposes, vs. business purposes vs. leisure purposes all carry different value of time which need to be applied.

3. care needs to be taken when quantifying travel time savings benefits to transport users other than walkers (for example motorists or public transport users). The parameters used in this appraisal, specifically the decongestion value and vehicle operating cost value, make the assumption that travel time savings to these other user groups is not being captured. In the case of decongestion, this parameter already accounts for travel time savings that road users receive (given that the decongestion value is made up of both travel time costs and vehicle operating costs).

4. Hence, multimodal appraisals do not capture both travel time savings to road users and decongestion savings as this constitutes a double count. The vehicle operating costs include both a perceived component and unperceived component of costs. If savings in travel time are captured, only the unperceived component of the costs should be valued. This is because the perceived component is inherently captured in a person's mode choice decision and the travel time savings they received from this mode choice decision.

5. demand would have to be segmented into existing walkers and new walkers, with the "rule of half" applied to the perceived benefits of new walkers.

5.1.10 Barrier Effect

Litman (2010a)[12] proposes this effect is important as it refers to delays and reduced access, or congestion that vehicle traffic imposes on non-motorised modes of transport. As a result, this may induce a shift back to motorised travel from non-motorised transport. The delays faced by pedestrians related to vehicle traffic may be significant (GTA 2011). Indeed, the results of a timed walk on Hunter Street in Sydney during the morning peak indicates that pedestrian delays at traffic signals increase the walking time by 60% - reducing travel speeds from 6.5km/h to just 4km/h (2011)[13].

Typical transport planning generally ignores these impacts, as the reduced accessibility of walking from, for example, building a road is not considered.

However, it may be argued that this effect could be considered with a valuation of changes in travel time, as individuals switching to walking may consider the delays caused by traffic lights and vehicle infrastructure.

Increased travel costs can be monetized using the same methods and travel time values used to calculate motorized traffic congestion costs. Litman (2010) estimated the impact of the direct costs imposed on pedestrians and cyclists by the barrier effect as ranging from $0.003 to $0.009 per vehicle km.

However, for the reasons discussed above in section 5.1.9, these barrier effects are not quantified as part of this initial methodology.

5.1.11 Amenity impacts

The amenity of an environment can have a major impact upon the enjoyment, or benefit, the people may get from walking. Hence, infrastructure and programs designed to increase the ambience of a walking environment have an impact upon users' perceptions of walking.

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[12] Litman, 2010a, *Evaluating non-motorised transport benefits and costs, Victoria Transport Policy Institute*

[13] GTA Consultants, 2011, *Walking for transport and recreation in NSW; What the data tells us,* prepared for the Premier's Council for Active Living

Characteristics of journey ambience relating to walking could include street lighting, reduced crowding, increased greenery, better signage and the provision of benches. Studies in the UK have quantified the value to users that an improvement in journey ambience can results in.[14] It is understood that no comparable studies have been undertaken to determine Australian values.

The amenity value associated with walking can be captured during demand modelling where it is factored in as a demand determinant. If this is the case, then any increase in journey ambience should not be specifically quantified in the CBA as it is inherently captured within changing demand. If amenity values are not treated as a demand determinant then an argument could be made to quantify these directly within the economic appraisal. Any such quantification would need to consider the 'rule of half' and how this applies to the perceived increase in amenity to new walkers.

It is not recommended that changes in journey ambience be quantified within this initial walking methodology. This recommendation errs on the side of caution, with further, Australian specific research into this area required before such benefits can be treated with the same level of confidence as the other benefits discussed above.

5.2 Walking for leisure

The demand for increased walking for leisure or exercise purposes is particularly difficult to quantify. This is due to a lack current data and the difficulty in modelling changes in subjective drivers which lead to demand for this form of physical activity. Given the difficulty in measuring this demand, quantifying the level of benefits also proves challenging.

However, there are health benefits to the individual and society that stem from an increase in walking to for leisure purposes. Like walking for transport purposes, the level of these benefits will be dictated by the amount of additional walking undertaken and the level of physical activity the person was previously engaged in. Additional care also needs to be taken to ensure that the additional walking isn't simply a substitution for a different form of physical activity, in which case the health benefits would remain relatively constant.

If a specific study quantifies the demand for walking for leisure purposes, then it is recommended that the change in health benefits be applied in the same manner as walking for transport purposes.

It is also likely that increased levels of people walking for leisure with the introduction of new or improved infrastructure are doing so due to a perceived increase in amenities of journey ambience.

5.3 Summary of recommended parameters

The table below is a summary of the recommended parameters to evaluate walking, presented in cents per kilometre travelled. The table includes the raw parameter value and the parameter value which has been adjusted the diversion rate (car mode share) of 58.3%.

Table 9 - Summary of parameter values

Benefit	Parameter value (walking for transport and leisure) (cents)	Parameter value (adjusted by Sydney mode share) (cents)
Reduced congestion	41.55	24.22
Reduced vehicle operating	24.14	14.07

[14] DfT, 2009, Guidance on the Appraisal of Walking and Cycling Schemes

Benefit	Parameter value (walking for transport and leisure) (cents)	Parameter value (adjusted by Sydney mode share) (cents)
costs		
Reduced noise costs	0.81	0.47
Reduced air pollution	2.53	1.48
Reduced greenhouse gas	1.49	0.87
Reduced infrastructure (roadway provision) costs	3.95	2.30
Parking costs savings	4.05	2.36
Health benefits	207.8	Na
Changes in travel time	n/a	n/a
Reduced barrier effect	n/a	n/a
Amenity impacts	n/a	n/a

6 Results and sensitivity testing

6.1 Reporting outputs

1. The results of the CBA should provide the following measures of economic performance:

1. *Net Present Value (NPV)* – the difference between the present value (PV) of total incremental benefits and the PV of the total incremental costs;

2. *Net Present Value : Investment Ratio (NPVI)* – the NPV divided by the PV of the investment costs (NPVI);

3. *Economic Internal Rate of Return (EIRR)* – the discount rate at which the PV of benefits equals the PV of costs; and

4. *Benefit Cost Ratio (BCR)* – the ratio of the PV of total incremental benefits to the PV of total incremental costs.

5. Scenarios that yield a positive NPV imply that the incremental benefits of the project exceed the incremental costs over the evaluation period. The NPVI measures the overall economic return in relation to the required capital expenditure.

6. An EIRR greater than the specified discount rate (default 7%) also indicates that a project is economically worthwhile. However, the EIRR can yield ambiguous results if the stream of costs and benefits is not continuous over time. It is therefore commonly recommended that the EIRR be used in conjunction with other measures when assessing economic viability.

Finally, a BCR greater than 1.0 indicates that project benefits exceed project costs. However, a higher BCR is desirable to cushion larger projects against unforeseen capital expenditure, delays and optimism bias.

6.2 Sensitivity analysis

NSW Treasury and Infrastructure Australia Guidelines all require a number of standard sensitivities to be undertaken. These include:

7. testing alternate discount rates (4.0% and 7.0%);

8. testing fluctuations in capital costs (+30% and -30%);

9. testing fluctuations in recurrent costs (+30% and -30%);

10. testing fluctuations in demand (+30% and -30%); and

11. scenarios that involve both an increase in capital costs and decrease in demand.

Variances in the range of health benefits and the extent to which the project relieves road congestion should also be tested. Finally, any additional, project specific assumptions that have the ability to influence the viability of the project should also be tested.

7 Case Studies

The hypothetical case study below demonstrates how the methodology can be used to quantify the benefits of a walking initiative.

7.1 Background

An option identified for releasing local road congestion is reducing the number of private vehicle trips undertaken which are less than 1km in length by switching a proportion of these trip to walking.

The benefits of achieving a 5% switch and a 10% switch have been examined. The costs associated with achieving these outcomes are not quantified.

7.2 Appraisal assumptions

Key methodological assumptions include:

12. 7% real discount rate;
13. 20 year appraisal period; and
14. The target is achieved through a 1% switch per year. Hence, it takes 5 years to achieve a 5% switch, 10 years to achieve a 10% switch.

7.3 Demand forecasting

The Household Travel Survey indicates that there are 239,613,935 private vehicle trips which are between 0 - 1KM in length in 2008.[15] Assuming a normal distribution this equates to approximately 119,806,967 private vehicle kilometres travelled. Shifting 1.0% of these private vehicle trips to walking therefore reduces the number of private vehicle KM travelled each year by 1,198,070 KM. This also then implies the number of KM walked increases by 1,198,070 KM per year.

7.4 Identify quantifiable benefits

A range of quantifiable benefits have been identified as directly attributable to walking schemes. These benefits include:

- Health benefits
- Decongestion
- Reduced vehicle operating costs
- Avoided or deferred infrastructure provision
- Reduced environmental costs

Because these trips are being shifted directly from private vehicle there is no need to apply the diversion rate of 0.583. There is also the need to apply the rule-of-half[16] to the

[15] Source: BTS, Request 10/382, Household Travel Survey 2008

[16] Applying the rule-of-half to the perceived benefits of induced users is common practice in transport appraisals. For a full description of the methodological justification and details on the application refer to Australian Transport Council *National Guidelines for Transport System Management, Volume 4 Urban Transport*, 2006.

perceived benefits of the new walkers, in this case the perceived health benefits. The parameters used are shown below.

Table 10 - Case Study Parameters

Benefit	Parameter value (walking for transport and leisure) (cents)
Reduced congestion	41.55
Reduced vehicle operating costs	24.14
Reduced noise costs	0.81
Reduced air pollution	2.53
Reduced greenhouse gas	1.49
Reduced infrastructure (roadway provision) costs	3.95
Parking costs savings	4.05
Health benefits	167
Crash costs	(8.37)
Total	***237.15***

7.5 Assess the benefits

A 1% shift in private vehicle trips of less than 1KM to walking for trips therefore results in an annual, undiscounted, benefit of $2.8 million per annum.

The results of this shift, using a 7.0% discount rates, are shown in the table below.

Table 11 - Case Study Parameters

Scenario	Benefits ($M, undiscounted)	Benefits ($M, Discounted at 7.0%)
5% shift	$255	$134
10% shift	$439	$214

This implies that if the present value of the cost associated with achieving the 10% shift were less than $214 million, then the initiative would yield economic benefits to the wider community.

To complete a full appraisal and justify the merits of the initiative, the appraisal would have to include robust costs estimates and the required sensitivity testing on the results.

8 Next steps

An immediate opportunity exists to incorporate a robust quantification of walking benefits into existing multimodal transport appraisals. Currently, multimodal demand modelling and economic quantification only capture the perceived user costs of walking. This cost is needed to explain travel behaviour and calibrate the demand models. This cost reflects stated preference research indicating that:

- people are willing to trade off 1.15 – 2.00 minutes of additional time spent travelling on rail to avoid 1 minute of walking access time; and
- the willingness to trade-off is higher weight in crowded conditions or when the walk is part of an interchange; [17]

It is not valid to suggest neglecting to include this perceived user cost within the demand or economic component of a CBA. There is however the potential to include the appropriate walking benefits (during the economic appraisal) to offset the perceived user costs of walking.

Adopting this recommendation is not likely to have a major impact on the magnitude of benefits quantified in multimodal transport appraisals. This is because walking is only one mode of transport examined and it is usually one of the less significantly influenced by the transport appraisal (compared to, for example, rail travel in a multimodal appraisal which is looking at the construction of a new rail line). However, this recommendation would ensure that both the cost and the *benefits* of walking are adequately captured in the appraisal. It also ensures that all the impacts of walking are being taken into account when the results of multimodal appraisals are being used for decision making and planning purposes.

[17] Australian Transport Council *National Guidelines for Transport System Management, Volume 4 Urban Transport*, 2006.

- Appendices

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