23rd Australasian Transport Research Forum
Perth, Western Australia 29 September – 1 October 1999

A Cost Benefit Analysis of Travel Blending

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Abstract

Travel Blending is a recently developed technique aimed at reducing the impact of the car Travel diaries are used to observe a household's travel patterns, with customised changes then suggested to the household which would reduce the impact of its car use. A number of Travel Blending trials in Adelaide, South Australia, over the past 3 years have shown very promising results. The Adelaide initiative has consisted of two trials of 100 and 329 households, and a further 900 household trial currently being undertaken in the Adelaide suburb of Dulwich.

This paper reports the results of an economic cost benefit analysis of the Travel Blending initiative. Using the travel reduction results from the 329 household Adelaide trial, an analysis is undertaken of the 900 household Dulwich trial The quantified benefits consist of travel time savings, vehicle operating cost reductions, accident savings, environmental benefits and network congestion reduction benefits The cost analysis includes consideration of initial survey costs, follow up costs which might be required on annual and 5 yearly cycles, and any costs incurred by the household The paper reports net present value and benefit cost ratio results for a range of input parameters scenarios

The paper also attempts to extrapolate these results to the case where Travel Blending might be applied on a city wide basis in Adelaide.
The overall conclusion that the paper draws is that Travel Blending appears, at least on the basis of the analysis reported here, to be a sound initiative and investment from an economic cost benefit perspective

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Introduction

In recent decades, the level of concern about the impact of the motor car has steadily increased, with travel demand management being a regularly advocated response strategy (e.g. see Austroads 1995). A recent addition to the travel demand management toolkit is the concept of travel blending. Travel blending was developed by Steer Davies Gleave and Monash University for the NRMA as a tool for reducing car pollution prior to the 2000 Sydney Olympic Games (Steer Davies Gleave, 1997, p1). It has since undergone further trials in Adelaide to further develop and assess the technique with the aim of reducing the impact of the car (Ampt and Rooney, 1998).

To date, travel blending has demonstrated considerable potential for reducing car travel (Ampt and Rooney, 1998). Given this, it is important to assess the viability of the concept from a formal evaluation perspective. Whilst an indicative benefit cost calculation was done after initial stages of travel blending, to date no formal evaluation has been undertaken. The purpose of this paper is to commence to fill this gap by undertaking an economic cost benefit analysis of travel blending as it is being applied, and could be applied, in Adelaide.

The travel blending initiative in Adelaide

The travel blending concept

Travel blending (Ampt and Rooney, 1998; Steer Davies Gleave, 1998, 1997, 1996) is a diary based household interview system in which participants receive personalised feedback about their travel patterns, with the aim of identifying ways in which the household can reduce their level of car usage.

Travel blending reduces car use in four ways (Ampt and Rooney, 1998, p.808):

1. thinking about activities and travel in advance
2. blending modes (i.e. sometimes car, sometimes walk, sometimes public transport)
3. blending activities (i.e. doing a range of things in/on the same place/journey,)
4. blending over time (i.e. making small sustainable changes over time).

Travel blending is therefore broader than simply switching modes. Its key aspect is that it encourages participants to think about their travel decisions by the introduction of short term goals that are compatible with peoples' lifestyles and therefore sustainable over the longer term.

Outcomes of travel blending trials in Adelaide to date

Two stages of travel blending have already been undertaken in Adelaide, with a third currently under way.

Stage 1, pilot study: A study of 100 households revealed very promising results, with average reductions across households approached of 14% in trips, 11% in vehicle kilometres and 19% in hours of car travel.

Stage 2, expanded sample: A larger study of 329 households produced average reductions of 15% in car driver trips, 8% in car passenger trips, 17% in vehicle kilometres and 10% in hours of car travel across the household sample.

Stage 3, the Dulwich study: The third study, being conducted in 1999 in the Adelaide suburb of Dulwich, has a much larger sample size (900 households) It is this study which is the focus of the cost benefit analysis discussed in this paper since its more significant sample size, and geographic sample concentration, is likely to allow a better indication of the benefits and costs of travel blending

Unfortunately, travel reduction results for the Dulwich exercise were not available at the time this evaluation was undertaken For the purpose of the cost-benefit analysis, it has been assumed that the percentage travel reduction (vehicle kilometres and hours spent travelling) in the 329 household stage 2 trial would also apply in the Dulwich case.

Overview of benefits

There are both private and community benefits which result from travel blending Private benefits accrue to travel blending households, whereas community benefits accrue to the broader community

Benefits quantified and valued

The benefits quantified and valued in this analysis are:
Private benefits (those that accrue to the travel blenders)
- Travel time savings
- Reduced vehicle operating costs

Community benefits
- Accident cost reductions
- Network travel time savings (due to reduced congestion)
- Pollution Reduction

Reduced travel will result in fewer road accidents, benefiting the community generally and reducing a range of social costs. Network travel time saving benefits exist since travel reduction by travel blenders benefits other users of the road network through reducing the level of road congestion, thus reducing everyone's travel times

The reduced travel by travel blenders will also reduce greenhouse impacts, local air pollution, noise and water pollution. Pollution reduction benefits were limited to the direct reduced pollution impacts of travel blending vehicles (- it was assumed that any reduced network congestion would not significantly impact on pollution levels).

Intangible benefits

Arguably there are also some other intangible benefits For example:

- Increased fitness from more walking and cycling
- Utility gained by travel blenders by helping a good social cause
- Reduced community severance.

Given the difficulty in quantifying these, they have not been formally included in the quantitative analysis which follows. They should not be forgotten however

Household costs, gross and net private benefits, and total benefits

The private benefits listed above are *gross* private benefits In analysing the overall value of travel blending, *net private benefits* need to be assessed, i.e. gross private benefit minus the "household" costs experienced by travel blending households (see further discussion later)

Finally, the total benefits used to calculate cost benefit results is the sum of net private benefits and community benefits

Gross private benefits

Travel time savings

Travel time savings are the reduction in travel time that result from travel blending. The value of travel time savings are given by the following formula:

Annual Travel Time Savings = initial travel hours/wk/hh
  * *% reduction in travel hours*/100 * *effective number of hhs* * 52 wks/yr
  * *value of travel time savings/hr* (1)

where *hh* denotes household;

*effective no. of hhs = households approached * penetration rate* (2)
households approached = 900
penetration rate (% of hhs approached which end up completing two diaries)
= *acceptance rate * completion rate*
acceptance rate = % of hhs approached which participate in travel blending
completion rate = % of participating hhs which complete two diaries

The parameters were derived as follows:

- From the 329 hh survey, the initial travel hours were 6.29 hrs/wk/hh, and there was a 10 % reduction in hours travelled.
- From the 329 hh survey, an *acceptance rate* of 0.925, and a *completion rate* of 0.76 were used, yielding a *penetration rate* of 0.703 (i.e. 70.3%) and therefore an *effective number of hhs* of 900*0.703 = 633

- Two *values of travel time savings* (*VTTS*)/hr were needed in the analysis. Both values were derived as weighted averages (Transport SA, 1998, Appendix D.4, based on standard AUSTROADS *VTTS* values). The first value, used to value the time savings of travel blending households, was weighted across private and business car travel and across all time periods. The second value, used to value road network time savings, was weighted across all vehicle types (private and business car, plus light and heavy commercial vehicles) and across peak and inter-peak periods. The resulting average weighted *VTTS* values were $9.75/hr for valuing household time savings, and $12.85 for valuing network time savings.

Vehicle operating cost reductions

Reduced car use due to travel blending produces lower operating costs for travel blending households. Vehicle operating costs were considered as two components: fuel used, and other vehicle operating costs (Transport SA, 1998, Appendix D1-D2). The latter includes both fixed vehicle costs and variable operating costs (wear on tyres, oil used, depreciation and maintenance (servicing)).

Vehicle operating cost reductions were calculated using the following formula:

Annual Vehicle Operating Cost Reduction = initial vehicle-kms of travel/wk/hh
    * *% reduction in veh-kms*/100 * *effective no. of hhs* * 52 wks/yr
    * (*fuel cost/litre* * *fuel consumption/km* + *other veh op costs/km*) (3)

The unit (resource) cost parameters used were:

- *fuel cost/litre* = 35.4 c/litre (Transport SA, 1998, Appendices D1-D2)
- *fuel consumption/km* = 0.115 litres/km (Bray and Tisato, 1997, p.613)
- *other vehicle operating costs/km* = 11.9 c/km (Bray and Tisato, 1997, p.613).

Household costs and net private benefits

As discussed earlier, it is net (rather than gross) private benefits which are relevant to evaluating the merits of the travel blending scheme, where net private benefits are gross private benefits less household costs.

Travel blending households could experience a number of "household costs", e.g.

- Time spent completing the travel blending diaries during the survey
- Time required to plan travel and transport under travel blending
- The delaying of trips so as to share transport and/or trip chain
- Any other inconvenience incurred (compared to the pre travel blending situation)

It is not possible to estimate the size of these household costs from the information currently collected in the travel blending surveys. Household costs were therefore taken into account by considering a number of interesting cases about the possible size of household costs relative to gross private benefits. The cases are as follows

1. *Zero household costs*: The case where household costs are zero (or very small). As a result, the net private benefits for all participants are equal to their gross private benefits.

2. *Large Household Costs*: Household costs are now assumed to be large - almost as big as gross private benefits, making net private benefits very small, in fact almost zero. Thus households only just benefit from participating in travel blending, but do participate because the net private benefit to them is still positive. The overall primary benefit of the scheme would then effectively be limited to the community benefits.

3. *The Half Way Case*: In reality, gross private benefits and household costs are likely to vary across participants, and thus net benefits will vary across households. The fact that not all households approached participated in travel blending suggests that at least one of those that did participate are at the margin. Being at the margin means that, for that household, their net benefit will be close to zero, with gross benefit and household cost approximately equal. In contrast, the household which gains most will be the one with the highest gross private benefits and zero household costs, and thus net private benefits equal to gross private benefits. In line with the "rule of half" in economics, we assume that net benefits of other households are distributed evenly between these two extremes, the overall benefit will therefore be half of that in case 1.

Qualitative information from interviews held with travel blending participants suggest that different households gained to differing degrees from participating in the exercise, and some households found they made significant overall gains (Steer Davies Gleave, 1998). This tends to preclude case 2 discussed above. It is also unlikely that no household is at the margin (as in case 1 above), otherwise more households would have agreed to participate. The real situation is likely to fall somewhere in between, and is likely to be closer to the *Half Way* case 3.

Given the lack of information on household costs, results have been generated here for all three household cost cases discussed above.

Community benefits

Accident reduction savings

Accident reduction savings were calculated using the following formula:

Annual Accident Reduction Savings = initial vehicle-kms of travel/wk/hh
* *% reduction in veh-kms*/100 * *effective no. of hhs* * 52 wks/yr
* *accident cost/veh-km* (4)

Transport SA (1998, Appendix D.6) reports a weighted average accident cost per million veh-kms (weighted by road type and relative usage) of $53,400 for urban roads.

Network time savings

As discussed earlier, time savings accrue not only to travel blending participants, but also to users of the road network in general as the resultant travel reduction leads to less road congestion. Assuming growth in network traffic and network capacity negate each other over time, network time savings are given by the following equation:

Annual Network Travel Time Savings =travel time savings/veh-km (3.3*10^{-6}hrs/veh-km)
 * *network veh-kms/hr post travel blending* (226,425) * *hours of operation/day* (12)
 * *weekdays/yr* (250) * *value of network travel time savings/hr* ($12.85) (5)

Network veh-kms post travel blending were derived as follows:

- Travel by travel blenders was assumed to be confined to a circular region of radius equal to average trip length (9 kms (OTPP, 1994)) from the Dulwich suburb centroid
- Assuming 2 lanes (one-way) per road section and an average lane capacity of 1200, the network capacity was determined. Factoring this by a volume/capacity ratio (v/c) of 0.825 yielded a pre travel blending volume of 226,600 veh-kms/hr. v/c = 0.825 is the average of the peak (0.95) and inter-peak (0.7) values (BTCE, 1996).
- Travel blending reduces network volume by only 175 veh-kms/hr. Thus, network volume post travel blending is 226,425 veh-kms/hr.

The travel time saving of 3.3*10^{-6} hrs/veh-km (= 0.012 secs/veh-km = 0.11 secs/9 km trip) was derived by applying the BTCE (1996) travel time formula (Bray and Tisato, 1997, p601) to the pre and post travel blending network volumes. The miniscule time saving per trip could not be effectively utilised for any useful activity. Hence, network benefits were *excluded* from the Dulwich analysis.

Pollution cost reductions

Pollution cost reductions were calculated using the following formula:

Annual Pollution Cost Reduction = initial vehicle-kms of travel/wk/hh
 * *% reduction in veh-km*/100 * *effective no. of hhs* * 52 wks/yr
 * *pollution cost/veh-km* (6)

Unit costs based on "best estimates" in (Bray and Tisato, 1997, p602 & 614) are: greenhouse 2cents/veh-km; local air pollution 2 c/v-km; noise 0.3 c/v-km; 0.2 c/v-km.

Survey Costs

A range of travel blending survey cost scenarios are conceivable, depending on the assumptions one makes about the persistence of travel reductions which flow from travel blending. Four survey cost scenarios were analysed here.

Scenario 1: Reduced travel behaviour by travel blenders is maintained on a continuing basis, with no reversion to old habits. Hence, annual benefits discussed above would apply for the full evaluation period, i.e. the benefit stream does not "decay" over time.

Scenario 2: Now assume travel behaviour reverts to old habits if there is no follow-up contact with households after the initial survey. Here assume reversion to old habits is avoided if an annual follow-up (tips, education, awareness campaigns) are undertaken. These are assumed to be sufficient to avoid decay of the benefit stream. The annual follow-up cost was estimated to be $5 per hh per annum (Steer Davies Gleave, 1999).

Scenario 3: Assume the follow-up in scenario 2 minimises rather then eliminate decay. Resurveying would then be needed (say) every 5 years to fully maintain annual benefits. This scenario assumes that such resurveying is undertaken, with resurveying costs the same as the initial survey cost, except design costs would not need to be incurred again.

Scenario 4: As per scenario 3, except now assume the original survey is out of date for the 5-yearly re-surveys. A redesign of diaries is therefore needed to keep diaries relevant to the public as peoples' tastes change (Steer Davies Gleave, 1999).

There are therefore three series of costs across the four survey cost scenarios:

- Initial travel blending survey costs: design costs, printing costs and field and analysis costs (-initial sunk research costs have not been considered here)
- Annual follow-up costs (tips, educational and awareness campaigns)
- Resurveying costs incurred every 5 years (with or without redesign costs).

Discussions with Steer, Davies, Gleave (1999) suggest the following:

- Design cost of $50,000 is a fixed cost incurred for a survey of any number of hhs.
- Printing costs of $25,000 and $65,000 apply for surveys of 350 hh and 2000 hh cases respectively. If printing costs vary linearly with the number of hhs, we can deduce a fixed printing cost of $16,515, and a marginal printing cost of $24.24 per hh. The printing cost for the 900 hh Dulwich exercise is therefore about $38,300.
- Marginal field cost is $92.50/hh, implying a field cost of $83,250 for 900 hhs.

The above information yields the following cost formulas:

Design cost = $50,000 per survey (7)

Printing cost = $16,515 + $24.24**hh* (8)

Field and analysis cost = $92.50**hh* (9)

Annual follow-up cost = $5**hh* (10)

Economies of scale exist due to fixed design and printing costs.

The four cost scenarios reflect different behavioural assumptions. At this stage, scenario 4 is considered the most realistic scenario (Steer Davies Gleave, 1999)

Results

Table 1 summarises the various Dulwich study benefit and cost components discussed above. The dominant gross benefit components are travel time savings (47%) and vehicle operating cost savings (33%). The initial survey cost, and subsequent re-surveying costs, are the largest components on the cost side.

The cost benefit analysis undertaken here generated the following results for a range of survey cost scenarios, household cost cases and parameter values:

- Net Present Benefit (*NPB*): sum of discounted benefit streams over evaluation period;
- Net Present Cost (*NPC*): sum of discounted cost streams over the evaluation period;
- Net Present Value (*NPV*) = *NPB-NPC*; and
- Benefit Cost (B/C) Ratio = NPB/NPC.

Table 1 Summary of Dulwich study annual benefit and cost components

Benefits and cost components	Undiscounted Value ($000)	%	Calculation
Benefits:			
Gross Private			
Travel time savings	201.6	47	6.29*0.10*633*52*9.75
Vehicle operating cost savings	141.4	33	154.19*0.174*633*52 *(0.354*0.115+0.119)
Total private gross benefits:	*343.0*	*80*	
Community			
Accident reduction benefits	47.1	11	154.19*0.174*633 *52*0.0534
Network benefits	0	0	Unit savings negligible
Pollution reduction	39.7	9	154.19*0.174*633 *52*0.045
Total community benefits:	*86.8*	*20*	
Overall total benefits:	*429.8*	*100*	
Costs:			
Initial TB cost	171.6		
Re-design costs (every 5 years)	50.0		
Re-survey cost (every 5 years)	121.6		
Annual follow-up costs	4.5		

Note: Minor errors are due to rounding.

An *NPV* > 0, and the equivalent of *B/C* > 1, means that more benefits than costs (in present value terms) will result from travel blending, and as a result society's total welfare will be increased by the project (in this case travel blending). This is the first test a project must pass if it is to be considered viable in economic cost benefit terms. If government funds were unlimited, a *B/C* > 1 would be sufficient to justify a project. In reality, however, with the availability of government funds being constrained, a *B/C* ratio in excess of 1 may be needed if the project is going to deliver higher net benefits than other projects competing for the same funds.

An evaluation period of 30 years was used. This allows the ongoing costs (annual follow-up and 5-yearly re-survey) to be accounted for. Arguably, if benefits continue over the longer term, an in perpetuity analysis should be undertaken.

Results for all cases reported are relative to the Base Case of "no travel blending".

Results for the Dulwich study are reported in table 2. The first row of results are for a base set of parameters, namely the parameter values discussed earlier and household cost case 3 (household costs equal 50% of gross private costs) and a 7% real discount rate. The remaining rows in table 2 report results for the following sensitivity tests:

- Discount rate was varied from 7% to 4 & 10%.

- Environmental benefits were excluded from the analysis. The justification for this might be that some may consider it inappropriate to cost environmental effects, and/or that uncertainty exists about the exact size of unit environmental costs.
- Variation of household cost case. The base parameter set results are based on household cost case 3. The other two household cost cases were considered in the sensitivity testing.
- Finally, the travel behaviour of those households that only completed one diary was considered. The base parameter set case assumed that there was no change in their level of travel. However, it is possible that their behaviour did change, and that they chose not to complete the second diary because they did not perceive that any further gains could be made (Steer Davies Gleave, 1999). A sensitivity test was conducted by assuming that they reduced their travel by the same extent as those households that completed both diaries

Table 2 Dulwich study cost benefit analysis results

Analysis case	Survey cost scenario 1				Survey cost scenario 2			
	NPB ($m)	NPC ($m)	NPV ($m)	B/C	NPB ($m)	NPC ($m)	NPV ($m)	B/C
1 Base parameter set results (including household cost case 1)	*3.2*	*0.17*	*3.0*	*18.7*	*3.2*	*0.22*	*3.0*	*14.7*
2. Discount rate: 4%	4.5	0.17	4.3	26.0	4.5	0.24	4.2	18.9
3 Discount rate: 10%	2.4	0.17	2.3	14.2	2.4	0.21	2.3	11.7
4 No Pollution Reduction Benefits	2.7	0.17	2.5	15.8	2.7	0.22	2.5	12.4
5. Household cost case 1[a]	5.3	0.17	5.2	31.1	5.3	0.22	5.1	24.4
6. Household cost case 2[b]	1.1	0.17	0.9	6.3	1.1	0.22	0.9	4.9
7 Travel reduction for 1-diary hhs same as 2-diary hhs	3.7	0.17	3.5	21.6	3.7	0.22	3.5	17.0

Analysis case	Survey cost scenarios 3				Survey cost scenario 4			
	NPB ($m)	NPC ($m)	NPV ($m)	B/C	NPB ($m)	NPC ($m)	NPV ($m)	B/C
1. Base parameter set results (including household cost case 1)	*3.2*	*0.46*	*2.7*	*6.9*	*3.2*	*0.57*	*2.6*	*5.7*
2 Discount rate: 4%	4.5	0.59	3.9	7.6	4.5	0.73	3.7	6.1
3. Discount rate: 10%	2.4	0.39	2.0	6.3	2.4	0.46	2.0	5.3
4. No Pollution Reduction Benefits	2.7	0.46	2.2	5.8	2.7	0.57	2.1	4.8
5 Household cost case 1[a]	5.3	0.46	4.9	11.5	5.3	0.57	4.8	9.4
6 Household cost case 2[b]	1.1	0.46	0.6	2.3	1.1	0.57	0.5	1.9
7. Travel reduction for 1-diary hhs same as 2-diary hhs	3.7	0.46	3.2	8.0	3.7	0.57	3.1	6.5
8. Analysis cases 3 and 7					0.82	0.46	0.36	1.8

Footnotes: a: Household costs equal gross private benefits
b: Household costs equal zero

Discussion

For any given analysis case, *NPB* is the same across the four survey cost scenarios since, by definition, the cost scenarios were designed to ensure there is no decay in the benefit stream over time. Not surprisingly, *NPC* increases from scenario 1 to 4 due to the additional surveying effort required. Hence the differences in *NPV* and *B/C* results across cost scenarios directly reflect the gradual increase in costs from scenario 1 to 4.

In all cases of the base parameter set results, the *B/C* ratio is significantly greater than 1.0, suggesting travel blending easily passes tests of economic justification.

Table 2 shows that results are only mildly sensitive to the discount rate chosen.

The exclusion of pollution reduction benefits only reduced the *NPV*'s & *B/C*'s slightly, reflecting the relatively small magnitude of this benefit compared to other components such as time savings and vehicle operating cost reductions (see table 1)

The most significant effect observable in table 2 is the impact of variation in the household cost case being considered. Sensitivity test 5 considers household cost case 1 (zero household costs). This results in significant increases in *NPV* and *B/C*, with results ranging from *B/C* = 9.4 for cost scenario case 4, to *B/C* = 31.1 in cost scenario 1

Next, consider household cost case 2, where household costs equal gross private benefits. In the worst case, with the largest cost structure (cost scenario 4), *B/C* = 1.9. This is the overall worst case of all the results generated. It is however unlikely that household costs would be of this magnitude, and so the true *B/C* result is likely to be greater. A further sensitivity test (8) was done by running this worst case with a 10% discount rate rather than 7%. This produced little change in *B/C* (= 1.8).

Finally, sensitivity test 7 considered the effect of households that completed only 1 diary reducing their travel by the same degree as households that completed both diaries. This increased the *B/C* ratio only slightly to *B/C* = 6.5 for cost scenario 4.

In essence, the sensitivity testing revealed that the tentative conclusion, that travel blending would increase society's welfare, appears quite robust. Not only is the *B/C* ratio consistently above 1.0 in all cases considered, but *B/C* is quite significant in many cases. It was suggested earlier that the most realistic household cost case was case 3, where household costs equal half gross private benefits. When this case is combined with the most likely survey cost scenario 4 (where annual follow-up reminders and 5 yearly resurveying and redesign are required), a discounted outlay over the 30 year evaluation period of (*NPC* =) $0.57million yields the very respectable outcome of *NPV* = $2.6 million and *B/C* = 5.7 (see base parameter set results line).

Application to greater Adelaide

This study also briefly undertook a cost benefit analysis of applying travel blending to the whole of Adelaide (the Adelaide Statistical Division). Results for greater Adelaide were approximated through a modification of the Dulwich analysis. Travel blending households were assumed to undertake the same percentage travel reduction as those in the 329 household survey (a similar assumption was used in the Dulwich analysis). Hence all the benefits and costs of the Dulwich analysis can be scaled up accordingly, except network benefits and design costs.

A penetration rate of 70.3% was used in the Dulwich analysis. Since the degree of participation is likely to depend on demographic factors (e.g. income), lower penetration rates might be likely across a larger and more diverse sample such as greater Adelaide. Without further information available, results for greater Adelaide were derived for two penetration rates: 60% and 40%.

With Adelaide's population being 1,080,972 in 1995 (ABS, 1997,p62), and assuming 3.1 people per household, there are therefore 348,701 households in the Adelaide Statistical Division. The effective number of travel blending households is therefore 209,200 and 139,500 for 60% and 40% penetration rates respectively.

Network benefits were computed as follows:

- The 1995 veh-kms of travel in Adelaide (ABS, 1995, Area Package, Table 7) was factored upwards for traffic growth to 1998, yielding 7,088 million veh-kms/yr.
- Noting that 39% of weekday traffic occurs in peak periods, and 46% in the inter-peak period, and noting the earlier Dulwich network analysis discussion, weekday peak and inter-peak vek-kms/hr were derived.
- As in the Dulwich case, network traffic growth is assumed to be matched by capacity increases. Hence, without travel blending, the peak and inter-peak v/c ratios of 0.95 and 0.7 quoted earlier would continue to apply in future years.
- With travel blending occurring across the whole city, the resulting % reduction in traffic volume on the network is assumed to equal the observed % reduction in travel from travel blending factored downwards by two factors: the penetration rate; and the proportion of traffic which occurs on arterial roads (estimated to be 90% in Adelaide).
- With a 17.4% reduction in veh-kms due to travel blending, a penetration rate of 60%, and 10% local traffic, the resulting post travel blending v/c ratios for peak and inter-peak are 0.86 and 0.63.
- Applying this to the BTCE travel time formula (see earlier discussion) again yields a miniscule time saving per vehicle in the inter-peak. The peak time saving is 0.0018 hrs/veh-km = 6.5 secs/km = 58 secs/ 9 km average trip, which produces a city-wide benefit of $45.2 million/year. Although the peak unit time saving is still relatively small, it has been included in the greater Adelaide cost benefit analysis results.

Table 3 provides a breakdown of the relative size of benefit and cost components. Given the debate about whether small time savings should be valued (e.g Meyer and Gomez-Ibanez, 1981), table 3 shows the relative proportion of benefit components both with and without network benefits accounted for. When network benefits are ignored, private benefits once again dominate. However, when network benefits are acknowledged, they constitute a significant 24% of overall benefits

The results for greater Adelaide are reported in table 4 for the base parameter value set. Note that the *NPB*, *NPC* and *NPV* results are all significantly higher than in the Dulwich study, merely reflecting the much greater scale of the exercise.

The *B/C* ratios without network effects (as per Dulwich) and 60% penetration rate are greater than those for Dulwich (base parameter set), even though the Dulwich participation rate was higher (70.3%). The reason for this is that the Adelaide case can take far greater advantage of travel blending economies of scale than can the Dulwich exercise. The average travel blending cost is $191/hh for Dulwich, and $117/hh for Adelaide, thus causing the Adelaide *B/C* ratios to be higher than for Dulwich.

In table 4, the introduction of network effects increase the *B/C* ratios, while lowering the penetration rate raises it, both as expected.

Importantly, all the *B/C* ratios in table 4 exceed 1.0 by a significant amount, making travel blending across Adelaide appear to be a highly worthwhile investment. Finally, note that the *B/C* ratios are reported as being the same for cost scenarios 3 and 4. This is due to the $50,000 5-yearly resurveying cost difference between the two scenarios being swamped by other costs in the greater Adelaide study.

Table 3 Summary of Greater Adelaide study benefit and cost components (penetration rate 60%)

Benefit/Cost	Undiscounted value ($m)	% (No network benefits)	% (With network benefits)
Benefits			
Private			
Travel Time Savings	66.7	47	36
Vehicle Operating Cost Savings	46.8	33	25
Total Private Benefits:	*113.5*	*80*	*61*
Community			
Accident Reduction Benefits	15.6	11	8
Network Benefits	45.2	0	24
Pollution Reduction	13.1	9	7
Total Community Benefits:	*73.9*	*20*	*39*
Total Benefits:	*187.4*	*100*	*100*
Costs:			
Initial TB survey cost	40.7		
Re-design costs (every 5 years)	0.05		
Annual follow-up costs	1.7		

Note: Numbers may not add due to rounding.

Table 4 Greater Adelaide study results (with base parameter set, including household costs equal 50% of gross private benefits)

	Penetration Rate (%)	Survey cost scenario 1 NPB ($m)	NPC ($m)	NPV ($m)	B/C	Survey cost scenario 2 NPB ($m)	NPC ($m)	NPV ($m)	B/C
Without network benefits	60	1060	41	1020	26.0	1060	59	1001	18.0
	40	707	41	666	17.3	707	59	648	12.0
With network benefits	60	1622	41	1581	39.8	1622	59	1563	27.6
	40	1186	41	1145	29.1	1186	59	1127	20.1
	Penetration Rate (%)	Survey cost Scenario 3 NPB ($m)	NPC ($m)	NPV ($m)	B/C	Survey cost scenario 4 NPB ($m)	NPC ($m)	NPV ($m)	B/C
Without network benefits	60	1060	141	919	7.5	1060	142	919	7.5
	40	707	141	565	5.0	707	142	565	5.0
With network benefits	60	1622	141	1480	11.5	1622	142	1480	11.5
	40	1186	141	1044	8.4	1186	142	1044	8.4

Table 5 Greater Adelaide study: Impact on B/C ratios of variation in congestion level (survey cost scenario 4, penetration rate 60%)

Peak v/c ratio	0.8	0.85	0.9	0.95	1.0	1.05	1.1
% network benefits	5	7	12	24	56	81	88
B/C ratio	8.2	8.5	9.2	11.5	23.2	59.7	97.3

Finally, table 5 reports the variation in both network benefits as a % of all benefits, and *B/C* ratio, as the peak period v/c ratio is varied from the current Adelaide figure of 0.95. It shows that as road traffic volume approaches capacity, and thus v/c approaches (and then exceeds) 1.0, delays become very large, network benefits begin to swamp other benefit components, with a dramatic increase in the *B/C* ratio.

The above analysis for Adelaide is relatively coarse. However, it does provide an order of magnitude indication of the merits of travel blending when applied to Greater Adelaide. The overall conclusion that can be drawn is that, like the Dulwich analysis, travel blending appears to be readily justified from an economics perspective

Before concluding, a few qualifications are needed First, it should be remembered that any intangible benefits would further advantage the results, as would any increase in road network congestion over time. Second, it should be noted that no account has been taken of the impact that any shift in trips to other modes (public transport, walking, cycling). It was felt that this would not impact greatly on the results since indications to date are that the vast majority of travel reduction has been due to increased trip chaining (- preliminary figures suggest as high as 80%). The remaining % consists of shifts to other mode, less travel per se, and any other factors.

Conclusions

Travel blending is a new and innovative form of travel demand management Based on the experience of trialing travel blending in Adelaide over the last 3 years, the technique appears to offer considerable potential as a key future instrument for reducing the impact of the car. This paper has presented the results of an economic cost benefit analysis of travel blending. Results were derived for two cases: a current 900 household study in the Adelaide suburb of Dulwich; and the longer term potential application of travel blending to the whole of metropolitan Adelaide.

Results were derived for a range of parameter value cases, thus testing the sensitivity of the results. In all cases considered, the lowest benefit cost ratio was 1.8, and in most cases was substantially greater. In the Dulwich study, for possibly the most likely situation (household costs equal half gross private benefits, and ongoing follow-up reminders and resurveying), the very respectable outcome of NPV = $2.6 million and *B/C* = 5.7 result

The analysis of travel blending in greater Adelaide demonstrated fairly similar results, with substantial cost benefit ratios, even when lower penetration rates were applied.

Overall, the analysis in this paper suggests that, besides being intuitively attractive, travel blending appears to be economically justified, promising to deliver both private and community benefits, and potentially significant increases in social welfare.

The analysis should be updated when actual Dulwich travel reduction results become available. Further research can be justified on the estimation of household costs given they are the factor to which the results were most sensitive. However, as the sensitivity testing revealed, this is unlikely to alter the viability of travel blending.

Acknowledgments: The authors wish to thank Liz Ampt, Ian Ker, Andrew Rooney, Margaret Starrs and Andrew Zeicman for their comments on an earlier draft.

Disclaimer: The views expressed in the paper are those of the authors, and should not be attributed in any way to the South Australian Government.

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