The Cost of Cycling

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sustainability in travel, energy and climate

Abstract
This paper estimates the cost of cycling, on a basis that is directly comparable with common estimates of car operating costs. A bicycle is cost-effective if it is purchased in place of a car. Its standing costs are around 5% of those of a car, and its running costs, per kilometre for respective average distance travelled, are similar to those of a light car. However, the average Australian adult bicycle travels only about 12 km per week. As a result, its overall operating cost per kilometre is comparable to that of a small car. As a supplement to the use of a small car, a bicycle is cost-effective only if it substitutes for more than 12 km per week of car travel.

Significant issues for bicycles include the cost of scheduled maintenance, and frequent requirements for unscheduled maintenance.

The paper briefly discusses the implications of these results for bicycle purchasers, for the bicycle industry, and for travel demand management programs.

1 Introduction

People purchase and ride bicycles for a variety of reasons, including the belief that a bicycle is cheap to own and cheap to use.

The costs of motoring are well known and frequently publicised. In contrast, the costs of cycling are not well publicised.

The Australian National Cycling Strategy 2005-2010 (Austroads, 2005, esp. p.12), surprisingly, provides more precise estimates of car operating costs than of the costs of cycling. Car operating costs are estimated at between $5,652 and $16,314 a year, while cycling costs are "around 1% of the cost of buying and maintaining a car".

This paper addresses this information gap, by estimating the cost of cycling on a basis that compares directly with common estimates of car operating costs. The results show that the purchase price and standing costs of a bicycle are around 3% of those of a car, and its running costs are around two-thirds those of a small car. However, because the average bicycle travels much less distance than the average car, its total operating cost, per kilometre, is comparable to that of a small car.

Shayler, Fergusson and Rowell (1993) have estimated the cost of cycling in the UK. The assumptions underlying that estimate are not necessarily current in 2007, nor appropriate for Australian conditions.

2 Methodology

The primary methodology for this paper is that used by the Royal Automobile Club of Victoria (2006) to calculate car operating costs. This method takes into account:

- average distance travelled;
- loan costs, for a five year private loan on a new vehicle;
- a range of popular models;
- depreciated value at five years;

- annual interest, registration and RACV membership costs; and
- fuel, tyre and scheduled and unscheduled servicing costs

2.1 Limitations of the Methodology

This paper focuses on adult cycling - in part for reasons of data availability, and in part because there is little value in comparing car driving costs with cycling costs for children (who do not have the option to drive).

This paper also focuses on direct costs. rather than indirect or social costs. However, some indirect costs of cycling are included - public liability insurance, for example, covers at least some of the indirect costs of cycling. Similarly, some of the indirect costs of motoring are included through fuel tax and insurance.

The Centre for International Economics (2005) estimates the social costs of congestion, emissions, accidents, air pollution and subsidies for road traffic authorities to be over 40 cents per vehicle km. This is comparable to the direct cost of motoring. Other indirect costs include the cost of land (e.g. garage and driveway space) for vehicle parking. There can also be indirect benefits from transport, such as the health benefits of exercise from cycling or walking. These social and indirect costs and benefits are appropriate topics for further research and may be significant also for bicycle travel. However, they are largely outside the scope of this paper.

The RACV methodology also ignores the cost of the time required to own, maintain and use a vehicle. This includes not only travel time, but also the time required to park the vehicle and walk to and from the parking space, to refuel the vehicle and to deal with maintenance, and also the time spent working to earn the money to buy and operate the vehicle. Paul Tranter's "Effective Speed" paper (Tranter, 2004) considers the time issue in greater detail.

The methodology ignores some of the indirect costs of unreliability. When a vehicle breaks down, it can cause inconvenience costs in terms of the need to rearrange journey plans, and in terms of the consequences of a late arrival or failure to arrive.

The methodology over-prices standing costs, relative to running costs. It considers only the first five years of ownership, when depreciation is high and maintenance costs are relatively low. Since the average age of Australian registered passenger motor vehicles is 9.8 years (Australian Bureau of Statistics, 2006a), the average life span of cars would approach twenty years. During the new car warranty period of between one and five years, unscheduled maintenance is in effect a standing cost included in the purchase price. After the end of the warranty period maintenance becomes a running cost.

Many cyclists minimise their monetary costs by doing their own maintenance - for example, by repairing punctures themselves rather than having them repaired at a bike shop. This does not mean that they do not incur maintenance costs, but rather that they incur them in the form of the cost of the time taken to learn and apply maintenance skills, rather than as the monetary cost of paying for others to learn and apply these skills on their behalf.

3 Average Distance Travelled

Each week in Australia, on average, an adult bicycle travels 12 km and an adult cyclist travels 37 km. This anomalous result arises from the fact that Australia has more adult bicycles (estimated below at 4.9 million) than its 1.65 million adult cyclists (Australian Sports Commission, 2005). When averaged over adult cyclists and adult non-cyclists, Australians cycle an average of 197 km per year. In comparison, the average car travels 14,800 km per year (Australian Bureau of Statistics, 2005b) or 284 km per week.

Austroads (2005) provides bicycle ownership rates for Australia's six largest capital cities. A national ownership rate of 0.39 bicycles per person can be estimated by weighting these rates according to population. With a national population of 20.092 million at June 2004 (Australian Bureau of Statistics, 2006b), the total number of bicycles is estimated to be 7.8 million.

The National Cycling Strategy also provides figures for the proportion of the population of the larger capital cities who cycle on the average day. From these figures it is estimated that there are 151 million "cycling days" per year. This suggests that the average bicycle is used on 19 days each year - just over once every three weeks.

A more direct estimate of trip numbers can be obtained from the Australian Sports Commission's Participation in Exercise Recreation and Sport surveys. According to the 2005 annual report, 1.65 million Australian adults cycled in 2005. The mean participation frequency was 89 occasions per year (Australian Sports Commission, 2005). This implies a national total of 148 million adult trips per year.

According to the Cycling Promotion Fund (2006), adult bicycles comprise 753,843 (i.e. 62%) of 1,209,000 total annual bicycles sales. If adult bicycles also comprise 62% of Australia's estimated 7.8 million bicycles, then Australia has 4.9 million adult bicycles.

4 How Many Bicycles? How Many Cyclists?

There is a discrepancy between the number of bicycles and the number of cyclists - there appear to be three bicycles for every cyclist. Also, the data indicate that the average adult bicycle is used on only 19 days per year, while the average adult cyclist cycles on 89 occasions per year.

These apparent discrepancies could result from a combination of factors such as:

- some of the assumptions behind these estimates are of limited accuracy - e.g. the assumption that the ratio of adult to children's bicycles is the same for existing bicycles as it is for bicycle sales;
- some cyclists own more than one bicycle; and
- some bicycle owners are not active cyclists.

Investigation of these discrepancies could be the subject of further research.

5 Participation in Exercise and Sport

Participation in Exercise Recreation and Sport (Australian Sports Commission, 2005) provides aggregated data on the frequency and duration of participation in exercise and sport. Using reasonable assumptions (eg that where the duration of exercise sessions is stated as between two and five hours, the average duration can be assumed to be the mid-point of two and five), the average duration of participation is estimated to be 1.25 hours per session. At an average speed of 17 km/h (the average speed recorded by the author when managing the Australian Greenhouse Office bicycle fleet), the average distance travelled per session is 21 km and the total distance travelled each year by the average Australian adult cyclist is 1,907 km. This is equivalent to 644 km per adult bicycle.

6 Depreciated Value at Five Years

Depreciation is addressed in this paper by assuming, in effect, that the initial cost of a new bicycle is reduced by 23% through trading-in a 5-year-old bike. Although this is a crude method of calculating depreciation, the author believes that errors inherent in the assumed depreciated value (and the range of variability in the price of new bicycles - see below) will outweigh any errors resulting from the depreciation methodology.

The RACV bases the depreciated value of a car on the predicted trade in value of the vehicle in average condition as determined by Glass's Future Values. Comparable information on future bicycle values is not available.

The average life of an adult bicycle can be estimated at 6.5 years, by dividing the adult bicycle population of 4.9 million by the annual new adult bicycle sales figure of 753,843. The average age of bicycles is about half the average life – i.e. around 3 years. In comparison, the average age of registered passenger motor vehicles is 9.8 years (Australia Bureau of Statistics, 2006a).

Based on linear depreciation to zero at 6.5 years, the depreciated value of a bicycle at five years is 23% of its initial price. This is a lower depreciation estimate than would be obtained using compound depreciation.

7 Loan Interest Costs

Annual debt repayment for a bicycle is estimated to be $150, as follows:

- the average retail price of an adult bicycle is $730. Seventy per cent of adult bicycles sold in Australia are mountain bikes with an average retail price of $535, 19% are comfort/city/hybrid bikes ($548) and 11% are road bikes ($2,212) (Cycling Promotion Fund, 2006);
- the minimum additional cost is $20 for a bicycle helmet, which is legally required for road riding. Accessories - pumps, lights, mudguards, carrying racks, saddlebags, backpacks, specialised clothing etc. - can add as much as $1,000 to the bicycle's set-up cost;
- the initial cost of an average bicycle and accessories is conservatively estimated at $800. After allowing for a trade-in (see the discussion above under "depreciated value"), the initial debt reduces to $617; and
- loan repayments are based on an interest rate of 8.49%, with monthly repayments over five years. A loan application fee is not included for a bicycle on the assumption that, being relatively inexpensive, a bicycle does not require a separate loan. This assumes in effect that bicycles extend existing debt rather than creating new debt.

8 Periodic Registration, Licence and Motoring/Cycling Association Membership Costs

These costs are estimated at $49.50 per year.

Bicycles do not require a driver's licence or third party insurance. Nor do they incur registration costs.

Personal accident costs for cars are covered by compulsory third party insurance. Personal accident costs for bicycles can be covered through personal accident cover, which can be obtained through membership of a cycling organisation such as Bicycle Victoria. Bicycle Victoria membership costs $99 per year for a couple ($49.50 each).

No estimate is included for the bicycle equivalent of comprehensive car insurance. Many household insurance policies provide bicycle theft coverage, at no additional cost.

9 Scheduled Servicing Costs

For bicycles, scheduled servicing is treated as a standing cost of $75 per bicycle per year. This treatment is different from that for cars, where servicing is treated as a running cost.

For bicycles that travel large distances (more than 70 km per week), scheduled service intervals would depend primarily on distance travelled, and it would be appropriate to treat scheduled servicing as a running cost of 3.8 cents per km.

Few bicycle manufacturers specify servicing schedules for their bicycles. One Cycling Promotion Fund member recommends servicing every 25 hours of on-road use (Felt Racing, 2004) (i.e. 850 km, if at an average speed of 17km/h) while another recommends a $50 6-month/3,000 km service and a $130 annual/5,000 km service (Abbotsford Cycles, 2007). Transport for London recommends that pool bicycles be serviced every three months or every 500 km (Transport for London, 2006).

10 Running Costs - Fuel, Unscheduled Servicing and Tyres

These running costs are estimated at 10.5 cents per km - 5.4 cents for fuel (food), 3.8 cents for unscheduled servicing, and 1.4 cents for tyres.

If maintenance is included as a running cost, for bicycles that travel more than 40 km per week, the standing cost is reduced by $75 per year ($1.44 per week) and the running cost increases to 14.3 cents per km.

10.1 Fuel (Food) Costs

In 2003-04 the average Australian household of 2.53 people spent $153 per week on food and non-alcoholic beverages (Australian Bureau of Statistics, 2005a). This equates to $8.62 per person per day.

For a person who neither gains nor loses weight, food energy intake is proportional to energy expenditure. Energy expenditure, in turn, is a function of activity. Very light activity, such as driving, results in an energy expenditure 1.5 times the Resting Metabolic Rate (RMR). Light activity, such as walking, expends energy at 2.5 times the RMR, while cycling expends energy at 4 (slow) to 10 (race pace) times the RMR (Manore, M and Thompson, 2000, Table 6.2, p. 138). A typical person might have a daily average metabolic rate of 1.375 times the RMR.

If on any given day that person spends 1 hour per day cycling at 17 km/h at an average of 5.0 x RMR instead of driving at 1.5 x RMR, then their average daily metabolic rate rises by 11% to 1.52 x RMR. This would increase food costs by $0.91, or 5.4 cents for each km cycled.

10.2 Unscheduled Servicing

The most common form of unscheduled service requirement for a bicycle is a flat tyre. The Australian Greenhouse Office bicycle fleet experienced flat tyres at an average interval of 400 km, during the two years when it was managed by the author . At a repair cost of $15, flat tyres represent an unscheduled servicing cost of 3.8 cents per km.

10.3 Tyres

A pair of bicycle tyres is estimated to cost $70 and to last for five thousand km. On this basis, the cost of tyre replacement is 1.4 cents per km.

11 Findings

The average total cost of operating a bicycle is $6.78 per week, or $0.53 per km.

Standing costs of $5.26 per week ($0.43 per km) are much greater than average running costs of $1.52 per week ($0.11 per km).

Table 1 shows the costs of cycling, expressed in weekly terms. Table 2 shows the same costs in terms of cents per km. These costs are shown graphically in Figure 1.

Table 1 Weekly bicycle operating costs

Item	Cost ($)
Loan repayment	2.88
Scheduled servicing	1.44
Cycling organisation membership	0.95
Food (fuel)	0.88
Unscheduled repairs	0.46
Tyres	0.17

Table 2 Bicycle operating costs (cents per km)

Item	Cost (cents/km)
Loan repayment	23.3
Scheduled servicing	11.6
Cycling organisation membership	7.7
Food (fuel)	5.4
Unscheduled repairs	3.8
Tyres	1.4

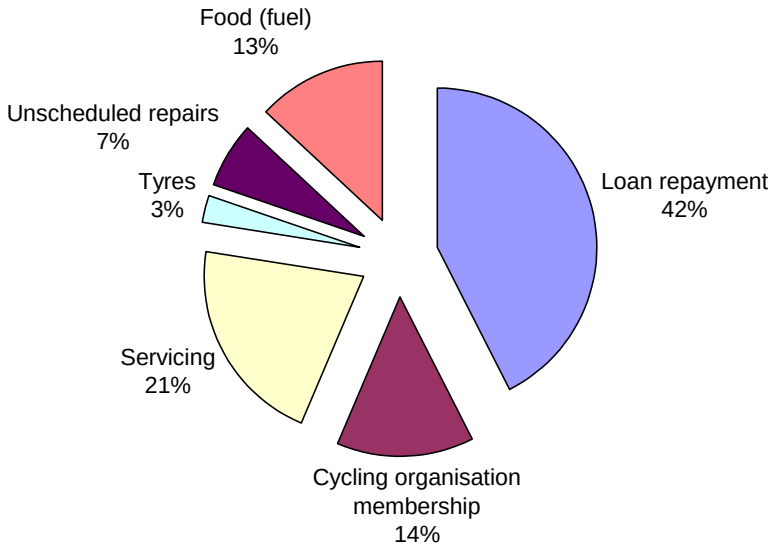

Figure 1 Pie chart representation of bicycle operating costs

11.1 The Distance Effect

The cost of cycling, per km, varies inversely with distance travelled (see Figure 2). At distances of less than 5 km per week, the operating cost is over $1 per km. At 12 km per week (the distance travelled by the average bicycle), it falls to 53 cents per km and at 37 km per week (the distance travelled by the average adult cyclist), it falls to 25 cents per km.

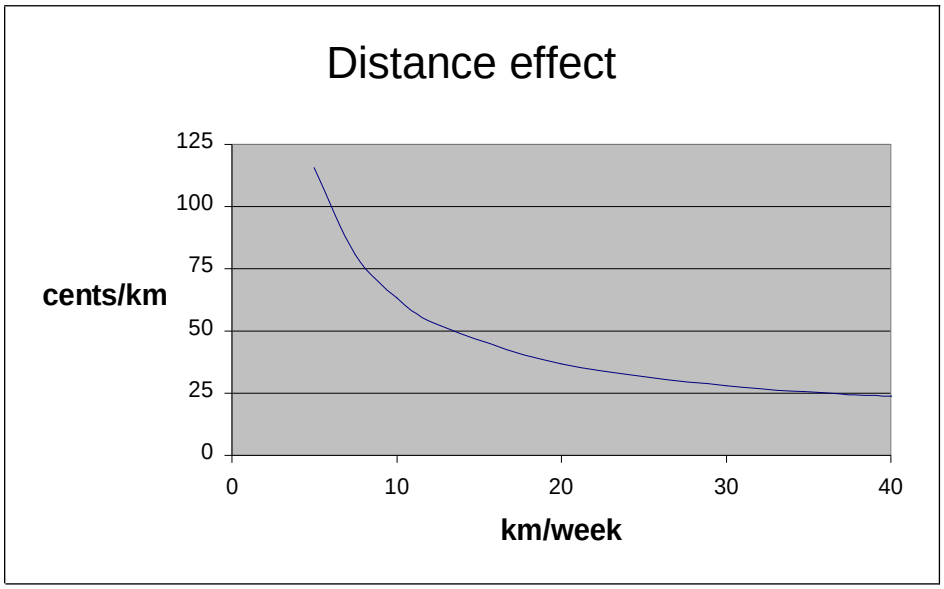

Figure 2 The distance effect on the cost of cycling

12 Relative Costs of Driving and Cycling

According to the RACV (2006), the list price of a typical small car is $23,000, its average weekly standing cost is $107, its running cost is 16 cents per km and its total operating cost is 53 cents per km. A smaller "light" car has running costs of 13 cents per km, and a medium car has running costs of 18 cents per km.

The weekly costs of travel by bicycle and by small car are compared in Figure 3.

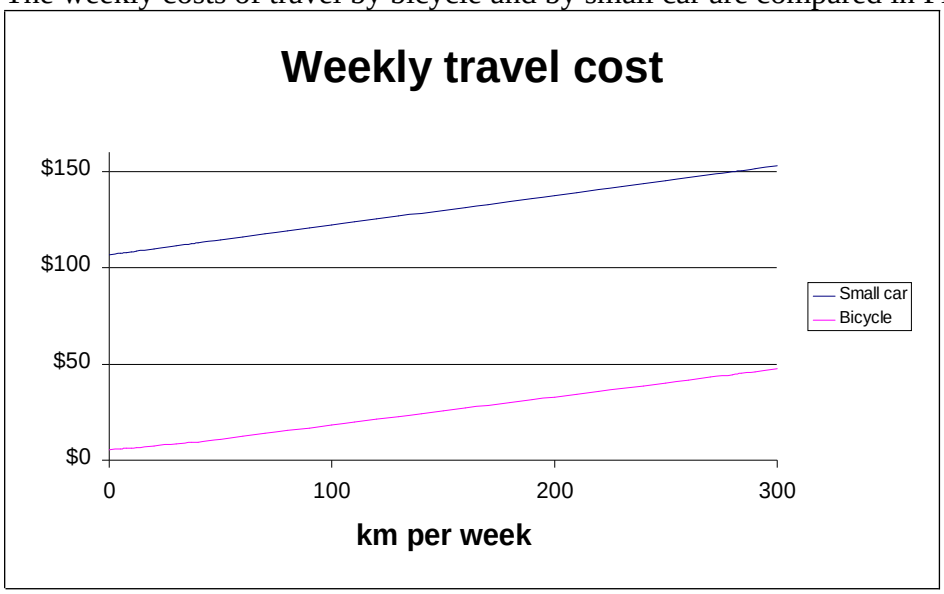

Figure 3 Weekly travel costs

For any given distance, a bicycle is cheaper to run than a car. However, because of the distance effect (discussed above) and the fact that the average car travels almost 300 km per week compared with only 12 km per week for the average adult bicycle, the average operating cost of a bicycle is the same as that for a small car for their respective average weekly distance travelled. This is shown in Figure 4.

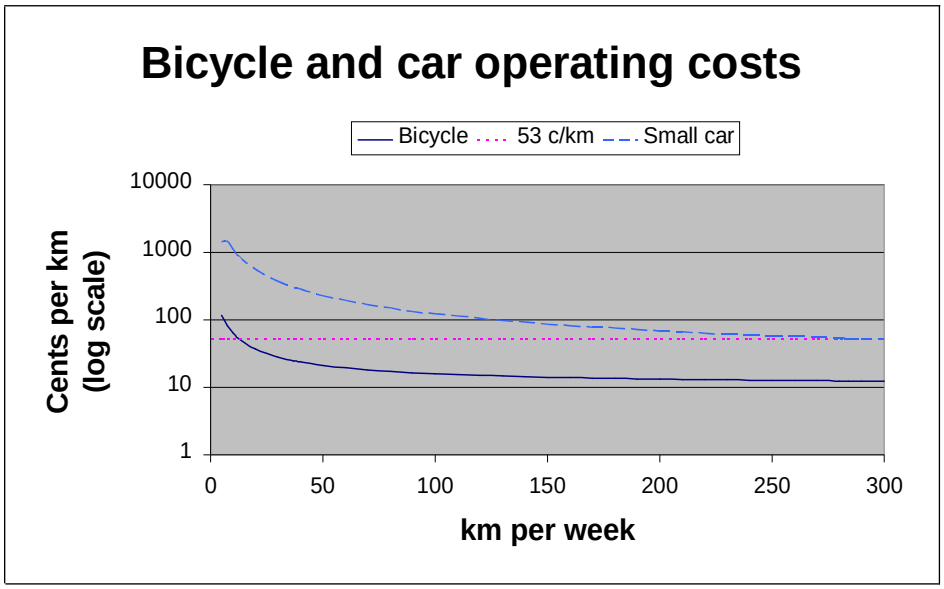

Figure 4 Bicycle and car operating costs

It is interesting to note that, if two people travel together on two bicycles, then the running costs double from 11 cents per km to 22 cents per km. This is greater than the 18 cents per km running cost of a medium car.

13 Implications for Bicycle Purchasers

13.1 Bicycle or Car?

Saving money is one of the many reasons why people choose to buy a bicycle.

If the choice is to either buy a car or to buy a bicycle, a bicycle is both cheaper to buy and cheaper to run.

The financial benefits of a bicycle depend primarily on how much the bicycle is used.

If you already own both a car and a bicycle, then riding the bicycle will save you up to seven cents per kilometre, depending on the size of your car.

If you already own a large car, purchasing a bicycle is cost-effective if you ride it more than 7.5 km per week.

At 12 km per week - the distance travelled by the average bicycle - purchasing a bicycle is cost-effective compared with using a medium or large car, and cost neutral compared with a small car.

If you already own a light car, purchasing a bicycle is cost-effective if you ride it more than 20 km per week.

13.2 Minimising Standing and Running Costs

Bicycle purchasers can minimise their standing costs by buying the least expensive bicycle that meets their needs, has an adequate service interval (e.g. preferably more than one year or 1,000 km), has low rolling resistance and wind resistance, and has adequate puncture resistance.

Puncture resistance can be improved by, for example, kevlar-belted tyres, thorn-proof tubes, tyre liners or liquid tube sealants.

Fuel (food) represents more than half the running cost of a bicycle. Cyclists can minimise food costs (and personal effort!) by reducing the amount of food energy needed to travel from A to B. This can be achieved by minimising rolling and aerodynamic resistances.

Cyclists can reduce their food requirements by using low rolling resistance tyres and inflating them to the maximum recommended pressure. Rolling resistance is largely determined by tyre pressure. High pressure tyres reduce pedalling effort by up to 25%, compared with medium pressure 50 psi tyres. Knobbly mountain bike tyres have higher rolling and wind resistances than smooth road tyres.

Wind resistance can be minimised through riding more slowly, through adopting a more aerodynamic riding position (which may be subject to comfort considerations), and through the use of aerodynamic fairings, smaller wheels and/or recumbent bicycles.

Hadland (1982, p.121) reported test results in which a bicycle with 17 inch wheels had a 6% lower power requirement than a similar bicycle with 27 inch wheels. This can be at least partly explained by the smaller area swept by the spokes. At the top of their travel, spokes are travelling almost twice as fast as the speed of the bicycle. Since wind resistance is proportional to the square of speed, reducing the swept area of spokes will reduce wind resistance.

A one kilogram reduction in bicycle weight reduces pedalling effort by less than 1% (Derived from Hadland (1982) pp. 120-121).

14 Implications for the Bicycle Industry

The bicycle industry has some scope for action to reduce the costs of cycling.

The largest component of the scheduled servicing cost is labour. If service intervals increase, then service costs are decrease. Service intervals can be increased through improved equipment selection and design. Since the 1970s, car service intervals have increased from 5,000 km to 15,000 km. If the service interval for a bicycle increases from one to two years, its total operating cost falls by ten per cent.

Unscheduled repairs are not only a financial cost but also an annoyance and a deterrent to bicycle use. The frequency and cost of unscheduled repairs - principally flat tyres - can be reduced by providing puncture-resistant technologies as original equipment. In 5,000 km, a car is unlikely to require unscheduled servicing, while a bicycle will require unscheduled servicing about 12 times. The unscheduled service interval for the Australian Greenhouse Office bicycle fleet in 2005-06 was 400 km. The NRMA (National Roads and Motorists Association, 2006) has 2 million members and in 2006 attended more than 1.5 million stranded motorists. At 15,000 km per member per annum, this represents an average of around 11,000 km between unscheduled service calls.

Although modern bicycles have mechanically efficient drive trains, there is scope for reducing the fuel (food) cost of cycling by reducing rolling resistance and aerodynamic drag.

Most road bicycles use low rolling resistance tyres, but mountain bikes and some "comfort" bicycles use low pressure, high rolling resistance tyres. Aerodynamics can be improved by greater use of aerodynamic fairings and smaller wheels.

Aerodynamic fairings have long been permitted in motorcycle racing. As a result, they have become standard on many sport and touring motorcycles. Small wheels, bicycle fairings and recumbent bicycles offer reduced wind resistance, and are legally permitted on Australian roads. Their benefits would become more apparent if they were also permitted in bicycle

racing. New bicycle and bicycle accessory markets could be opened up if cycle racing rules were made more consistent with the Australian Road Rules.

15 Implications for Travel Demand Management Initiatives

Travel demand management initiatives often use financial arguments to encourage people to leave their car in the garage and to cycle instead.

This analysis shows that the savings from this approach are less than seven cents per km. For a person who already owns a car, buying a bicycle can actually increase overall travel costs if it displaces less than 12 km of car travel per week.

Much more significant savings – in excess of $100 per week – can be obtained through avoiding the purchase of a car (whether it be a "first" car or an additional car).

For a person to decide not to purchase a car, they need to be confident that their travel needs can be met without owning an additional car. A bicycle can be used to meet some of those needs, but it need not meet all of them. A complete car-substituting travel solution might include not only a bicycle, but also taxis, aeroplanes, public transport, walking, car sharing and car rental.

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