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A walking strategy for NSW

Assessing the economic benefits of walking

Prepared for PCAL and DECCW

February 2011

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
AT	active transport
ATC	Australian Transport Council
BCR	benefit cost ratio
CB	Colin Buchanan and Partners Ltd
CBA	cost benefit analysis
CO	carbon monoxide
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
GHG	greenhouse gas
GTA	GTA Consultants
HFW	Heart Foundation Walking
IA	Infrastructure Australia
IVT	In vehicle time
LOS	level of service
LTNZ	Land Transport New Zealand
MJA	Marsden Jacob Associates
NMT	non-motorised transport
NOx	nitrogen oxides
OVT	out of vehicle time
PCAL	Premier's Council for Active Living
RTA	Roads and Traffic Authority (NSW)
SKM	Sinclair Knight Merz
TDC	Transport Development Council
TDM	Transport demand management
VTPI	Victorian Transport Policy Institute
WHI	Walking the way to Health Initiative
WHO	World Health Organisation

1 Executive summary

Walking is both an important transport mode and a valued leisure activity for many Australians. However, there is limited data available about the extent of walking in NSW and there is still significant scope to increase people's propensity to walk. Specifically, there appear to be significant opportunities associated with decreasing the frequency of short automobile trips (those less than 1 km) in NSW by shifting people to active transport modes, including walking.

While walking is an important aspect of active travel, it is often under-represented or even ignored in traditional transport appraisal methodologies. It is evident that walking, and a potential increase in physical activity, can have a range of both quantifiable and non-quantifiable benefits.

Quantifying the benefits of walking

While we intuitively know that walking has far reaching benefits, there is limited recognition of the potential economic benefits in formal CBA methodologies. Research is continuing in this area, not only in improving the availability of robust data, but also in economic appraisal methodologies.

Current methodologies suggest several benefits of walking which includes:

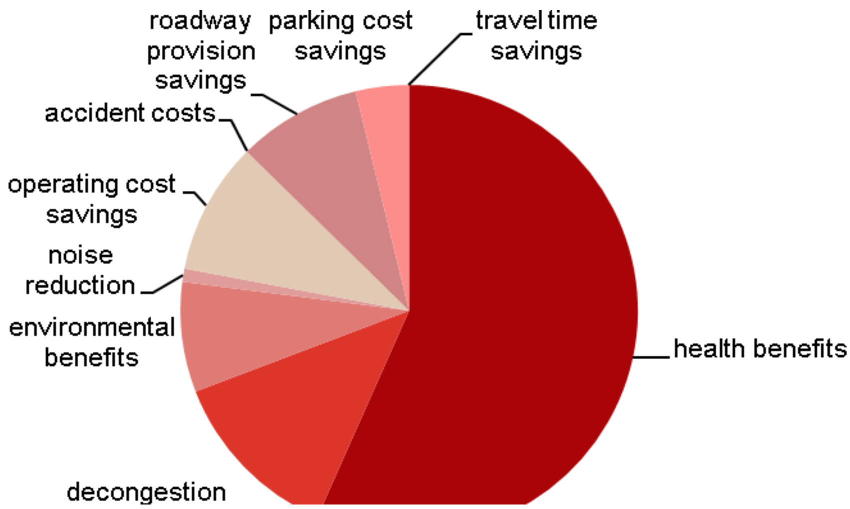
- Congestion savings – a shift from motor vehicles to walking will reduce the number of vehicles and congestion and increase road speeds
- Road provision savings – a decline in the motor vehicle use of roads will reduce road maintenance and construction costs in particular
- Vehicle operating cost savings – individuals may save on the costs of maintaining a vehicle, including fuel, depreciation and tyres
- External parking savings – user parking costs will be reduced and also the public cost of providing and maintaining vehicle parking facilities
- Road safety – safety is improved when separated pathways or roadway safety and awareness initiatives are implemented
- Environmental pollution savings –in greenhouse gas (GHG) emissions, air pollution and water pollution are reduced
- Noise reduction – noise levels are reduced if more individuals walk rather than use transport, especially in residential areas where the costs of noise are high
- Health cost savings – an increase in physical activity may reduce morbidity and mortality

The delays and reduced access that vehicle traffic imposes on pedestrians, known as the 'Barrier effect', reduces the accessibility of walking and may act to shift transport back to vehicle use.

The estimated health benefits of walking are a significant portion of the quantifiable benefits. Increasing walking activity can improve health by reducing both morbidity and mortality among participants.

The benefits per kilometre of walking are generally quantifiable benefits. However, these parameters are fluid and are categorised differently in various economic assessments, depending on the nature of the project and available data. Figure 1 provides an indication of the potential distribution of benefits from a walking policy. Note that the size of the benefits between each category may change, but the benefits from improved health in most cases contributes the greatest share, followed by decongestion and environmental benefits.

Figure 1 Possible distribution of quantifiable benefits from walking



Source 1 PwC analysis

Non quantifiable benefits of walking

There are also a number of community benefits that reflect the local and social characteristics of walking but have not yet been quantified.[1] As such, these benefits are more easily assessed on a qualitative basis.

Broader social capital impacts of walking

There are several impacts of increased walking within a community that are not necessarily borne by the individual user. These impacts are generally felt by the wider population and tend to be more difficult to quantify than more traditional appraisal parameters:

- Liveability and economic development as increasing transportation options can help communities become more 'liveable,' resulting in increased property values and commercial activity
- Journey ambience or enjoyment, relating to reduced stress, improved views and increased quality and cleanliness, may encourage more participation in walking
- Option value, which relates to the value that travellers may place upon having the option to walk
- Social equity may improve as active travel is more equitably distributed than leisure time physical activity

Overall, the current methodologies to evaluate the economic viability of walking, and indeed all active transport are in early stages. Nonetheless, the methodology can reflect and mirror that of conventional transport assessment.

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[1] However, with improving data collection methods and evolving CBA methodologies, there may be scope to quantify these aspects in the future.

2 Introduction

2.1 PwC's role

Walking is a low-cost, socially-engaging activity that the vast majority of individuals can take part in. Walking offers mobility to individuals who might not have access to other modes of transport and also provides a cheap form of physical activity, especially among inactive members of the population.

The benefits of walking to both individuals and the wider community are widely recognised. However, attempts to robustly quantify these benefits, particularly when compared with other transport modes, are in their infancy and there is little data available about the prevalence of walking.

The Premier's Council for Active Living (PCAL) and the Department of Environment, Climate Change and Water (DECCW) are currently working together to develop a Walking Strategy for New South Wales (NSW), with the aim of increasing both recreational and transport-related walking in NSW.

As part of the development of the Strategy, PCAL and DECCW have engaged PwC to review the current methods used to evaluate programs focused on walking, both within Australia and internationally, and to develop a methodology for policy makers to use to undertake a cost benefit analysis (CBA) of walking projects.

As part of this work, PwC has prepared this literature review to draw together evidence and research about how best to assess the potential benefits generated by walking projects.

This review includes:

- An overview of the current treatment of walking in economic appraisal and CBA frameworks
- A summary of research regarding the key benefits associated with walking and methodologies to quantify the parameters associated with these
- A series of case studies relating to projects that aim to increase walking and the impacts of these
- A summary of the key reports that aim to quantify the impact of walking

2.2 Walking in NSW today

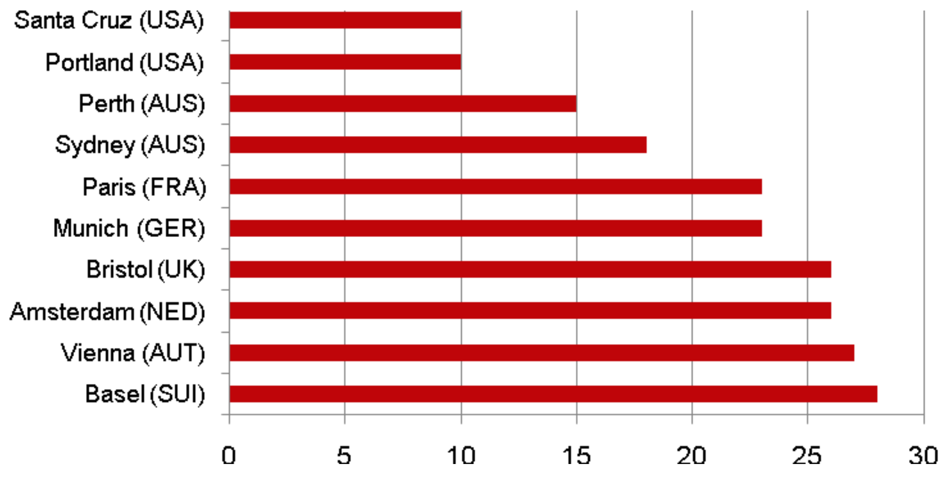
As illustrated in GTA Consultant's report, *Walking for travel and recreation in NSW: What the data tells us (2011)*, there is limited data available about the extent of walking across NSW. However, there is some evidence to suggest that participation in walking has increased in recent years.

In their report for the NSW Centre for Physical Activity and Health, Chau et al (2007) concluded that the prevalence of sufficient physical activity in NSW increased between 1998 and 2005 and that walking was a major contributor to this increase, with participation in walking increasing from 28.8% in 2001 to 39% in 2004. Chau et all suggest that an increase in the prevalence of walking to work and rising petrol prices may have contributed to the increase.

However, there is still significant scope to increase people's propensity to walk in NSW. As demonstrated in the Transport Data Centre's (TDC) *2008/09 Household Travel Survey*, the proportion of 'walk only' trips as part of total weekday trips in Sydney accounted for 18% of all trips in 2006; however, using trips as an indicator disguises the true impact of walking as these 'walk only' trips only represented 2% of total distance and 11% of total time.

Furthermore, while the modal share of walking in Sydney, as a portion of total trips, compares favourably to other cities in Australia and the USA, rates are considerably lower than cities of comparable size in Europe, such as Amsterdam and Vienna (Figure 2).

Figure 2 Walking mode share in international centres (%)



Source 2: Wittgens and Campbell (2010)

Walking is both an important transport mode and a valued leisure activity for many Australians.

Of all trips made in Sydney on an average weekday in 2008/09, 20% were less than 1km, and 35% were less than 2km. Almost 3.5 million trips of less than one kilometre were made each weekday and about 65% of these were walk only trips (TDC 2010). There therefore appear to be significant opportunities associated with decreasing the frequency of short automobile trips (those less than 1 km) in NSW by shifting people to active transport modes, including walking.

The Australian Sports Commission's 2009 *Exercise, Recreation and Sport Survey* showed that walking is now the most popular physical activity in Australia and that a total of 6.2 million people walked (excluding bushwalking) for recreation in 2009. This represents a participation rate of 36% and a 43% increase in participation since 2001.

2.3 Quantifying the benefits of walking

While walking has far reaching benefits (Ramblers 2010), there is limited recognition of the potential economic benefits in formal CBA methodologies.

There have been a number of attempts to quantify the benefits of walking but there is not yet a consistent approach to quantification in Australia. There is ongoing debate on the appropriate method to calculate the benefits of walking, but generally, the benefits can be classified into several broad parameters.

- Congestion savings – as a shift from motor vehicles to walking will reduce road congestion
- Road provision savings – in particular road maintenance and construction costs with a decline in the motor vehicle use of roads. Some costs may be transferred to pedestrian pathways, but the maintenance costs are generally lower for this type of infrastructure

- Vehicle operating cost savings – individuals may save on the costs of maintaining a vehicle, including fuel, depreciation and tyres
- External parking savings – savings in not only user parking costs, but also the public cost of providing and maintaining necessary motor vehicle parking facilities
- Road safety – safety is especially important when separated pathways or roadway safety and awareness initiatives are implemented as there are reduced opportunities for vehicle-pedestrian accidents
- Environmental pollution savings - through a reduction in GHG emissions, air pollution and water pollution
- Noise reduction –a transfer to walking as a mode of transport reduces vehicular noise, especially in residential areas where the sensitivity to and corresponding costs of noise are high
- Health cost savings – an increase in physical activity may have strong personal benefits, in particular impacts on morbidity and mortality as well as other ailments related to inactivity. It is also likely that improved health outcomes will reduce health care costs to society. It has also been argued that improved health can result in increased productivity and reduced absenteeism in the workplace

The delays and reduced access that vehicle traffic imposes on pedestrians, known as the 'Barrier effect', reduces the accessibility of walking and may act to shift transport back to vehicle use.

These parameters are fluid and are categorised differently in various economic assessments, depending on the nature of the project and available data. Generally, all are included, in some form, in traditional economic CBAs (VTPI 2009; PwC 2010).

Marsden Jacobs Associate (MJA) (2009) distinguishes the various benefits of active transport into those due to increased walking and cycling, benefits from reductions in motor vehicle use and other (social) benefits.

There are also a number of community benefits that reflect the local and social characteristics of walking [Tolley (2003) and Litman (2010)] but have not yet been quantified.[2] As such, these benefits are more easily assessed on a qualitative basis.

These benefits include:

- Liveability – the quality of the local environment and the degree that walking improves the local environment by reducing vehicle traffic and speeds
- Economic development – effects on commercial activity and shifts in consumer expenditures towards more local businesses and locally produced goods
- Option value - this concerns the value that travellers may place upon a travel option that is available to them, but which they do not regularly use
- Social equity – distribution of resources and opportunities, and the degree to which walking helps to increase the mobility and accessibility of disadvantaged people

[2] However, with improving data collection methods and evolving CBA methodologies, there may be scope to quantify these aspects in the future.

2.4 Recognition of walking in economic appraisal

Evaluating the economic viability of new transport interventions in the road and rail sectors is well developed in Australia. Furthermore, while there have recently been significant developments in the application of traditional economic appraisal to active transport initiatives, particularly with regard to cycling [see PwC (2010) for an example of an Australian study], CBA of active travel is not currently widespread in Australia.

There is widespread acceptance of the importance of active transport in NSW, as reflected in the NSW State Plan, which has a target to *increase the mode share of bicycle trips to 5% by 2016* and the Sydney Metro Strategy, which aims to improve local and regional walking and cycling infrastructure. However, these strategies only reference walking as a component of 'active transport' and tend to be grouped along with cycling; there are few specific references to walking-only plans and policies.

Furthermore, while walking is an important aspect of active travel, it is often underrepresented or even ignored in traditional transport appraisal methodologies. Indeed, there is limited quantification of the impacts of walking-specific policies in international literature; the majority of literature reviewing active transport is focused on cycling.

In a recent review of evidence related to the promotion of walking for transport, Krizek et al (2009) suggest that a comprehensive understanding of active transport is elusive. This is due to the fact that evaluation needs to consider multiple reasons for participation and there is considerable variation in the quality of data collected.

The development of a robust and consistent methodology for the quantification of the benefits associated with walking presents a significant opportunity to raise the profile of walking initiatives and generate increased resources (Litman 2010d). For example, Infrastructure Australia has commented that walking initiatives should be subject to the same analytical rigour as other infrastructure initiatives (Infrastructure Australia 2010). The UK Department for Transport (2010) also advocates the application of an analytical framework (similar to that used for cycling) to evaluate the economic desirability of walking.

Current evaluation practices tend to undervalue non-motorised modes of transport, especially walking, as a result of various factors which include: (Litman 2010d)

- Walking tends to be more difficult to measure than vehicle travel
- Walking is generally considered a lower status activity compared with motorised travel
- Walking tends to be overlooked because it is so inexpensive
- Conventional planning tends to ignore or undervalue benefits such as fitness and public health benefits, enjoyment, and improved mobility options for non-drivers.

While actual participation in walking is often under-reported, there are data limitations specific to NSW, including under-representation of data collection in the Household Travel Survey; and the lack of a uniform mandate for councils within NSW to review the provision and maintenance of walking and pedestrian infrastructure (GTA 2011). This limited knowledge of both walking activity, and of the infrastructure supporting the activity, may limit the robustness of economic evaluation.

3 Quantifiable benefits of walking

As set out, there are a number of benefits associated with walking. The methodologies adopted by several studies are summarised in Chapter 6.

This chapter draws together these studies by each benefit type and discusses the methodologies used to quantify them. It is important to note that this list includes those studies with a specific relevance to walking initiatives – those specifying 'active transport' and 'cycling only' generally rely heavily on cycling specific data, and thus may not provide an accurate comparison.

Where benefits are quantified for economic appraisal purposes, the values are expressed as parameters. In terms of CBA, a parameter refers to the dollar value applied to an increase in the number of kilometres walked to estimate the total benefits associated with that increase (e.g. a parameter of $1.2/km for decongestion would mean that an increase in walking of 1km would generate economic benefits of $1.2).

For the purposes of this report, all parameter values have been converted into September 2010 Australian dollars using Australian Bureau of Statistics (ABS) price index values for September 2010 in order to facilitate comparison.

It is evident that the values for each parameter vary significantly, sometimes to a magnitude of ten. This could be due to differing sources, quality of data, and also reflect the values/perception of the local community. Hence, while the literature provides a guide as to the relative weighting of individual parameters, the actual values used should reflect the goals of the initiative and local area.

3.1 Health

The health benefits of walking are widely recognised in literature (Boarnet et al (2008) and research suggests this is the largest benefit area, as it can contribute to reduced mortality (death) and morbidity (illness or disease burden). Specifically, increased activity through brisk walking has been shown to reduce both coronary and cardiovascular-related illnesses (Manson et al 2002)

Table 1 lists the various methodologies for quantifying the health benefits of walking and the associated parameters that have been proposed. As indicated in Table 1, a relatively low health benefit parameter is realised when the costs of mortality are examined. Including morbidity costs leads to a substantially increased value, although varying methodologies lead to differing values.

In addition to reduced mortality and morbidity costs, arguments have also been made that an active and healthy population is more productive due to reduced absenteeism (Manson et al 2002). However, the World Health Organisation (WHO) (2004) suggested that "the evidence linking active transport modes and reduced sick days and other measures of productivity was simply not robust enough". Hence, the health benefits of walking are likely to be mostly related to decreased mortality and morbidity, with an as yet unproven effect on productivity (although research is still occurring in this area).

As with most forms of physical activity, there are injury risks as well as health benefits associated with walking. Furthermore, while increasing rates of walking have health benefits, it is important not to over-estimate these benefits. For instance, it can be argued that the health benefits of walking can be overstated if the increase in participation reflects a switch in the type or time of physical activity, rather than genuine additional physical activity.

In addition, the marginal benefit of additional physical activity differs depending upon a person's individual level of fitness. Specifically, those individuals considered active will not gain significant benefits from walking compared to those who are sedentary (there are decreasing marginal returns to increasing activity) (LTNZ 2010).

Marsden Jacob Associates (MJA) assumes that walking and cycling have the same health benefits per kilometre ($0.16 /km). This was derived from the Cycling Promotion Fund estimate of $0.376 per kilometre cycled, adjusted down to allow for the reduced benefits of AT to people already active, and assuming that those already active will be more likely to take up AT. However, this assumes that cycling and walking yield the same health benefits per kilometre travelled.

Table 1 Methodologies to quantify health benefits

Author	Methodology	Overall health benefits($/km)
Campbell and Wittgens (2004)	Base health cost of physical inactivity on research that indicates 2.5% of health care costs are due to inactivity. In Canada, in 2002, $90 was spent per person on health care attributed to physical activity	Specific value not applicable to pedestrian initiatives
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	A new A to B walking trip is $0.75 and a new walk to public transport trip is $0.18.
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 to generate a per kilometre benefit of maintain an active activity status	If sedentary: $0.78 to $1.08 [3] If inactive: $2.07 to $2.92
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	$0.96 for walking, with a cap of annual health benefits of $1,000 per year or 30 minutes per day.
Marsden Jacob Associates	Benefits of $0.376 per kilometre cycled, adjusted down to allow for the reduced benefits of AT to	$0.16

[3] These values are obtained by dividing the number of kilometres across which health benefits could be obtained. Sedentary individuals typically have zero or minimal activity levels. Thus, they need to walk more kilometres than inactive individuals to reach sufficiently active status. Inactive people already engage in some moderate activity and therefore on average only need to walk an additional 450km (compared to 625 km for sedentary) to become sufficiently active. Thus, benefit per km for sedentary individuals is lower than that for inactive individuals.

Author	Methodology	Overall health benefits($/km)
	people already active. However, this assumes that that cycling and walking yield the same health benefits per kilometre travelled and a single value for inactive compared to active	
Land Transport NZ (2010)	Values for the health benefits of walking resulting from planning decisions. Half the estimated benefits are internal to the people who increase their physical activity, and half are external benefits to society due to medical cost savings	$0.54
PwC (2010)	Based upon methodology contained in: Genter et al (2008) The methodology substitutes 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.	$0.035 to $3.252 for walking

3.2 Congestion

One of the greatest potential opportunities associated with increased walking is the scope to substitute car and bus trips. This substitution decreases road congestion and generates a range of environmental benefits such as improved air quality, and reduced consumption of non-renewable energy sources. Only the external costs of congestion are considered in this section. Congestion costs borne by the individual are considered separately under travel time and vehicle operating costs.

A decongestion cost saving is calculated by analysing the additional journey cost incurred when travelling in congested conditions against a hypothetical journey cost of optimal congestion levels. Speed is a function of volume, while congestion costs are a factor of road capacity compared to volume (the vehicle per capacity ratio). As a result, any reduction in the number of motor vehicles which generate increased traffic speeds and reduced traffic volumes should result in decongestion cost savings.

A reduction in traffic volume may allow higher value road users and vehicles, including freight, service, urgent emergency services, to travel unimpeded by congestion (Litman 2010b). Furthermore, congestion is a non-linear function: on congested roads a small reduction in traffic volumes can provide a relatively large reduction in delays (Litman 2008).

We note that walking can impose congestion costs if pedestrians delay traffic while crossing streets but this impact is generally small since pedestrians seldom cross major highways, and usually cross during regular signal cycles or breaks in traffic flow (Litman 2008).

Conventional congestion cost analysis only measures the delays vehicles impose on other vehicles. More comprehensive analysis also considers the delays motor vehicle traffic imposes on pedestrians and cyclists, known as the 'Barrier effect',[4] which is estimated to represent between $0.003 and $0.009 per kilometre. Efficient pricing of this cost requires taking into account non-motorised demand (the amount of walking and cycling that would occur if given the opportunity), and the degree to which a motor vehicle hinders this travel (Litman 2010c).

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

The total number of new walkers is likely to include those who previously utilised various other modes of transport, including train, bus and passenger vehicles; the movement of one individual to walking will affect each mode differently.

An argument may exist for quantifying the decongestion benefits that are associated with a decrease in bus demand. However, to justify this, an appraisal would need to show that the decrease in demand is large enough, and spatially targeted enough, to influence the service patterns of specific bus operations. This is due to public transport service kilometres and timetabling showing little sensitivity to marginal changes in patronage (PwC 2010).

The *2008/09 Household Travel Survey,* published by NSW Transport, indicates that vehicle drivers and passengers accounted for 58.6% and 21.2% of total trip distance in the Sydney statistical division, respectively (TDC 2010). In terms of distance, the modal share of vehicle drivers is 58.6%. Hence, the replacement value, or the reduction in vehicle kilometres from a 1 km increase in walking can be assumed to be 58.6%.This value can be used to calculate the user congestion cost savings of walking.

The following table lists various methodologies, and their respective values of quantifying decongestion benefits.

Table 2 Methodologies to quantify decongestion benefits

Author	Methodology	Overall congestion savings ($/km)
Campbell and Wittgens (2004)	Reference was taken to the estimated cost of congestion in Greater Montreal, Toronto and Vancouver, which totalled more than $3 billion per year. It was assumed that walking causes little congestion and the congestion value per km was calculated using Litman methodology	$0.042
Cycling Promotion Fund (2008)	Noted that values would be higher in urban areas compared to regional areas, and also distinguished between peak and off-peak driving in urban areas.	Average value of $0.50 Urban, peak: $0.125-$0.888/car-km; Urban off-peak $0.033-$0.177/car-km.

[4] See Litman, T., (2008), *Transportation Cost and Benefit Analysis*, Victoria Transport Policy Institute available at www.vtpi.org/tca

Author	Methodology	Overall congestion savings ($/km)
Litman (2010c)	Includes both congestion cost and delays to non-motorised travel due to motor vehicle use	Congestion cost of $0.62 and delay cost of $0.31
PwC (2010)	Utilises NSW Transport published mode share and CityRail (2008) cost of congestion to estimate the benefits from reduced vehicle kilometres in Sydney. Costs from buses and trains have been excluded based on unlikely reduction in bus and rail km travelled	Congestion cost of $0.41 and a replacement value equal to vehicle mode share
DfT (2010)	Develop a weighted average marginal external cost for car congestion imposed on society by adding a marginal vehicle to the road. (TAG unit 3.9.5: Road Decongestion Benefits)	$0.20

3.3 Environmental benefits

Domestic transport accounts for 14.4% of Australia's total greenhouse gas emissions, 88% of which result from road transport compared to 2% for rail transport. The cost of greenhouse gas emissions from road transport in Sydney is estimated at $144.8 million for 2005, and is forecast to rise to $186.9 million in 2020 (BTRE 2005).

Walking is a very low emission form of transport and therefore offers significant potential to lower emissions in the transport sector.

Motor vehicles, which are a major contributor of air pollutants, account for more than 50% of the emissions of nitrogen oxides (NOx), Carbon Monoxide (CO) and almost half the emissions of hydrocarbons in Australia each year (Austroads 2000). In Australia, cars produce an average of 0.3 kg of greenhouse per km travelled (DEWR; Beer et al 2004). As a consequence, for each kilometre walked instead using a car; a saving of approximately 0.3 kg of greenhouse emissions could be achieved.

There is mounting epidemiological evidence that air pollution generated by road traffic has adverse health effects for the community including (Litman 2010c):

- Acute effects, which occur due to short-term variation in pollution exposure and manifest as symptoms and variations in bodily functions, principally respiratory and cardiac functions, and include exacerbations of pre-existing illness
- Longer-term effects, which are cumulative effects of exposure to air pollutants and may result in either the initial manifestations of new illnesses, such as chronic lung disease, or the persistence of pre-existing illnesses

The costs attributed to air pollution and noise can vary according to vehicle type, location (urban/rural), time and whether the area is vulnerable to pollution. Thus, these may require location-based pricing (Litman 2010c).

Indeed, there are potentially large reductions in per kilometre air pollution emissions because walking can replace short, cold start trips where motor vehicles have high emission rates. Each 1% of automobile travel replaced by walking or cycling can decrease motor vehicle emissions by 2% to 4% (VTPI 2004).

Overall, the monetisation of environmental impacts associated with shifting from motor vehicles to walking varies between studies. While some methodologies includes all aspects as a single parameter (for example Land Transport NZ), others separate out noise from pollution and carbon emission savings. Monetising carbon emissions separately from other environmental outcomes may provide more clarity, especially if different carbon prices are included in the analysis.

The following table lists various methodologies, and their respective values of quantifying environmental benefits.

Table 3 Methodologies to quantify environmental benefits

Author	Methodology	Overall environmental benefits ($/km)
Campbell and Wittgens (2004)	Identify the benefits associated with GHG reduction (including a price of carbon), air pollution and water quality improvements	$0.098
Colin Buchanan Partners (2008) *Thames Pedestrian and Cycle Bridge*	Walking and cycling are zero-emission modes. Therefore all mode shifts to walking and cycling generate a net emissions reduction. In this appraisal, a benefit has been applied to all car trips that shift to walking and cycling.	£0.038
Litman (2010c)	Includes optimal emission fees covering air, noise and water pollution costs. Air pollution varies	$0.025
PwC (2010)	Utilise the values published by ATC (2006) which lists the average total environmental externality costs for cars	$0.025 (air pollution), $0.0034 (water pollution), and $0.0147 (greenhouse gas)

3.4 Noise pollution

Noise refers to unwanted sounds and vibrations and is an important, yet potentially under-represented aspect, relating to increased walking. While walking for recreation will not result in a significant change in vehicle noise, walking for a mode of transport will reduce vehicle travel and associated noise. Indeed, pedestrians generate minimal noise other than vocal sounds. On the other hand, motor vehicles produce noise from tyre and wind noise, plus engine acceleration and braking, amongst other causes.

There may be significant perceived benefits from a reduction in vehicle traffic, especially in residential areas where the cost of noise is highest (Campbell and Wittgens 2004). The cost from noise may also vary according to time of day.

There are various methods to monetise the cost of noise to individuals. The UK Department for Transport (DfT) measures the cost of noise based on the annoyance from a change in decibels. The Victorian Policy Transport Institute (VTPI) (Canada) reviewed a number of studies using different methods to evaluate the cost of transport noise.

One method to measure noise uses hedonic pricing surveys. This involves the effects of noise on residential property values. However, hedonic methods have been criticised on the grounds that their noise level thresholds tend to be arbitrary, the data used is often incomplete, they assume that home buyers have accurate knowledge of noise exposure at each location, and they do not account for non-residential noise impacts (such as on businesses and pedestrians) (VTPI 2010).

The type of displaced vehicle should also be considered, as heavy vehicles produce more noise, and thus a greater benefit when they are taken off the road, than small cars. It can be assumed that the majority of displaced vehicles will be cars and motorcycles; nonetheless, these two types may have different noise costs (motorcycles have higher noise costs than cars). Generally, most noise costs are generated based on the assumption that the noise from motorcycles and cars are valued equally.

The following table lists various methodologies, and their respective values of quantifying noise reduction benefits.

Table 4 Methodologies to quantify noise reduction benefits

Author	Methodology	Overall noise reduction benefits ($/km)
Campbell and Wittgens (2004)	Calculate a weighted average based on proportion of trips in urban/rural and peak/off-peak periods	$0.022
Australian Transport Council (2006)	Developed a value for urban noise externalities; the value is a function of population distribution and where vehicle transport usually takes place. This was used by PwC (2010)	$0.0081
DfT (2010)	Suggest cost per household of dB change (noise increase) based on the annoyance response relationships for road and rail traffic noise	Values range from $0 to $0.98 depending on annoyance due to dB change
Victorian Transport Policy Institute (2010)	Summary of methodologies used to estimate noise cost per vehicle, including car, truck, bus and motorcycle. Notes that many of these studies looked at the marginal cost of additional vehicles on major highways and so are not sensitive to urban street traffic noise, where a few additional daily vehicle trips can significantly affect ambient noise and property values	$0.003 to $0.06

3.5 Operating Cost savings

Savings in car user costs are based on the premise that people walking instead of driving avoid vehicle operating costs which include fuel, tyre repair, maintenance and depreciation. Indeed, the costs of operating a car are likely to be ten times more than walking, as the only equipment required for walking is footwear (Wittgens and Campbell 2010). Furthermore, the cost of vehicle operation may increase by 50% during stop-and-go driving in peak periods. The short trips replaced by active transport may be twice the usual cost, due to the greater maintenance and fuel cost associated with frequent cold-starts (Wittgens and Campbell 2010).

As proposed by PwC (2010), the latest estimates suggest car operating costs are $0.238 per vehicle km. This operating cost can be converted to user cost savings by considering the replacement rate of vehicle use from increased walking activity. This includes both the perceived and resource costs of operating vehicles.

Arguments have been made that an increase in active transport also reduces the vehicle operating costs of train and bus services (in this case CityRail and Sydney buses). However, while the infrastructure does reduce bus and rail passenger trips, it is not likely to reduce bus or rail service kilometres (PwC 2010).

The following table lists various methodologies, and their respective values of quantifying operating cost savings benefits.

Table 5 Methodologies to quantify operating cost savings

Author	Methodology	Overall savings in operating cost ($/km)
Campbell and Wittgens (2004)	Average automobile operating cost of $0.14 per km and active transport cost of $0.01 per km. Costs are higher in urban and peak periods. Assume that 60% of trips in Canada are urban with 33% occurring in peak periods.	$0.034
PwC (2010)	Average vehicle operating cost of $0.238 per km and replacement rate of 61.5%. Costs from buses and trains have been excluded based on unlikely reduction in bus and rail km travelled	$0.146
Land Transport NZ, *Economic Evaluation Manual, volume 2*	This value represents peak periods for travellers in Auckland and is a combination of travel time, vehicle operating costs and carbon dioxide reduction benefits to other road users. People that change modes do not always consider additional travel time as a cost.	$1.41

3.6 Accident costs

The economic costs associated with walking and accidents will depend on the nature of the initiative. It may not be appropriate to include accident costs in appraisals of projects aimed at increasing recreational or leisure, as these costs may not be considered by participants. On the other hand, investments in off-road pedestrian facilities for walking as a mode of transport may need to consider the user costs of avoided collisions. In these cases, the exclusion of accident costs in transport appraisal could lead to an under investment in safety at a national level and lead to difficulty in assessing the relative merits of projects that improve safety (ITS 2003).

Depending upon the form of transport or recreational activity which walking is substituted for, there may be either a reduction or increase in the risk and number of crashes associated with walking.

It has been suggested that as a form of transport, walking carries approximately five to ten times higher a risk of injury per kilometre travelled than a car (WHO 2004; Elvik 2009). While there is limited literature on the health benefits of walking compared with the risk of injury, it has been suggested that the benefits of increased physical activity are substantially larger than the risk of injury. Given that the health benefits for cycling are on average nine times greater than the risk of injury (Hartog et al 2010); this ratio is likely to be similar, if not greater, for walking, where individuals are not subject to potential on-road accidents.

PwC (2010) examined people's willingness to trade off (avoid) fatality or serious injury on roads and calculated the bicycle crash costs by looking at the number of accidents per million kilometres travelled (MKT) for cycling and driving. Using the unit accident cost of $89,586[5] per accident, the accident costs per million kilometres travelled for cycling and driving were calculated. In this case, it was assumed that 44% of bicycle-vehicle crashes occur at intersections, and thus 56% of potential crashes (on roads) would be avoided by developing off-road cycleways.

The calculation of crash costs in pedestrian initiatives requires a slightly different methodology, depending on the aim of the proposal. Separated pathways will lead to different values of crash costs than initiatives aimed at improving road-bordering pathways or recreational plans. For example, if it is assumed that pedestrians only cross roadways at dedicated crossings, a separated pedestrian pathway that avoids intersections would remove a majority of (if not all) crash costs. On the other hand, pathway provision on existing roads may provide smaller reductions in crash costs.

The following table lists various methodologies, and their respective values of quantifying accident costs.

Table 6 Methodologies to quantify accident costs

Author	Methodology	Overall accident cost savings ($/km)
Campbell and Wittgens (2004)	Calculate a weighted average based on proportion of trips in urban/rural and peak/off-peak periods	$0.052
PwC (2010)	Examines people's willingness to trade off (avoid) fatality or serious injury on roads by calculating the avoided accidents and their associated costs for bicycles.	$0.023 to $0.093
Land Transport NZ Economic Evaluation Manual v2	If the risk of pedestrian accidents is perceived in the decision to change mode then this is offset by the fall in the average per kilometre accident cost per pedestrian that results from an increase in the number of pedestrians (i.e. safety in numbers).	$0
Litman, T. (2010)	Net safety benefits of shifts from automobile to non-motorized travel (reductions in motor vehicle risk minus increases in risks to non-motorised travellers).Crash reduction benefits can be	average $0.03 per urban peak km, $0.025 per urban off-peak km, and $0.019

5 Willingness to pay valuation methodology, PricewaterhouseCoopers and the Henscher Group 2009, adopted by NSW Treasury and incorporated in the RTA Economic Appraisal Manual, Version 2, Appendix B: Economic Parameters for 2009.

Author	Methodology	Overall accident cost savings ($/km)
	much larger with policies and programs that improve walking safety.	per rural km.

3.7 Roadway provision

Although pedestrians and cyclists use roads, they require less space and impose less wear than motorists, and so cost less per km of travel. In addition, sidewalks and paths are relatively inexpensive to build and maintain (Litman 2010a).

Depending on the extent of any substitution between car and walking trips, there is potential to reduce road maintenance costs. Paths for pedestrians are also more efficient, handling 20 times the volume per hour than roads for cars in mixed traffic (Campbell and Wittgens 2004).

Roadway costs include the public expenditures of adding new road capacity, maintaining roads and safety enhancements to roads. This does not include costs that are paid for by road users through tolls or gas taxes. Most local roads are paid for through property taxes and development charges and are not paid for directly by the users of the infrastructure (Campbell and Wittgens 2004).

Following the work of the NSW Roads and Traffic Authority in 2003, it can be assumed that roadway cost savings associated with the provision of new pathways are 3.3 cents per pedestrian kilometre. Following work undertaken by Austroads (1994) and the Sydney Future Directions Study (1991), it can also be assumed that the provision of walkways and cycle ways are similar.

The following table lists various methodologies, and their respective values of quantifying roadway provision savings.

Table 7 Methodologies to quantify roadway provision savings

Author	Methodology	Overall roadway provision savings ($/km)
Campbell and Wittgens (2004)	Roadway costs assumed to decline with a shift to non-motorised transport due to the smaller space requirements per individual. A weighted average of roadway cost savings assumes that 60% of trips are urban with 33% of those occurring during peak times (Litman 1999)	$0.028
PwC (2010)	Utilised values of the roadway cost savings associated with the provision of new pathways developed by the NSW RTA in 2003	$0.039
Litman (2010a) Evaluating non-motorised transportation benefits and costs (Canada)	Shifts from driving to walking or bicycling are estimated to provide roadway facility and traffic service cost savings	$0.04

3.8 Parking Cost savings

For an economic appraisal, a key concern is the number of car parking spaces that will be avoided as a result of the initiative and the value of these car spots (ATC 2006). The costs associated with parking automobiles are significant, for both motorists and the government, including those costs for land, construction and operating costs of parking facilities.

When parking is provided for free, this represents a significant subsidy to motorists. The costs of parking a bicycle is approximately 5% of the cost for a motor vehicle, and pedestrians do not require any parking facilities (Campbell and Wittgens 2004).

If the price of parking is considered by car drivers when making travel decisions and is included in the decision to divert from car travel, the benefit to these travellers will include the perceived parking cost saving.

The following table lists various methodologies, and their respective values of quantifying parking cost savings.

Table 8 Methodologies to quantify parking cost savings

Author	Methodology	Overall parking cost savings ($/km)
Campbell and Wittgens (2004) UK	Calculate a weighted average based on proportion of trips in urban/rural and peak/off-peak periods	$0.74
Litman (2010c) (Canada)	Estimated as optimal parking fees when motorists pay to recover all parking facility construction and operating costs, as well as equivalent land rent and taxes. Note that this value differs from the following Litman (2010a), potentially due to per km cost compared to per trip cost calculation.	$0.075
Litman (2010a) *Evaluating non-motorised transportation benefits and costs* (Canada)	Parking costs are not generally affected by trip length, so this cost is measured per trip rather than per mile. Shifting from automobile to non-motorised travel is estimated to provide parking savings.	• $2 to $4 per urban-peak trip • $1 to $3 per urban off-peak trip • about $1 per rural trip
PwC (2010)	Utilise values of parking cost savings adopted by the NSW RTA	$0.012
Land Transport NZ, *Economic Evaluation Manual, volume 2*	In this report, the resource cost and average parking fee for a peak period in Auckland are calculated. However, these costs are per round trip, not per km travelled.	• Peak period: $11.40 • Noon-peak period: $2.85

3.9 Time savings

The availability of time can be a factor in determining an individual's propensity to exercise and ability to participate in active transport. Some argue that time savings should be a goal of a health and environmental intervention, and needs to be facilitated by creative solutions and cross-sector collaborations (Strazdins and Loughrey 2007). However, travel time unit costs attributed to walking vary depending on type of trip, travel conditions, and traveller preferences (Litman 2008). Hence the ability to quantify time savings depends on numerous factors and may be difficult to accurately predict.

Existing Australian and international research on the value of walking time suggests that the value increases with distance. Also, walk time is valued more highly when undertaken in highly congested conditions, or when there is increased effort on the part of the traveller (such as steep gradients) (ATC 2006).

It has been suggested that the value that people assign to travel time is highly variable, depending on factors such as comfort and enjoyment. It may be assumed that those who choose to walk for leisure are choosing a high value use of time. For example, some people enjoy walking for recreation and exercise, and will choose to walk even if trips take longer.

If journeys are switched from motorised modes, there may be an increase in journey time reliability, as journey times for walking and cycling are fairly reliable. Uncertainty over how long a trip will take and unexpected delays can arise along the same motor vehicle route, as congestion and other factors may vary. This may be particularly important for connections to public transport (DfT 2010).

Travel time unit costs vary significantly depending on conditions and preferences. Where walking and cycling conditions are unfavourable, travel time costs are high, but under favourable conditions costs are low or even negative: time spent walking or cycling is considered a benefit rather than a cost (Litman 2010).

For these reasons it has been argued (PwC 2010) that the broad assumptions on time spent on the journey and also the time taken to wait or transfer between modes may introduce uncertainty into economic appraisal. Hence, where the time savings or costs are minimal (for distances up to 1 km) it may be reasonable to treat time savings as internalised by the user and hence not included in the analysis.

The following table lists various methodologies, and their respective values of quantifying time savings.

Table 9 Methodologies to quantify time savings

Author	Methodology	Overall time savings ($/km)
Land Transport NZ, *Economic Evaluation Manual, volume 2*	This value represents peak periods, travellers in Auckland and is a combination of travel time, vehicle operating costs and carbon dioxide reduction benefits to other road users. People that change modes do not always consider additional travel time as a cost.	$1.41
Litman (2010) *Evaluating non-motorised transportation benefits and costs*	Various methods can be used to measure the value user place on their travel time. Higher values are suitable under unfavourable walking conditions and lower values under favourable	valued at 30-50% of prevailing wages

Author	Methodology	Overall time savings ($/km)
	conditions.	
PwC (2010)	Typical transport appraisal accounts for the time spent on the journey (referred to as in vehicle time – IVT) and the time taken to walk to, wait for or transfer from other modes of transport (referred to as out of vehicle time – OVT). The inability to accurately IVT and OVT factors would introduce uncertainty to the appraisal.	Not included in appraisal

3.10 Barrier Effect

Litman (2010a) 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 (GTA 2011).

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 monetised using the same methods and travel time values used to calculate motorised 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.

4 Comparison of walking to cycling mode appraisals

We found that, overall, the current methodologies to evaluate the economic viability of walking, and indeed all active transport are in early stages. Nonetheless, the methodology can reflect and mirror that of conventional transport assessment, as long as the distinguishing factors between each mode are considered and reflected in each analysis. The monetisation of various parameters must also be developed on a case-by-case basis, with data and key parameters reflecting the goals of the project and local community.

Despite the importance of walking as a means of transport, the funding received by walking projects is dwarfed by expenditure on hard modes such as road and rail. Buchanan (2004) suggests that the reason why other modes, such as rail, bus and highway infrastructure, receive more funding in the UK is that there are established scheme appraisals to measure their economic impacts.

Even within active transport, there are significant differences in the quality and activity of appraising 'active transport' (walking and cycling) compared to walking only. This could reflect the dual use of many infrastructure developments in servicing both pedestrians and cyclists.

The majority of research utilises cycling data as the benefits and current methods of data collection are more advanced than those for walking. There may be a need to address the inadequacy of walking and pedestrian data in order to improve future evaluations (GTA 2011).

The variation in literature examined suggests there are fundamental differences which should be considered when appraising walking compared with cycling initiatives:

- Accident costs – Due to higher speeds and on-road travel, cyclists may face higher risk of accidents and costs accruing to crashes may be higher than pedestrian crashes. The reduction in accident costs should reflect the individual appraisal, for example, a separated pathway will reduce the potential for pedestrian crashes at non-intersection areas whereas a sidewalk improvement may not act to reduce the risk of accidents.

- Travel time – walking is significantly slower than cycling, yet walking does not require parking time, thus generating a debate on the overall door to door travel time compared to cycling. The total travel time will depend on aspects such as the barrier effect and availability of parking for bicycles.

- Parking cost savings – Although cycling does not require the extensive space and subsequent costs accruing to vehicular parking, there are some costs in establishing bike racks. Comparatively, walking does not require parking facilities and represents a gross saving in costs.

- Operating costs - When compared to cycling, the operating costs of walking are lower than that of cycling since bicycles require maintenance and repairs, whereas walking requires footwear – this cost is minimal and is not considered part of the decision to walk.

5 Broader social impacts of walking

While a CBA should be 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 cannot be quantified for CBA purposes.

There are several impacts of increased walking within a community that are not necessarily borne by the individual user. These impacts are generally felt by the wider population and tend to be more difficult to quantify than more traditional appraisal parameters.

The benefits outlined in this chapter are not currently quantified but may be particularly important outcomes resulting from increased walking, particularly for local policy makers, and therefore a qualitative discussion of these factors should accompany any formal CBA.

5.1 Liveability and economic development

Many people value living in or visiting a community where walking and cycling are safe, pleasant and common. There are also public health benefits from increased walking and cycling. As a result, transportation options can help communities become more "liveable," resulting in increased property values and commercial activity (VTPI 2010).

Campbell and Wittgens (2004) suggest that redevelopment and promotion of pedestrian friendly communities will lead to increased mobility, a sense of community, reduced barrier effect and improved liveability. This is further examined in Witten et al (2009) who suggest various methods to assess the objective compared to experimental measures of walkability in neighbourhoods. However, the study did not relate the built environment to behaviour, such as physical activity.

The aspects related to improved liveability may be reflected in higher property values in more walkable communities. In several case studies, improving walking conditions in a community significantly increased retail sales and property values (LGC 2001).

An analysis by Sztabinski (2009) indicates that converting a parking lane into wider sidewalks or bicycle lanes can benefit urban retailers overall, since only a minority of customers arrive by automobile. Thus, improving walking and cycling conditions tends to improve the attractiveness of the street to pedestrians and may encourage increased walking.

Cortright (2009) evaluated the effects of walkability on housing prices and found that 'walkability' (i.e.: more pedestrian friendly areas) had a statistically significant, positive impact on housing values. The researchers concluded that these results reflect the value consumers attach to walkable neighbourhoods, which tend to be denser, mixed use neighbourhoods with good accessibility, including transit service (VTPI 2010).

5.2 Journey ambience

Policies that improve the quality of infrastructure or move pedestrians to areas uncongested by vehicles may present improvements in the 'journey ambience' and enjoyment. This aspect relates to three elements of the experience of travellers (DfT 2010):

- Traveller care: the quality and cleanliness of facilities and information provided
- Travellers' views: the extent to which travellers can see the surrounding landscape and townscape
- Traveller stress: frustration, fear of potential accidents and route uncertainty

MJA (2009) further defines these components as comfort and convenience, environmental quality and perceptions of safety and stress.

Although difficult to monetise, this aspect may prove important in inducing modal shift and sustaining future demand. An increase in ambience may present a perceived improvement in safety; unsafe areas are often cited as deterrents to walking. Specifically, walking, for both recreation and as a mode of transport, may be affected by changes in levels of personal security (DfT 2010).

As noted by MJA (2009), journey ambience values published by the DfT (2009) were assigned on the basis of previous studies, and varied according to the infrastructure and facilities provided. These effects accounted for a significant proportion of benefits in case studies of AT infrastructure by DfT (18-20%) in the UK.

Table 10 Intrinsic values proposed by the DfT (UK)

Infrastructure improvement	Journey ambience estimate per km ($AUD)
Street lighting	$0.53
Reduced crowding	$0.27
Level kerbing	$0.38
Information panels	$0.13
Pavement evenness	$0.13
Directional signage	$0.08
Benches	$0.08

Source: DfT (2010)

Further research into this area in the future may provide robust monetised figures for journey ambience. As yet, there do not appear to be agreed methodologies to quantify this aspect.

5.3 Option value

This concerns the value that travellers may place upon a travel option that is available to them, but which they do not regularly use. The provision of safe and appealing walking infrastructure will provide a greater number of options available to people even where they continue to use alternative modes.

Therefore a new walking facility might be valued simply because it exists as an option. Ideally the option value should be evaluated, although in practice this is problematic, especially given the limited volume of research on this issue (DfT 2010).

5.4 Social equity

Although difficult to quantify, active travel is more equitably distributed than leisure time physical activity, as socially disadvantaged social groups who are unable to participate in leisure time physical activity or sport are more likely to engage in active transport (Garrard 2009).

Walking also provides more options to a wider range of people to enable them to access good, services and activities.

Appendices

Appendix A Case studies

There have been a number of initiatives, both within Australia and internationally, that aim to increase the local rate of walking. Table 11below outlines some initiatives and policies that have been directed towards walking specifically and the impact that they have been estimated to have, both in terms of participation and wider benefits.

Table 11 Walking initiatives and policies

Project	Description	Outcomes
Australia		
Heart Foundation Walking (HFW)	HFW is Australia's largest network of free community-based walking groups, led by volunteer Walk Organisers. HFW was launched nationally in 2007 and aims to increase community participation in physical activity by making being active easy, event for those not used to being active. Based on the successful Heart Foundation 'Just Walk It' program, it is the largest population based, group walking program in Australia, with more than 8300 participants in over 650 groups. Groups are coordinated by staff from health, local government authorities, workplaces and community groups as part of their core business	HFW has consistently demonstrated an impressive six-month retention rate in excess of 80%. Research indicates that a three-to-six month retention rate of 50% is standard for physical activity programs. HFW attracts and retains a number of population groups that have been identified as being least likely to be physically active including: • Women (80%) • Older people (29% aged 45 – 64yrs; 43% aged over 65) • People of lower socio-economic status (38%) • People who live alone (23%).
Global Corporate Challenge (GCC)	An international event that encourages workforce participants to increase the amount of walking per day. The participants, in teams of seven, record daily steps and are taken on an interactive tour of the world. Each participant receives a 'GCC pack' that includes two pedometers. Over the 16 weeks of the GCC participants record and enter their daily step count (or bicycle and swimming distances) into	In 2010, close to 100,000 participants from 1,000 workplaces in 55 countries took part. In 2009, according to research conducted by Sustainability Victoria (Moriarty 2009), during the Challenge: • Walking by participants increased by approximately 390%; • Driving by participants decreased during by approximately 75%; • Travel by public transport decreased during the Challenge by

Project	Description	Outcomes
	the GCC website. The site adds individual step counts to their team total then converts this to a kilometre/mile distance, and plots the team's progression along a virtual tour of the world. The more active they are, the further they go, the healthier they become, the more productive your organisation becomes. Participants are also encouraged to look at their eating habits and are supported to change to a healthier diet with daily information, and weekly eating plans.	an average of 62.5%; and • Of all possible changes to travel behaviour, the major change was from driving a fossil fuelled motor vehicle to walking (57%).
Bendigo Community Health Service 'Go for your life' Walking Program	The Bendigo Community Health Service 'Go for your life' Walking Program was established in March 2006 through 'Go for your life' funding. The goal of the program was to increase physical activity levels and enhance the mental health and wellbeing of the residents of the City of Greater Bendigo during 2006 and 2007. Participants were targeted through a range of social marketing strategies. Before commencing the program, a Physical Activity/Lifestyle Assessment was conducted by BCHS staff. There are currently between 30 and 40 walkers meeting to walk twice a week for at least an hour.	BCHS conducted both process evaluation to measure participants' satisfaction and reach of the program, and impact evaluation to examine the changes that occurred. A total of 25 walking group attendees participated in the evaluation over a 12 month period. • Participants reported they felt that their physical and mental health had improved over the 12 months since joining the walking program • 85% of participants reported at 6 and 12 months that they had increased their walking distance since joining the walking program • 88% reported numerous reasons why they were motivated to continue walking, such as the opportunity to meet new people, keep active, the increased feeling of physical activity, wellbeing and fitness, and the friendliness of the group • 75% of the walkers had also participated in other services provided by BCHS.
Walk Together Grant 2007: Walk for Wellness	The Walk for Wellness Program received 'Go for your life' funding for 2008 through the Frankston	Evaluation of the Rye Coastal Walk identified that: • 34% of the participants have

Project	Description	Outcomes
Program	Mornington Peninsula Primary Care Partnership (PCP, Health Promotion Alliance. The project was developed as a partnership between Ageing Well, Peninsula Health, Brotherhood of St Laurence, Royal District Nursing Service (RDNS) and a range of hotels/restaurants within the region. The Walk for Wellness program established three structured nature walks encouraging people to walk. The walking program caters for people with a chronic illness and/or a disability and their carers, in the communities of Mornington, Frankston and the established walking group in Rye. All walks are supported by RDNS, community care aides, personal care attendants and volunteers.	been inactive for at least 12 months (i.e. walk outside for less than 15 minutes/day) • 37% of participants joined the walk for the health benefits walking can provide because they were recommended to walk by a health professional • 17% of the participants could not attend the walk if not for the provision of transport support.
International		
Gloucester Safer City, UK (1996-2000)	£5 million of government funding was provided to undertake road safety measures. Employed local safety scheme measures aimed at reducing casualties, focussing on education, training, publicity and enforcement	Between 1996 and 2000: • Child pedestrian casualties fell 13% • Adult pedestrian casualties fell 22% • Children allowed to go to school on their own rose from 32% to 49%. Overall the one-off project, with major investment in road safety engineering was particularly successful in reducing pedestrian casualties
Shoreditch Triangle, East London, UK (2004)	Scheme to give additional priority to pedestrians during a major road reconstruction project.	An evaluation of the scheme found: 1. Pedestrian use of assigned crossing areas

Project	Description	Outcomes
	Involved an increase the number of light controlled pedestrian crossings to ensure that crossings were installed on pedestrians desire lines and to widen pavements where pedestrian numbers warranted road space reallocation	had risen 56% 2. Informal crossings away from assigned crossing areas had fallen 61% 3. Overall crossings had risen by 9% All parties believed that the overall accident risk has been substantially reduced and that, as the roads have become easier to cross, the impact of community severance has also been reduced
London Millennium Bridge, UK (2000)	The Millennium Footbridge connects Tate Modern on the South Bank with St Paul's Cathedral on the north side of the River Thames. The bridge is 320m long and cost £18 million to build.	One estimate had suggested that around 10,000 people per day would use the bridge – these estimates proved conservative. Up to 5,000 people an hour cross the bridge at peak times.
Addenbrooke's Hospital workplace travel plan, UK	The hospital employs 4,500 people and the travel plan sought to set targets for changes in travel behaviour away from the car to improve accessibility for staff, patients and visitors. Addenbrooke's Hospital invested in car sharing, ran promotional events for bus travel and improved the walking infrastructure. The objectives of the plan were: • to increase travel choices and make them safe and accessible for all • to reduce demand for car parking • to encourage healthy transport options • to reduce the environmental impact of the travel needs of the campus	Between 1993 and 2003, car use fell from 74% to 42% with walking increasing from 4% to 7%.
Walking the way to Health Initiative (WHI),	An initiative to get people, in areas of poor health or low exercise, walking for	Evaluations indicate numerous benefits from increased stamina, mobility, and health related quality

Project	Description	Outcomes
UK	leisure. The local walks are usually led by volunteers and are promoted with a 'social' and 'health' emphasis. Overall, WHI has helped to create more than 350 health walk schemes and is estimated to have encouraged over 1 million people to walk more. WHI is a joint initiative between the British Heart Foundation and the Countryside Agency. Extra funding comes from the UK lottery via the New Opportunities Fund distributing body and through sponsorship from Kia Cars as part of their 'Think Before You Drive' campaign. Schemes can have a range of costs, depending on the number of walkers and use of volunteer or staff representative. Small schemes cost from £500 (20 walkers per week) while large schemes can cost upwards of £100,000 (1,500+ walkers per week)	of life to mental health. In addition to health, participation has had an effect on transport habits, with 'an average of 50% of respondents indicating they are now more likely to use walking as a mode of transport' (WHI 2006). Case study evidence, backed up by data collected thus far, shows that new participants are sedentary when they join, and that they will remain with the walk scheme for an average of eighteen months, walking three times a week WHI has been able to show that by encouraging people to rediscover the habits and pleasures of walking it can encourage other positive lifestyle changes, including being less dependent on the private car for short journeys. The cost of a single walk for a participant is estimated at approximately £0.84. However, it is suggested that for every pound spent on the WHI, the health care savings will equal £7.00. The scheme has a cost benefit ratio of 1:7.18
***Go for Gold* Initiative, Buckinghamshire County**	Go for Gold is an incentive scheme rewarding children for walking at least some of the way to school. It is a simple and effective way to encourage children to walk. Children earn stamps and stickers depending on the amount of walking and can earn rewards at local leisure centres. Go for Gold achieved international recognition when it was awarded the first International Walk to School Award in March 2004 The scheme is designed to fit with other strategies and aims to encourage children to walk for a sufficient period of time for it to	Modal shift attributed to this scheme has been dramatic with walking rising from 30% in 2000 to 59% in 2003. There has been a decline in car use from 62% to 25%. The scheme is running at 74 schools and there has been a sustained shift from car travel to walking.

Project	Description	Outcomes
	become a habit.	
School Street upgrade, Lodi, California, USA (1997)	A US$4.5 million investment (1997) in streetscape and pedestrian improvements on School Street in Lodi, California, as well as some economic development initiatives.	Credited with attracting 60 new businesses, decreasing the vacancy rate from 18% to 6% and increasing downtown tax revenue by 30% (LGC, undated)
Links to Schools, UK	Three schemes aimed at increasing the participation of school-aged children in walking and cycling to school. The DfT's economic appraisal method, a benefit-cost ratio was developed for each scheme: the Bootle, Hartlepool and Newhaven pathways (the underlying data used to calculate these results have not been made publicly available.	• Bootle: This scheme consists of a series of improvements to an existing route close to a number of schools. The improvements include resurfacing, some new construction, road marking, signing and lighting. The grant awarded was £131,000 towards an overall project cost of £231,000. BCR 29.3:1. • Hartlepool: This scheme involved the construction of a toucan crossing close to a primary and a secondary school, with some more general infrastructure improvements in the immediate vicinity. The grant awarded was £25,174 towards an overall project cost of £50,349. BCR 32.5:1. • Newhaven: A new shared-use path in an existing grassed verge adjacent to, and set back from, the busy A259 was constructed. The route is some distance from, but forms a link between, two secondary schools. It also links to their communities of Seaford and Newhaven. The grant awarded was £125,000 towards an overall project cost of £300,000. BCR 14.9:1.

Sources: KinectAustralia website, Sustrans: *Addenbrooke's Hospital - Case Study; Walking for Health*, www.wfh.org.uk; Heart Foundation, *Position statement The built environment and walking;* Sustrans, *Links to Schools;* LGC; Buckinghamshire County Council, *Go For Gold*

Appendix B Summary of key research

The following section provides detailed summaries of the key research reports that have informed this review. This list is not exhaustive, but is intended to provide guidance on the wide range of analysis conducted to date and the varying underlying methodologies used.

5.5 PwC (2010) *Evaluation of the costs and benefits to the community of financial investment in the Naremburn to Harbour Bridge Active Transport Corridor (Harbourlink)*

PricewaterhouseCoopers (PwC) and Sinclair Knight Merz (SKM) were engaged by North Sydney Council to perform a demand study and strategic CBA analysis for the completion of the Naremburn to Harbour Bridge Active Transport Corridor, including the proposed 'Harbourlink' shared use path.

The methodology is based on the significant existing body of work already undertaken by the RTA, DECCW and PwC in developing and refining an appropriate method for the economic evaluation of active transport infrastructure.

The economic methodology has utilised the core requirements for an economic appraisal of transport infrastructure in accordance with the NSW Treasury, Australian Transport Council (ATC) and Infrastructure Australia (IA) guidance.

The benefits adopted within this study are deemed to be the benefits which academic research and economic theory support as attributable to active transport infrastructure.

However given the debate surrounding some of these, comprehensive sensitivity analysis was undertaken on the project results.

Key benefits include:

- reduced congestion costs;
- reduced vehicle operating costs;
- reduced environmental costs (including greenhouse gas emissions, air pollution);
- noise pollution;
- changes in crash costs;
- reduced road and parking infrastructure provisions; and
- improved health outcomes.

A relationship was established between the replacement of car or public transport travel for active travel. The diversion rates used within the corridor specific demand modelling are:

- one active transport KM trip replaces 0.616 car KM trips
- one active transport KM trip replaces 0.297 bus, train and other forms of motorised transport trips.

These replacement values were multiplied to each parameter value to calculate the user cost savings from modal shift

Congestion savings

Congestion costs were assumed to be a factor of both the volume of vehicles on the road and average traffic speeds. The report used the most recent decongestion cost calculations undertaken by CityRail, which 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 per vehicle km in March 2010 prices

Savings in vehicle operating costs

This report used the most recently estimated car operating costs of $0.2382 per vehicle km, as developed by the RTA in the *Economic Appraisal Manual, Version 2, Appendix B: Economic Parameters for 2009*

Crash costs

The crash costs developed in this report primarily related to the total number of vehicle and bicycle crashes per annum and an assumed unit accident cost of $89,586, using a willingness to pay approach. It was suggested that a human capital approach may result in a cost of between 2.3 and 9.3 cents.

Travel Time

Transport CBA is required to account for not only the time spent on the journey (referred to as in vehicle time – IVT) but also the time taken to walk to, wait for or transfer from other modes of transport (referred to as out of vehicle time – OVT – and given a weighting to reflect the greater disutility associated with these activities).

While the major obstacle facing cycling appraisal is the inability to accurately measure IVT, these OVT factors add further uncertainty to the appraisal. Furthermore, the quantification of these components of journey time may be meaningless given cyclist and walkers are often willing to incur a longer travel time when choosing active transport for the trip.

To quantify any change in travel times would require making a large number of assumptions around public transport and cycling OVT, and broad assumptions on vehicle speeds. Quantification of travel time changes was therefore not undertaken in this report.

5.6 Land Transport NZ, *Economic Evaluation Manual, volume 2*

Transport NZ's *Economic Evaluation Manual, Volume 2* (EEM2) covers economic efficiency evaluation of demand management and transport services proposals for land transport, including:

- freight transport services
- new and improved passenger transport services
- walking and cycling
- travel behaviour change
- parking and land use
- pricing and financial incentives

Chapter 8 provides evaluation methods for walking and cycling projects.

Evaluation of transport demand management (TDM) activities considers not only direct impacts but also additional costs and benefits to participants and society that may influence transport choice. All impacts should be considered, regardless of where they occur.

Impacts of TDM initiatives relevant to the evaluation of walking include:

- vehicle operating cost (VOC) savings
- travel time cost savings
- trip reliability
- walking and cycling costs
- accident cost savings
- health benefits
- transport service user benefits
- parking user cost savings
- carbon dioxide reduction
- community liveability improvements
- increased consumer travel options
- adjustment for public transport fares
- land use benefits

Mode change benefits

LTNZ suggests that users who change their mode of transport will gain benefits from improved transport options, reduced vehicle operating costs, and reduced environmental impacts. These benefits can relate to improvements for current users (e.g. a reduction in travel time), perceived benefits to people that change (e.g. price or service level changes), and resource cost adjustments (e.g. changes in transport fares, parking charges and vehicle operating costs).

Value of travel time

People who change modes do not always consider additional travel time as a cost. The value that people assign to travel time is highly variable, depending on factors such as comfort and enjoyment. Other people enjoy walking or cycling for recreation and exercise, and will choose these modes even if the trips take longer.

Travel time, vehicle operating costs and carbon dioxide reduction benefits to other road users are assessed on a city-by-city basis. During peak periods, travellers in Auckland receive a benefit of $1.41 per vehicle km reduced (2008 values).

Accident Cost savings

Programs that reduce vehicle kilometres of travel tend to effectively reduce road accidents, while those that reduce congestion without reducing total kms, by shifting travel times and routes, and have mixed safety benefits.

It is assumed that people that change to walking have a fairly clear perception of the associated accident risk. If most internal costs are perceived (and included in the perceived benefit of changing travel behaviour), then the resource cost correction would be equal to the externality costs. However, it is assumed that this is offset by the fall in the average per kilometre accident cost per pedestrian that studies show is a result of an increase in the number of pedestrians. The resource cost correction is therefore taken as zero

Health benefits

Health benefits of walking have been assessed as $2.60 per km. It is assumed that people that change to walking or cycling do not perceive the wider savings to society (externalities) of their improved health, e.g. hospital cost savings, so a resource cost correction is required at least for this.

It is assumed that half of the total health benefits are internal to people that use walking and are perceived. A resource cost correction is required for the other half, i.e. the resource cost correction is $1.30/km for walking.

Parking Costs

Reduced vehicle usage results in a reduction in demand for parking facilities. The resource cost of providing parking includes the opportunity cost of using the land for parking, the capital cost of the parking facilities and the provision of security and other administration.

Motorists are usually charged a fee for the use of a parking facility. The charge differs depending on the destination of a journey and the time of day that the journey is made.

In this report, the resource cost and average parking fee for a peak period in Auckland are equal to $11.40 and $2.85, respectively. However, these costs are per round trip, not per km travelled.

Environmental impacts

A composite value for all environmental impacts including local air, noise and water pollution and greenhouse gas emissions is used. Peak private vehicle driver benefits per reduced km are $0.10 and off-peak are $0.05.

Non-quantified benefits

The EEM2 also lists several aspects that are not quantified, including community liveability, consumer travel options and land use benefits

5.7 Litman, T. (2010) *Evaluating non-motorised transportation benefits and costs*

This report describes methods for evaluating non-motorized transport (walking, cycling, and their variants) benefits and costs, including direct benefits to users from improved non-motorized travel conditions and increased use of non-motorized modes, and various benefits to society. Methods to evaluate the effectiveness of certain programs aimed at increasing non-motorised transport (NMT) are considered.

Litman suggests that a challenge facing proponents is the wide range of benefits that walking and cycling can provide. Too often, debates about the merits of non-motorized investments focus on just one or two benefits, such as mobility for non-drivers or public health, but overlook others. This results in underinvestment in walking and cycling compared with what is truly optimal.

The various forms of NMT are discussed and described, as well as their potential benefits and costs. Generally, the benefits of NMT can be distinguished as those resulting from improved conditions, increased NMT activity, reduced automobile travel and more walkable communities. Benefits are not without costs; NMT can result in increases in travel time, facility costs and traffic speed reductions.

Litman describes several performance indicators used to evaluate problems, prioritise improvements and measure progress. The most relevant to walking evaluation include:

- Level-of-Service (LOS, also called Service Quality) rates performance from A (best) to F (worst). (Walkability Tools Research Website, www.levelofservice.com)
- Pedestrian LOS considers pedestrian facility crowding, the presence of sidewalks and paths, vehicle traffic speeds and volumes, perceived separation between pedestrians and motor vehicle traffic (including barriers such as parked cars and trees), street crossing widths, extra walking required to reach crosswalks, average pedestrian road crossing delay, and special conflicts
- WalkScore (www.walkscore.com) calculates a location's proximity to services such as stores, schools and parks, as an indication of the ease of walking to such destinations. It provides no information on walking condition quality

Various methods to monetise the impact of NMT are suggested, including user savings (from reduced transport costs) and social cost savings (from reduced cost to Government or businesses) in amongst others that rely on direct surveys of people and revealed preference studies.

5.7.1 Benefits

The benefits of NMT are allocated to several aspects discussed below.

Health Benefits

Litman summarises a selection of international research that supports the benefits of active transport on health and also various methods to monetise the benefits of improved walking and cycling. However, the referenced studies typically aggregate the benefits of walking and cycling into an 'active transport' benefit and relate mostly to cycling (SQW 2007; Land Transport NZ). The active transport health benefit monetary values utilised by the LTNZ (2006) are summarised as $0.40 per km (NZD 2007) for walking.

Vehicle Cost savings

Vehicle cost savings can include operating costs, depreciation, parking cost and vehicle ownership costs. Savings can be estimated taking into account reductions in vehicle travel and ownership, and tend to be larger for reductions in short urban trips. In general, vehicle travel provides $0.09 to $0.19 per vehicle km reduced operating costs.

Congestion savings

Congestion costs are considered to consist of incremental travel time, vehicle operating costs, stress and pollution emissions that a vehicle imposes on other road users (Litman 2009). A small reduction in vehicle trips is assumed to do little to reduce long-term congestion as trips will be filled by latent demand. Specifically, if alternatives are slow, inconvenient or costly, travellers will continue to drive; this highlights the importance of providing reliable and attractive aspects relating to active transport.

Litman summarises various congestion costs that range from $0.06 to $0.22 per km, with higher values attributed during urban peak periods.

Barrier effect

Litman proposes this effect refers to delays and reduced access, or congestion that vehicle traffic imposes on non-motorised modes of transport. As a result, there may be a shift from NMT to motorised travel. Typical transport planning generally ignores these impacts, as the reduced accessibility of NMT from, for example, building a road is not considered.

Increased travel costs can be monetized using the same methods and travel time values used to calculate motorized traffic congestion costs. The barrier effect imposes direct costs on pedestrians and cyclists, typically estimated to average between $0.003 and $0.009 per vehicle km.

Roadway cost savings

Although pedestrians and cyclists use roads, they require less space and impose less wear, and so cost less per km of travel; than drivers. Since people who depend on non-motorized modes tend to travel less total distance, they also impose lower total per capita roadway costs than motorists. Sidewalks and paths are relatively inexpensive to build and maintain.

Shifts from driving to walking or bicycling are estimated to provide roadway facility and traffic service cost savings of $0.04 per km.

Parking cost savings

As driving requires parking facilities at both origin and destination, there is a cost attributed to the facility. It is noted that in the short run, travel shifted from automobile to alternative modes may simply result in unoccupied parking spaces, but a longer term reduction in spaces. Litman suggests that up to 20 bicycles can be stored in the space for one automobile.

Parking costs are not generally affected by trip length, so this cost is measured per trip rather than per mile. Shifting from automobile to non-motorized travel is estimated to provide parking savings of $2 to $4 per urban-peak trip, $1 to $3 per urban off-peak trip, and about $1 per rural trip.

Traffic safety impacts

Crashes are amongst the most monetised costs of transportation; although walking and cycling have higher per-km casualty rates than automobile travel, shifting travel automobile to non-motorized modes tends to reduce total crash costs.

Net safety benefits of shifts from automobile to non-motorized travel (reductions in motor vehicle risk minus increases in risks to non-motorized travellers) are estimated to average $0.03 per urban peak km, $0.025 per urban off-peak km, and $0.019 per rural km. Litman suggests that crash reduction benefits can be much larger from policies and programs that improve walking safety.

Energy Conservation

Since vehicles use large amount of resources, including oil and coal, petroleum consumption external costs are estimated to be $0.006 to $0.025 per vehicle km. Higher values may be justified if non-motorized travel substitutes for short urban trips in which motor vehicles are fuel inefficient due to cold starts and congestion.

Pollution Reduction

Litman proposes that non-motorized transport can provide relatively large energy savings because it tends to substitute for short urban trips, which tend to have high emission rates per mile due to cold starts (engines are inefficient during the first few minutes of operation, until they heat up) and congestion.

Various studies have quantified and monetized motor vehicle pollution damages, but many of these estimates include only a limited portion of total pollution costs, for example, considering ozone, CO and NOx damages, but ignoring particulate and air toxic damages.

Automobile air, noise and water pollution costs are typically estimated to average $0.01 to $0.09 per vehicle km, with lower-range values in rural conditions and higher values under congested urban conditions, but relatively high values can be justified to reflect the tendency of walking and cycling to reduce short urban trips.

Economic Development

This refers to the increased productivity, efficient land use development, expenditure impacts and development of industries related to non motorised transport. It is suggested that these aspects are important to consider, qualify and monetise where possible, but input-output models should be used for quantification. Hence, these aspects may be outside the realm of CBA, but should nonetheless be considered in the overall benefits of walking.

5.7.2 Costs

There are various costs associated with NMT, including facility costs, vehicle traffic impacts (where NMT cause delays on vehicle traffic), user travel time costs and the risks of accidents.

User time costs

Travel time is the largest variable cost for many trips, with walking and cycling typically slower than vehicles. Various methods can be used to measure the value users place on their travel time. It is generally valued at 30-50% of prevailing wages, with higher values under unfavourable conditions, and lower values under favourable conditions.

5.7.3 Conclusion

Some of the benefits associated with walking are relatively easy to monetize. Transport economists have developed methods for monetising traffic congestion, road and parking facility costs, vehicle expenses, crash risk, and pollution emissions (Litman 2009). Other impacts can be monetized by modifying existing values. For example, barrier effect costs can be monetized by applying traffic congestion delay cost values to the delays that motor vehicle traffic imposes on pedestrians and cyclists.

Walking and cycling health benefits can be monetised by applying the same values per avoided death or injury to diseases reduced by increased physical fitness. Affordability can be quantified by indicating cost savings to lower income users.

Other impacts are more difficult to monetize, but at a minimum should be described and monetized to the degree possible. These include user enjoyment, option value, support for equity objectives, more compact and accessible land use development (smart growth), economic development, improved community liveability, and additional environmental benefits such as habitat preservation

5.8 Marsden Jacob Associates (2009) *Economic feasibility of the Active Transport Policy*

Marsden Jacob Associates (MJA) was commissioned by the Department of Transport and Main Roads (DTMR) in Queensland to conduct an 'Economic Feasibility Assessment of the Active Transport Policy' (ATP). The ATP seeks to significantly increase investment in Queensland in infrastructure required to encourage people to choose active transport (AT) over other types of transport. The term "active transport" refers to the utilisation, or selection, of cycling and walking as the preferred modes of transport over other forms of transport such as private vehicle travel.

The ATP would incorporate the following key elements:

- Improved access for pedestrians and cyclists along applicable State Government corridors (public utility corridors, busways, rail corridors, and State controlled roads);
- Convenient, direct and safe access for pedestrians and cyclists to and within State Government infrastructure (building and public transport stations/stops);
- Ensure that State Government infrastructure buildings and corridors are located near public transport and walking and cycling networks; and
- Provide end-of-trip facilities and mid-trip facilities for cyclists and pedestrians within State Government infrastructure – buildings, corridors and public transport stations / stops.

MJA highlighted a range of potential benefits that investment in AT infrastructure can provide:

- Improving the health of the population, and reducing health costs. Increased cycling and walking assist in reducing physical inactivity – both are recommended activities in National Physical Activity Guidelines for Australians – and hence have significant potential benefits in terms of avoiding the health costs associated with physical inactivity.
- Reducing traffic congestion. The avoidable costs of congestion including private time costs (due to trip delays and variability), business time costs, extra vehicle operating costs (due to higher rates of fuel consumption during congestion) and extra air pollution costs. For Brisbane alone, this translates to a cost of $1.2 billion, which is expected to rise to $3.0 billion by 2020.
- Shifts away from private vehicle use as a result of increased active transport use have the potential to reduce these costs of congestion by around 2% for every 1% modal share shift to cycling and walking.
- Reducing vehicle emissions. As well as greenhouse gas (GHG) emissions, replacing vehicle trips with active transport trips reduces local air and noise pollution – both cycling and walking are significantly quieter than vehicle travel and are non-pollutive.
- Reducing private vehicle operating costs. Shifting from vehicle transport to active transport modes for trips under 5 km has the potential to reduce vehicle operating costs for individuals – including fuel costs and costs associated with registration, repairs and maintenance.

A key outcome expected under the ATP is that it will help the Government achieve the targets espoused under the Queensland Cycle Strategy and the Transport Plan 2007 for active transport. While there is no specific State-wide target for walking, Brisbane City Council's Brisbane Active Transport Strategy: Walking and Cycling Plan 2005-2010 sets cycling and walking targets for Brisbane City of 5% and 12% modal shares, respectively, by 2016

Estimates of the benefits of the ATP

Health benefits, reduced vehicle operating costs and reduced traffic congestion represent the three largest benefit items in dollar terms. MJA's economic model, however, includes the following additional benefits attributable to the ATP:

- Reductions in greenhouse gas emissions estimated at 0.8 cents per vehicle km in 2012 and increasing to 2.4 cents per km by 2040;8 and
- Reductions in localised air pollution valued at 2.45 cents per vehicle km.

MJA has conservatively adopted a health benefits estimate of $0.16 per km despite some studies indicating the benefit from increased physical activity could be as high as $0.38 per km. It was assumed that cycling and walking yielded the same health benefits per kilometre travelled.

Similarly, for the other primary benefit item, reduced traffic congestion, they conservatively estimated that the average avoided cost from reduced traffic congestion would be $0.50 per km (while the academic literature suggests the benefits would be $0.125- $0.89 per km during peak periods in urban areas.

Taking into account the above unit estimates for each of the major benefit streams attributable to the ATP, MJA estimated that the present value (PV) of the future stream of benefits of the ATP, for the 2010-40 period, is in the order of $648-1,296 million.

Table 12 Unit estimates for major benefit streams

Benefit type	Unit benefits
Health	$0.16 per km travelled (walking / cycling)
Vehicle operating costs	$0.25 per vehicle-km in urban areas, $0.20 per vehicle-km in rural areas
Decongestion	$0.50 per car-km
Air pollution reduction	2.45c/vehicle-km in urban areas
GHG reduction	$28 per tonne of CO2-e emissions in 2012, rising to $80 per tonne in 2040
Reduction in noise pollution	0.78c/vehicle-km (urban only)

Health

Benefit of cycling and walking was assumed to be $0.16 per kilometre. This was derived from the Cycling Promotion Fund estimate of $0.376 per kilometre cycled, adjusted down to allow for the reduced benefits of AT to people already active, and assuming that those already active will be more likely to take up AT. It was assumed that cycling and walking yield the same health benefits per kilometre travelled.

Intrinsic value

The benefits associated with 'intrinsic value' are related to 'journey ambience' and enjoyment as well as having a greater choice regarding travel modes. MJA defines journey ambience as a combination of benefits experienced due to user perceptions of safety/stress (fear of potential accidents, route uncertainty), comfort and convenience (i.e. quality and cleanliness of facilities), and environmental quality (i.e. views of surrounding landscape and town/cityscapes).

Investment in various infrastructure improvements, such as street lighting, pavement evenness and benches can all improve journey ambience and provide intrinsic value.

Journey ambience values were assigned on the basis of previous studies, and varied according to the infrastructure and facilities provided. These values were based on publications by the DfT (2009)

Table 13 Journey ambience benefits per kilometre from intrinsic value investment

Infrastructure improvement	Journey ambience estimate
Street lighting	**34p/km**
Reduced crowding	**17 p/km**
Level kerbing	**24 p/km**
Information panels	**8 p/km**
Pavement evenness	**8 p/km**
Directional signage	**5 p/km**
benches	**5 p/km**

Economic Assessment of the ATP

The net economic benefit of the ATP was estimate in net present value (NPV) terms, taking into account the overall economic benefits expected under the ATP and the estimated PV cost for the ATP of $482 million.

The ATP was not at a sufficiently advanced stage in the planning process to enable MJA to conduct a detailed cost estimate of the potential roll out of additional AT infrastructure as a result of the policy. However, MJA used indicative estimates of costs associated with ATP to be in the order of $482 million over a 30 year timeframe. The following components were included in the cost estimate:

- contributions to the cost of new bikeways / pedestrian paths and new bridges / raised structures (PV cost of $185 million);
- roll out of end-of-trip facilities in 30% of Government buildings (selected on the basis of where the benefits in terms of encouraging use of AT are considered to be the highest) (PV cost of $187 million);
- basic / essential mid-trip facilities drinking fountains (PV cost of $5.1 million); inter-modal infrastructure at train stations (PV cost of $0.6 million);

- inter-modal infrastructure at bus stations and stops (PV cost of $5.1 million);
- end-of-trip facilities at Brisbane's 13 major Government buildings (PV cost of $3.8 million); and
- provision for continued investment in AT infrastructure and asset refurbishment after the initial five-year roll out of new infrastructure under the ATP (PV cost of $94.5 million).

Applying base-case parameters the estimated net economic benefit of the ATP is $490 million (NPV) with a benefit cost ratio of 2:1, indicating that the ATP will generate large economic benefits for the State.

5.9 Colin Buchanan (2008) *Thames Pedestrian and Cycle Bridge*

Colin Buchanan and Partners Ltd (CB) were commissioned by Sustrans to conduct an economic appraisal of the proposed Thames Pedestrian and Cycle Bridge linking the Isle of Dogs and the Rotherhithe peninsula. This builds upon a preliminary economic assessment completed by CB in February 2007. The report refers to both cycling and walking modes of transport.

The Canary Wharf Travel Survey 2006 was employed to generate an up-to-date model of journey to work patterns into the Isle of Dogs and future pedestrian and cycle demand for bridge was also forecast. It was estimated that by 2020, the bridge will be carrying 1m pedestrians and 1.6m cyclists annually.

5.9.1 Costs

Ramboll Whitbybird completed a feasibility report in March 2008, including an updated proposal for the structure and location of the bridge, as well as a revised capital cost estimate. The total cost estimate is £171m (2007 prices):

- Capital cost: £107m
- Operating and maintenance cost: £69m
- Operating cost saving (ferry): -£6m

5.9.2 Benefits

Benefits of the bridge have been calculated from journey time savings, health benefits, congestion, relief, environmental factors and regeneration impacts. Total benefits (low case) have been calculated to be £236m. This results in a net present value of the bridge of £66m and a benefit-cost ratio of 1.4:1.

Methodology to forecast demand

A journey to work base model was generated using the Canary Wharf Travel Survey data. On this basis the elasticity of walking and cycling trips to changes in generalised journey time were calculated, and the relative changes in mode share forecast.

User Benefits

Journey time savings

It was estimated that the bridge would produce significant journey time savings for a number of users:

- Current cyclists whose journey time is reduced because they can take a shorter route and, in many cases, avoid Greenwich Foot tunnel which slows down cyclists due to the stairs and requirement for bicycles to be pushed;
- Users of the current ferry service who no longer have to wait to cross the river;
- New pedestrians and cyclists shifting from public or private transport.

Ambience

New pedestrian users will, however, experience a major improvement in journey ambience due to the high quality riverside walking environment and the attractive views from the bridge.

Wider Benefits

Health

Mode shift to walking and cycling generates increased levels of physical activity. This produces wider social benefits in terms of reduced mortality and absenteeism.

These 'per trip' values were 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 was calculated from an annual reduced mortality benefit and an associated annual absenteeism benefit of £32.53 (using the rule of half) prior to the 'per trip' calculation.

A new stand-alone walking trip has a value of £0.36 and £0.08 for each walk to public transport trip, as calculated from DfT.

Congestion relief

Mode shift to walking and cycling has benefits in terms of congestion relief on other modes. The congestion relief from private motor vehicle was valued at £0.40 per km.

Emissions reduction

Walking and cycling are zero-emission modes. Therefore all mode shifts to walking and cycling generate a net emissions reduction. In this appraisal, a £0.016 per km benefit was applied to all car trips that shift to walking and cycling.

Regeneration (economic) benefits

The regeneration benefits of the bridge were illustrated through the increase in employment and population density. The profile of jobs created and the portion of local residents attaining those jobs were multiplied by the average London salary in order to quantify the overall benefits to local residents over a period of 30 years.

Results

The results generated a BCR of 1.4:1, with a majority of the benefits accruing as journey time saving to existing and new users

5.10 Campbell and Wittgens (2004) A Business Case for Active Transportation: the economic benefits of walking and cycling

This study compiled existing research on the economic benefits of active transportation. Much of the report is built upon the work contained in *Quantifying the Benefits of Non-Motorized Travel for Achieving TDM Objectives* by Todd Litman (1999) of the Victoria Transport Policy Institute; it appears that the original Litman report has been superseded and now a similar methodology is referred to in *Evaluating Non-Motorized Transportation Benefits and Costs* (published 5 November 2010)

The current state of both cycling and walking in Canada is presented, including trip distance and time as well as mode share. The potential to increase active transportation is considered, given the climate and prevalence of active transport in various cities around the country.

For the purposes of estimating benefits, the report assumed that a walking trip replaces a driving trip of 1km. Transport related benefits were attributed to reduced congestion, decreased road maintenance, less costly maintenance, increased road safety, health and decreased user costs. The report also considered the wider benefits of active transport, such as social benefits, tourism, retail and property values, however these are not quantified. Social benefits are described as those affected by mode choice and land use patterns; these aspects include increased mobility for the general population, sense of community, reduction in the Barrier Effect and improved liveability.

The report estimated the benefits of active transport to Canada at its current mode shares of 6.6% and 1.2% for walking and cycling, respectively. The pre km benefits discussed below were multiplied by the total distance walked and cycled to generate a current value of cycling, walking and all other active transport in Canada. The benefits from increasing mode share to 10.4% and 4.8%, which would be equivalent to Victoria (the province with highest active transport participation) were also monetised.

The methodology and parameter values applied are discussed below

Congestion costs

Reference was taken to the estimated cost of congestion in Greater Montreal, Toronto and Vancouver, which totalled more than $3 billion per year. It was assumed that cycling and walking cause little congestion and the congestion value per km from Litman (2010) equal to $0.02 per mile was applied to a walking trip of 1 km to generate a benefit of $0.036 per km.

Roadway cost savings

Roadway costs were assumed to include the public expenditures of adding new road capacity, maintaining roads and safety enhancements to roads. The costs paid by road users through tolls or gas taxes were not included in this segment.

It was assumed that roadway costs would decline with a shift to non motorised transport due to the lightweight nature of bicycles and smaller space requirements per bicycle.

A weighted average of roadway cost savings assumed that 60% of trips are urban with 33% of those occurring during peak times (based on Litman 1999), and was presented as a combination of urban peak, non-peak and rural benefits, equalling $0.023 per km.

Road savings

The economic costs of collisions, estimated using data from Transport Canada, include those from medical expenses, vehicle and property damage, pain, suffering and loss of life. It was assumed that a switch to active transport would reduce collision costs, and the increased presence of cyclists would increase the awareness of drivers.

A weighted average value of road safety savings (based on Litman) was presented as a weighted average of urban peak, non-peak and rural, equalling $0.045 for a 1 km walking trip

User cost savings

The cost of active transport was estimated to be $0,01 per km, with a per km walking trip weighted average user saving of $0.298.

Parking Cost reduction

The cost of constructing a bicycle parking spot was assumed to be 5% of that for a car, while there is no cost for a pedestrian.

The weighted average benefits from the reduction in parking costs (based on Litman) were listed at $0.636. Urban peak parking cost savings were valued at $2.285, compared to non-peak values and rural values of $0.381 and $0.076 respectively. This highlights the high value of parking in urban areas during peak times of travel – the greatest benefit from reduced parking fees due to increased active transport would occur at this time.

Environmental Benefits

The environmental benefits were been separated into Greenhouse Gas emission reductions, air pollution reduction, noise reduction and water quality improvement.

The benefits relating to Greenhouse Gas emission reductions were derived using a predicted cost of Carbon Dioxide ranging from $10 to $50 per tonne. According to the Government of Canada, a price close to $10 is assumed, and used to generate a value of Greenhouse Gas reduction of $0.005 per km walking trip

While Greenhouse Gas reductions relate to Carbon Dioxide emissions, air pollution is generally associated with other pollutants, including Nitrogen oxides. Carbon monoxide, Sulphur Dioxide, particulate matter and other air pollution. The per km air pollution reductions from active transport are large because the shorter automobile trips emit proportionately more. The weighted average (base on Litman 1999) was assumed to be $0.052 per walking km.

Noise reduction is important in urban areas, where there is high sensitivity to noise, particularly on residential streets in the early morning. The weighted average benefits of reduction in noise were estimated at $0.018 per km walked.

Motor vehicles are assumed to be a major source of water pollution and hydrologic disruptions. The weighted average cost of water pollution was assumed to be uniform among urban peak, non-peak and rural periods and was estimated at $0.02 per km walked.

Although not quantified, the benefits from reduced land requirements were also discussed. The reduced need for roads may have benefits ranging from more greenspace to more land available for residential developments.

Health Benefits

Campbell and Wittgens discuss that those who use active transportation are likely to engage in other forms of activity, thus the benefits of physical activity will not be entirely attributed to walking. It was estimated that an average of 41% of an individual's activity can be attributed to walking if they walk for transportation purposes. A 1% increase in activity was assumed to result in a savings of $28 million in direct health care costs. Hence, the portion of physical activity attributed to walking was multiplied to the total savings from an increase of 1% in physical activity to generate a total estimate of the value of walking.

Gaps in research

The report concludes with a description of gaps in data. While many of these are specific to Canada, the issue of tracking non-commuting trips was raised. It was suggested that census commute mode share numbers are likely to understate the true levels of active transportation as non-commuting trips are more commonly undertaken using active transport.

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