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TRAVEL BEHAVIOUR MODIFICATION: A CRITICAL APPRAISAL

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ABSTRACT

Travel behaviour modification, also called TravelSmart®, Indimark® and Travel Blending®, has been offered as a solution to the dependence of urban populations on the car. Travel behaviour modification is a voluntary programme aimed at changing travel behaviour through providing better information about transport options, rather than through investments in public transport, or through disincentive programmes for the car. The policy has been implemented in Australia in Perth, Adelaide, and Brisbane, and is under active consideration at least in Melbourne and Sydney. The basis of this increasingly widespread potential application of travel behaviour modification is the claim that the program can deliver a shift of travel mode choices through the provision of better information about travel behaviour and travel choices. The claim that is made for these programmes is that they can lead to reductions in car use of the order of 10 to 14 percent. If this claim is real, then travel behaviour modification is an enormously valuable programme, with the potential to achieve what has never been done before, i.e. provide a doubling or more of public transport ridership and a significant drop in car use. Such a program would be the answer to the dilemma of how to reduce car use significantly and consequently reduce congestion and vehicular emissions. It is, therefore, appropriate to undertake a critical appraisal to determine if travel behaviour modification is able to deliver these major mode shifts, as its proponents claim.

In this paper, we review a number of published articles, based on the Australian experience with travel behaviour modification, and also review several reports, and materials from the application areas. From these reviews, analyses are performed to see what the actual expected shift is in mode use for the whole population. It is found that there appears to be evidence that the claims of 10 or more percent shift out of car driver are over-stated, and that real shifts may be of the order of five to seven percent. Second, some sampling issues are discussed that indicate that the numbers reported to date may not be as reliable as one would like. Third, the locations of the test applications are examined and discussed, and it is suggested that there may be some significant bias in these locations towards a larger uptake of the shifts into environmentally-friendly modes of travel. In sum, the paper concludes that travel behaviour modification is capable of making changes in the use of environmentally-friendly modes, but not at the rates that have often been claimed. It is suggested that the target populations may need to be limited and that expectations of the size of the shifts in mode use need to be tempered. Notwithstanding this, it is also concluded that travel behaviour modification is a viable policy option, and one that merits further pursuit.

1. INTRODUCTION

As a means to attempt to shift people out of their cars and into public transport or non-polluting modes of travel, such as walk and bicycle, the notion of travel behaviour modification has been introduced and tested, particularly in Perth and

Adelaide, and now most recently in Brisbane. This is a voluntary programme aimed at changing travel behaviour through providing better information about transport options, rather than through investments in public transport, or through disincentive programmes for the car. In Australia, Indimark® was initially pioneered in Perth, and has more recently been introduced in Brisbane. It is now also identified as one of the strategies expected to be implemented in Melbourne to achieve the goals of 20/2020, and is actively being considered for Sydney. It has also been implemented quite widely in Europe, is under consideration in the Northwest United States, and also in Britain. Another approach to travel behaviour modification, called Travel Blending® (Ampt and Rooney, 1998; Ampt, 1999) has also been tried in South Australia. Indimark® is reviewed in this paper, based on documentation of experiments in Perth and Brisbane.

The basis of this increasingly widespread potential application of Indimark® and Travel Blending® is the claim that these programmes can deliver a shift of travel mode choices through the provision of better information about travel behaviour and travel choices, and do not require any investment in capital projects to achieve this. Among the claims that are made for travel behaviour modification is that it can lead to reductions in car use of the order of 10 to 14 percent. If these claims are real, then travel behaviour modification is an enormously valuable programme, with the potential to achieve what has never been done before, i.e. provide a doubling or more of public transport ridership and a significant drop in car use, without substantial expenditures and without capital projects. Such programmes would be the answer to the dilemma of how to reduce car use significantly and consequently reduce congestion and vehicular emissions. It is, therefore, appropriate to undertake a critical appraisal to determine if travel behaviour modification is able to deliver these major mode shifts, as its proponents claim.

2. THE PERTH CASE

Perth represents the earliest application of travel behaviour modification in Australia, and was a pioneering application of the Indimark® programme. Indimark® attempts to undertake individualised marketing of public transport, walk, and bicycle to individuals, through provision of information. Indimark®, as implemented in Perth and Brisbane, is aimed at shifting people from car driver to more environmentally-friendly modes (EFMs), such as walk, bicycle, public transport, and, to a lesser extent, car passenger. It does not explicitly aim to reduce the amount of trip making, but rather to effect a shift from car driver to other modes.

2.1 WHAT WAS DONE

The Indimark® programme was introduced in Australia in South Perth, commencing in 1997 (James, 1998). A survey was undertaken in 1997 that established current travel patterns, and use of travel modes in particular. In common with most urban areas throughout the world, the survey showed a steady erosion of public transport, walking and bicycling as modes of travel, and a concomitant increase in car use, since a previous survey conducted in 1986.

The next step in the process was to contact these same households, to undertake individualised marketing. This was done in August/September of 1997. Goulias (2001) reveals that there was a second survey undertaken in November/December of the same year to evaluate the changes in behaviour as a result of Indimark®. The data from the before and after surveys of this experiment were combined into a

single pooled data set, together with one more survey, conducted in September/October 1998 (about a year after the original Indimark® intervention), which comprised a survey of households exposed to the programme and also households who were not exposed to it. This was used to establish the stability of the changes measured approximately a year earlier.

James (2002) describes a large-scale test of Indimark®, still in South Perth, commencing in 2000. No before survey was carried out for this test, but rather the before data from the 1997 pilot test was used as the base benchmark. An after survey was conducted in October 2000, which James (2002) indicates was conducted over three population segments in South Perth – the interested (I), those already using environmentally-friendly modes (EFMs) (R) and those not interested (N). In addition to these samples, a sample of households was drawn from the adjacent suburb of Victoria Park. Originally, there was a sample drawn in 1998, and in 2000, a subset of these households were successfully identified and asked to participate in a follow-up survey.

As can be seen, there is a complex set of surveys that were used to identify those who were willing and interested to participate in Indimark® and to evaluate the responses of the treatment populations to the individual marketing programme. As the first step in evaluating the results from the experiments, it is important to review the data sets used, and to determine whether these data sets are representative and can support the conclusions that it is desired to draw. Unfortunately, the various published papers and reports (both published and unpublished) are not very explicit on the different data sets, so that significant investigative detective work is necessary to determine what the actual surveys were. These are documented in the next subsection of the paper.

2.2 THE DATA SETS

2.2.1 The Pilot Study

Initially, a sample of 498 households was selected from the South Perth region, from which, 383 households (77 percent) agreed to participate in a travel diary survey (James,1998). James indicates that the 383 households who responded to the diary survey consisted of 865 persons. The published papers on this experiment are unclear on the sample sizes that were involved in the next step. However, an audit report by Goulias (2001) reveals that there was a second survey undertaken in November/December of the same year, in which 169 households were surveyed that had expressed interest in the programme and had received materials relating to it, and 153 households that had not been exposed to the programme were also interviewed. Although not explained this way in any published or unpublished reports, the sample is that shown in Figure 1. The not exposed group was from households not contacted previously (this is not documented, however).

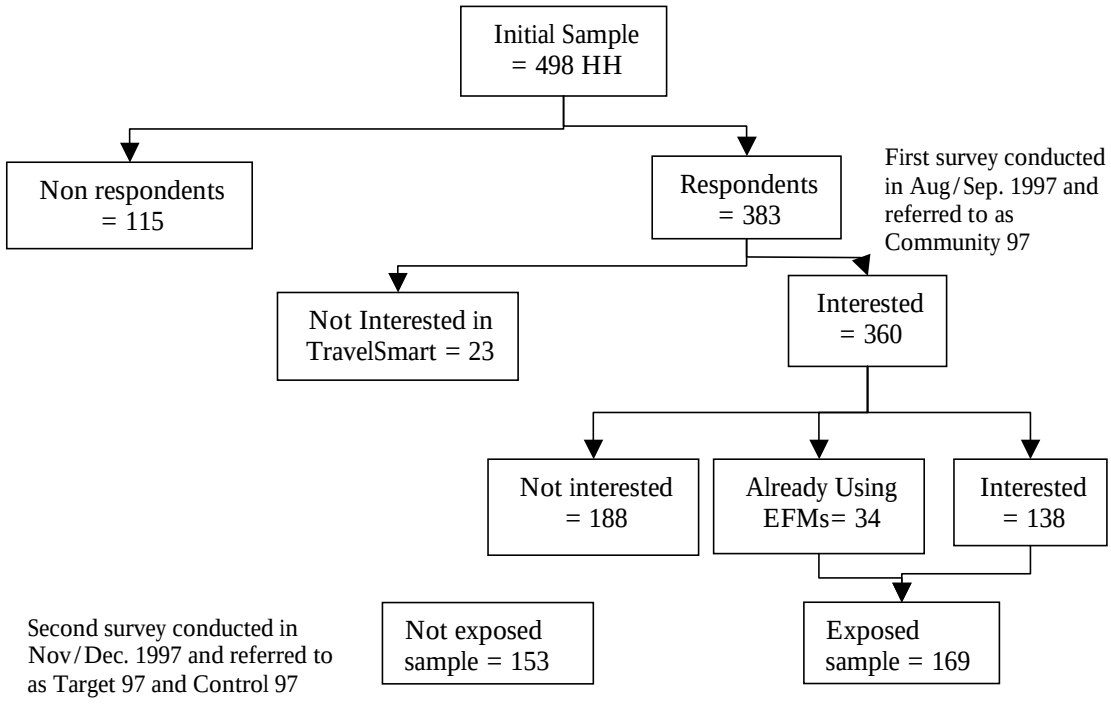

Figure 1: Identification of the Interested Households

There was one more survey, conducted in September/October 1998 (about a year after the original Indimark® intervention), which comprised a survey of 206 households exposed to the programme and 207 who were not exposed to it (Goulias, 2001). The relationship of these households to the original ones in the 169/153 samples of November/December 1997 and the August/September 1997 survey of 383 households is not specified, but they are assumed to be independent. There appears to be an inconsistency here that, if only 138 households originally were interested, together with 34 who were already users of public transport, there appear to be insufficient households that were exposed to the programme to make a sample of 206 households. Presumably, in the interim, additional households were introduced to the programme, or there is a disconnect between all the samples.

Goulias (2001) reports that these data sets were pooled and produced a single data set, called the "Before Survey", which contains 8,255 records, of which 7,834 are person trips, and the remaining 421 are persons who reported making no trips on the survey day. He further notes that there were 2,511 persons in this data set, all of whom reported at least substantially complete demographic data. From the previous discussion of households in the samples, it appears that these 2,511 persons belong to 1,118 households (383+169+153+206+207).

2.2.1 The Large-Scale Experiment

As with the description of the pilot test, full details of the surveys for the large-scale experiment are not readily gleaned from the published papers. However, the audit report (Goulias, 2001) and a Technical Report from Socialdata (Socialdata, 2003) provide some further insights.

From James' (2002) paper and the Goulias audit (Goulias, 2001), the following appears to be a description of what was done and what results were obtained. South Perth has a total population of 17,300 households (James, 2002) or 18,626 (Goulias, 2001). Of these, 15,300 (15,267 according to Goulias) provided a match of a telephone number and an address, and could be used as the basis of the large-scale test. Of these households, 94 percent, or 14,382 responded to a survey to determine qualifications for and interest in the Indimark® programme, according to James (2001). However, Goulias reports that 967 households were not contactable, and 918 refused to participate, leaving a sample of 13,382 households, representing 71.8 percent of the population that were included in the final evaluation sample.

According to James, this group of households split along similar lines to those in the pilot test, with 15 percent reporting that they were already using EFMs, 40 percent indicating interest in the programme, and 39 percent indicating no interest. The 40 percent who expressed interest were then involved in the programme, which would mean a total of 5,753 households or 33.3 percent of the population of South Perth. Goulias (2001) reports a slightly different split of numbers, which is also consistent with the Socialdata (2003) report, with 6,128 being interested (I) (46 percent), 1,667 already using EFMs and desiring further information (R with), 670 already using EFMs and not desiring any further information (R without) (a total of 2,337 or 17.5 percent), and 4,917 (37 percent) expressing no interest (N).

In his paper, James (2002) uses a base of September 1997 as the before situation for South Perth and for another suburb, Victoria Park, used as a control. No before survey is reported on for South Perth; it is apparently the survey used for the before situation for the pilot test. An after survey was conducted in October 2000, which the paper indicates was conducted over all three population segments in South Perth. However, no details are given of the results of the already using and the not interested groups. James (2002) reports that the after survey consisted of a sample of 706 households, although he does not specify the make up of these households. Goulias (2001), however, provides some detail here, although there remains some confusion. Goulias reports that 1004 households were identified from the four groups (labelled as Interested (I), Already Using but wishing for more information (R with), Already Using but not desiring further information (R without), and Not Interested (N)). Of these, 78 could not be reached, and 220 refused to participate, leaving a net sample of 706 or 70 percent. Goulias (2001) goes on to report that there were 300 households that were in the I group, 155 in R with, 61 in R without, and 190 in the N group. He also reports that the file for this combined set of results contains 4,976 records, consisting of 222 person records who made no trips on the survey day, 4,754 trip records, including 33 long-distance trips that are subsequently excluded, and that there is a total of 1,454 persons in the data set. In speaking of this after sample, however, the Socialdata report states "….2,601 households who participated in all phases of Indimark® received a questionnaire requesting feedback on the Indimark® initiative, and 1,018 responses were returned." These numbers do not match what James or Goulias report. They also show an uncharacteristically low response rate of 39 percent.

2.3 HOUSEHOLD SIZE AND TRIP MAKING

When assessing data, it is useful to look at certain characteristics to determine the quality of the data. Using the various figures from the reports and papers already referenced, the following information has been deduced from the survey figures. First, for each data set, the response rate has been recorded. (It is not reported for the individual subsets of the data.) Along with this, we have

estimated average household size for each sub-set of data, because the survey was weighted by gender and age of respondents, but not by household size. This is fairly critical, because it is typical of most household travel surveys that they tend to be biased against larger households. In addition, for each survey, or the pooled data, the percentage of non-mobile persons and the average trip rate of all persons surveyed are reported. The results are summarised in Table 1.

Table 1: Sample Statistics for the Various Surveys

Source	Sample			Statistics		
	Persons	**Households**	**Average HH Size**	**Response Rate**	**Non-Mobiles**	**Average Trip Rate/Person**
ABS 96	-	-	2.20	-	-	-
Community 97	862	383	2.25	77%	-	-
Target 97	389	169	2.30	98%	-	-
Control 97	319	153	2.08	N/A	-	-
Evaluation 98	941	413	2.28	N/A	-	-
PILOT TOTAL	2,511	1,118	2.25	-	17%	3.12
Interested	589	300	1.96	-	-	-
R (with and without)	484	216	2.24	-	-	-
Not Interested	381	190	2.01	-	-	-
Large-Scale TOTAL	1,454	706	2.06	70%	15%	3.25
Victoria Park 98	426	N/A	-	66%	-	N/A
Victoria Park 00	242	N/A	1.98	68%	-	N/A
ABS 96	-	-	2.0	-	-	N/A

N/A – not available in any sources
- – not reported

For the pilot survey, the average household sizes appear reasonable, and close to the report of the Australian Bureau of Statistics for the 1996 census (ABS, 2002a). However, for the large-scale application, the average household size of the entire sample appears low, and especially so for the interested (I) households, where an average of only 1.96 is obtained. For Victoria Park, the result from the after survey appears acceptably close to that of the census (ABS, 2002c). The results for the large-scale survey on household size appear to indicate a bias towards smaller households, which was not evident in the original pilot study.

The response rates are similar to those obtained in other household travel surveys around Australia. As a result, one would not expect to find substantial differences in such things as non-mobility rates and trip rates. Table 2 shows variations in person trip rates from two surveys, one in Adelaide from 1999, and one from Sydney, using figures from 1999-2001. Both the Adelaide and Sydney surveys were conducted as face-to-face interviews, collecting travel data prospectively after a recruitment in which a memory jogger was provided to respondents and a recording day set in the future. Against these, one can compare the surveys in Table 1 for response rates, non-mobility rates, and trip rates. Because the surveys in Perth are different from previous Perth surveys, and the last Perth Survey was several years before this work, we choose to compare to recent surveys in Adelaide and Sydney, rather than to an outdated Perth survey.

Table 2: Comparison of Trip Rates and Mobility Rates for Sydney and Adelaide

Source	Survey Response Rate	Non-Mobility Rate	Linked Person Trip Rate by Household Size					
			1	**2**	**3**	**4**	**5+**	**Overall**
Adelaide HTS	67%	14%	3.21	3.68	3.71	3.84	3.72	3.72
Sydney HTS	68%	15%	3.46	3.62	3.71	3.96	3.91	3.76

It can be seen that the response rates in these two surveys are comparable to the Perth rates, as are the non-mobility rates. However, the trip rates are much higher in these two surveys than those reported for Perth. Generally, trip rates do not vary much from urban area to urban area, although characteristics of the trips do vary significantly. Average trip rates of around 3.8 and higher are common in most household travel surveys, and some recent work (Stopher *et al.*, 2003) suggests that these rates may be under-reported by around 20 percent or so.

Overall, these statistics tend to suggest that there may be problems of representativeness of the samples used to evaluate the effectiveness of Indimark®. While not the case in the pilot study, the large-scale application appears to be biased against larger households, and both the pilot study and the large-scale application appear to be based on trip rates that are reported out as being about 15 percent too low.

2.4 THE RESULTS

2.4.1 The Pilot Study

In the original paper of James (1998), he reports on the results of the 1997 surveys. As noted earlier, from the after survey, which we can infer means both the Target and Control groups from 1997 (surveyed in November/December 1997), James (1998) reports the following findings:

- A 5 percent reduction in cars used, 5 minutes less per day use of a car, and a reduction of 0.5 car trips per day.
- A 14 percent reduction in car VKT.
- A reduction of 2 kms per day in distance travelled.
- Mode shifts averaged over both participating and non-participating households, amounting to an increase in car as passenger of 4 percent, increase in public transport of 21 percent, increase in bicycle of 91 percent, and an increase in walk of 16 percent, all of which are driven by a decrease in car use of 10 percent.

A number of reviewers of this work have made the assumption that the percentages listed here are those for the target group. Unfortunately, neither the paper by James (1998) nor any other published document clearly specifies the sample basis for these results, although it has been determined that these results are actually averaged across both the target and control samples (Ashton-Graham, 2003).

2.4.2 The Large-Scale Experiment

The 706 households showed shifts from car driver to walk, bicycling, public transport, and car passenger, at the expense of car driver. The base (1997) and October 2000 percentages by mode are shown in Table 3. Also, shown there are the percentages from the control group in Victoria Park.

Table 3: Results of the Large Scale Test in South Perth – Percentage of Trips by Mode

Main Mode	Base (September 1997)	After (October 2000)	Control Group (Victoria Park)	
			Before	**After**
Car Driver	60%	52%	56%	56%
Car Passenger	20%	22%	20%	22%
Public Transport	6%	7%	5%	5%
Bicycling	2%	3%	4%	4%
Walking	12%	16%	15%	13%
Sample Size	383	706	242	242

James uses the 1997 results as the base against which to claim the shifts achieved, e.g., of a decline of 14 percent in car driver and an increase in walking of 35 percent, among other changes. It is curious as to why the percentages obtained in the Victoria Park control group are not used as the base to define change, or why a survey of the same 706 households was not undertaken in South Perth before implementation, to benchmark the results of Indimark®. With the bias in both the trip rate and the household size, these percentages of shifts are probably too high. In later reports, it appears that the samples are weighted to ensure that age and gender are correctly represented between the various samples. However, household size was not used to weight the data. There is no public access to the weighted data, so any analysis must use the raw data, as derivable from the published papers.

It may be argued that the analysis concentrates on person travel, rather than on households. However, it is also well known that person trip rates are not constant with household size. Larger households, particularly where there are a number of school age children present, will tend to make more trips per person than one and two person households, and many of these trips will be for the purpose of ferrying children to and from various activities. Thus, the number of car driver and car passenger trips are likely to be higher proportionately, and public transport trips lower. There is also likely to be a greater resistance to travel behaviour modification, as conceived in Indimark®, so that it is more likely that these households would not change their behaviours.

There is a further problem here that the results appear to be based on comparison between the South Perth data and the Victoria Park data, without accounting for the biases inherent in the fact that almost 29 percent of households in South Perth were not included in the experiment, and their characteristics are unknown, and that the Victoria Park data represent only 38 percent of those originally targeted for surveying in 1998.

2.4.3 Implications for the Analysis

Given that it appears that the survey data on which the 14 percent shift from car driver is based are biased to smaller households and to households making fewer than average trips, what is the implication of this? It appears that the average household size of the large-scale experiment households that participated in Indimark® is 10 percent too low, and that the average trip rate per person is 15 percent too low in the large-scale experiment and 17 percent too low in the pilot. Let us consider the pilot results first. There are two extremes to consider here. Suppose,

first, that all of the trips that were not reported by households are car driver trips and that none of these were shifted into EFMs. Assuming that car driver trips represented about 60 percent of total person trips before Indimark®, then the reported number of car driver trips per person was 1.87 trips per day. If we assume that the missing trips are all car driver trips and do not shift, this means that we now have an additional 0.63 car driver trips per person to add. This brings the total to 2.50 car driver trips per person per day.

The shift resulting from Indimark® was a decrease of 10 percent in the car driver trips, or an average of 0.187 trips per day per person. However, on a new base of 2.5 car driver trips per person per day, this shift is reduced to 7.5 percent.

For the large-scale application, the absolute reduction in car driver trips is 8 percent (from 60% to 52%). As a proportion of the car driver trips, this is a shift of 13.3 percent. Applying the same argument as above, the average number of car driver trips in the large-scale experiment is 1.95 trips per person per day. If, again, this should have been 2.5 trips per person per day, then there are 0.55 trips per person per day that are missing. If, again, all of these are car driver trips and all remain as car driver trips, then the decrease of car driver trips is 0.26 trips per person per day. As a percentage of all car driver trips, this is just over 10 percent, not 13.3 percent.

However, in this case, we also have a problem with average household size. To see how to correct for that, we need first to determine household trip figures, and then back out to the corrected per person figures. According to the survey, there is an average of 1.96 persons per household making 3.25 trips each per day, for a total of 6.37 trips per household per day. The correct figure, we are supposing, should be a household of 2.2 persons each of whom makes 3.75 trips per day, or 8.25 trips per household per day. Again, if we assume that all of the missing trips (1.88 trips per day) are car driver trips that do not shift to EFMs, then we are looking at a shift of 0.51 car driver trips per household per day (1.96 times 0.26), which is 9 percent instead of 13.3 percent.

Finally, these figures have been obtained as averages over the percentage of the population that responded to the surveys. There is, however, a fraction of about 23-32 percent of the population that did not respond to the surveys. It is very likely that those who did not respond, failed to do so, because they were not interested in the survey, or what it purported to do. Others were not contactable, and presumably a similar proportion of the population will be non-contactable in any group to which this programme is applied, meaning that they will not be able to receive the individual marketing materials. If we assume that this is the case, then there is a need to factor the results to account for a larger fraction of not interested households. If we suppose that the proportion of non-respondents and non-contacts is 25%, then the figure of a 9 percent shift must be reduced to 7 percent, and the figure of a 7.5 percent reduces to 5.5 percent. If we assume that the proportion is higher, at say 30 percent, then these figures would reduce to 6.3 and 5.25 percent, respectively.

If the missing trips were all car driver trips, and the same shift occurred as with the reported trips, then the percentage shifts are as originally reported for the pilot survey. For the large-scale application, we still have the problem of the lower household size, which would reduce the overall percentage, although by a smaller amount than calculated above. The adjustment for the non-contacts and non-respondents would then produce shifts on the order of 7 to 9 percent.

In summary, if the adjustments are made to reflect more usual trip making, the correct household size, and for non-contacts and non-respondents, then the actual

range of car driver shifts are on the order of 5-9 percent, rather than the 10-14 percent that is claimed in most of the published materials.

2.5 SOME OTHER CONCERNS

Two other concerns arise from reviewing the material relating to the Large-Scale test in Perth. The first relates to the claim that the initial boardings and transfers for South Perth substantiate the large increase in bus ridership. Table 4 is a replica of what is contained in the Socialdata (2003) report. Unfortunately, figures for February 1999 were not collected by the Department for Planning and Infrastructure, and are probably no longer available. Figures for prior years have also not been found to be obtainable.

Table 4: Initial Boardings and Transfers City of South Perth

Month	1999	2000	2001
March	96,895	118,321	147,640
April	85,193	96,335	85,189*
May	94,587	121,282	126,242
June	81,396	112,019	115,256
July	88,072	109,757	
August	92,761	123,308	
September	91,219	114,377	
October	89,686	109,548	
November	95,681	114,211	
December	92,619	104,525	
January	90,790	113,061	
February	117,759	123,753	

* Bus service strike
Source: Socialdata, 2003.

The table is arranged in this manner, because Indimark® was introduced in March, April, and May of 2000. However, if one graphs these figures without arranging the graph to start in March of each year, but rather running from January, the result is shown in Figure 2. Indimark® was introduced in March-May of 2000. March and May ridership figures are about the same as February, with a dip in April, that also occurs similarly in 1999. There is really little evidence in the figures to substantiate an Indimark® induced increase in ridership for the bus.

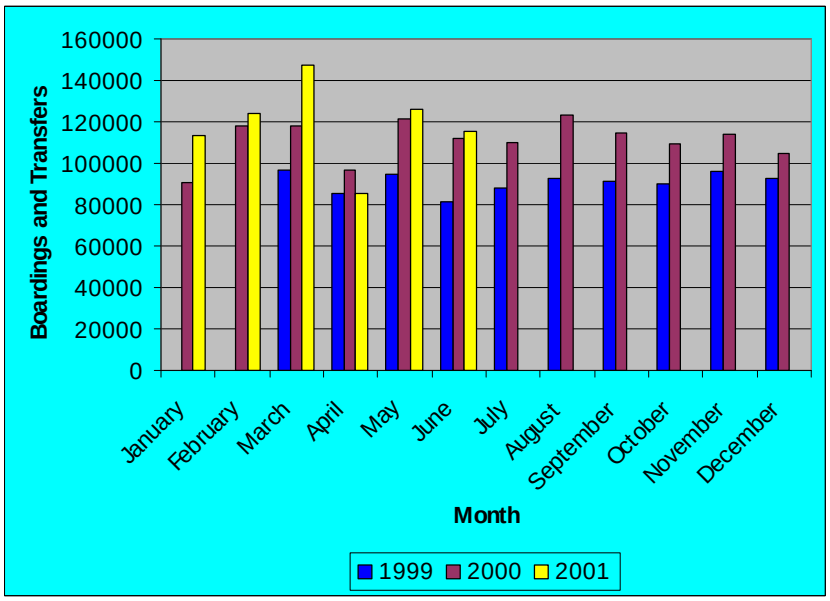

Figure 2: Boardings and Transfers for the City of South Perth

The second issue relates to a comparison of the effects of Indimark®, as shown in Table 5. It seems strange, to say the least, that the before and after data in South Perth are virtually identical (except for a small increase in distance). Based on figures from Socialdata (2003), the overall change was a reduction of eight percent of total trips from car driver, which resulted in four percent added to walking, one percent added to bicycle, two percent added to car passenger, and one percent added to public transport. However, with these shifts taking place, the average speed of travel actually increases from 27.9 km/h to 29.0 km/h. For this to be possible, car driver must be slower than bicycle, and public transport for the trips that switched from car driver, while car passenger is presumably the same speed as car driver. Alternatively, car driver must be no faster than walking, while bicycle and bus are both slightly faster than car driver. Another possibility is that the trips that are diverted from car driver are very short trips, where the time and speed differences between any of the modes is so small that it does not show up. In this case, while the shift from car as driver may be locally important, it will not have much effect on VKT or on congestion levels, in general.

Table 5: Changes in Mobility per Person per Day in South Perth and Victoria Park

Travel Characteristic	South Perth (Target Group)		Victoria Park (Control Group)	
	Before	**After**	**Before**	**After**
Activities	2.0	2.0	1.9	1.9
Travel Time (mins)	58	58	54	54
Trips	3.4	3.4	3.5	3.5
Distance (km)	27	28	22	22

3. THE BRISBANE CASE

Much more recently, Indimark® was implemented as a pilot test in a group of inner northern suburbs of Brisbane (Marinelli and Roth, 2002). Once again, the claim

is made that Indimark® produces a substantial shift in mode use, specifically a reduction of private vehicle use of 10 percent. The steps in the process were very similar in the Brisbane case. The pilot area chosen was a group of inner northern suburbs of Brisbane, with a total population of 10,000 households, or about 26,000 people.

In this case, the households were divided into two groups – a treatment group and a control group. The two groups comprised 1,080 households in total, all of whom were sent the before survey, and of which 843 (78%) responded (Marinelli and Roth, 2002). Following the before survey, 455 households from the treatment group were selected to participate in Indimark®. Of these, 26 were no longer contactable, 17 declined to respond, and the remaining 412 households were continued in the study. These households were split into four groups consisting of 32 households already using public transport and other sustainable modes who did not require further information, 66 households already using public transport and other sustainable modes who needed updated information on travel modes, 196 households who were interested in participating in the individualised marketing approach, and 118 households who desired no further contact. Of these 196 households, Marinelli and Roth (2002) report that 89 percent requested information. This would amount to 174 households. Of these households, some undefined proportion received a home visit to provide further information on a mode, and 8 percent or 15 households received a one month free pass to use the public transport system.

In the following five months, households in both the group of 196 and the control group were recontacted to measure changes in travel behaviour. Marinelli and Roth (2002) report that 700 households were contacted and 589 successfully completed the survey (84 percent). From the results provided, the average trip rate again is rather noticeably low at 3.2 trips per person per day. Subsequently, Marinelli and Roth (2002) show results on a per person per year basis, in which 1,076 trips are shown before the Indimark® programme is introduced. Curiously, this number of trips averages out to only 2.55 trips per person per day, which is lower than the average reported in the earlier table. The paper then shows that walking trips increase by 18 per year, bicycle by 1 per year, car as driver decrease by 60 trips per person per year, and car as passenger decrease by 14 trips per year, while public transport trips increase by 20. Two important issues come out of this analysis. The first is that overall trip making dropped from 1,076 trip per person per year to 1,047, or a decrease of 3.2 percent. Second, there is a reported decrease of 9.6 percent in car driver trips for this subsample of the population. There is also a drop of 5.3 percent of car passenger trips.

The main problem posed by what is reported is to determine to what proportion of the population this shift is attributed. From the earlier statistics provided, it appears that 843 households responded in the original survey from a sample of 1,080, of which 455 were selected to be in the “treatment” group, i.e., the group that participated in the Indimark® programme. We will assume that both the original 1,080 households, and the 455 who were selected as potential participants were drawn randomly from the population. Because there was a 78 percent response rate in the initial survey, we should assume that the original number of households from which the potential programme participants was drawn was 583 households. Of these, 196 households were interested in participating, but only 89 percent of them asked for further information. It would appear that 174 households were, therefore, at most the number of participating households whose behaviour contributed to the observed changes. This represents 29.8 percent of the original targeted sample.

Unfortunately, further statistics on the detailed results have not been published. As a result, it is not possible to complete an analysis similar to that undertaken for the Perth case. However, there are concerns raised by these numbers that would suggest the likelihood that, as with Perth, there may be overstatement of the shifts of car driver to other modes in the population, especially with the low trip rates that are given.

4. TRAVEL BLENDING®

The Travel Blending® approach is similar to yet different from Indimark®. Where Indimark® attempts to undertake individualised marketing of public transport, walk, and bicycle to individuals, through provision of information, Travel Blending® works by trying to make people more aware of their travel patterns and then offering suggestions for ways in which travel patterns could be changed, to reduce possibly unnecessary or wasteful travel (Rose and Ampt, 2001). The first test of this method in Australia was in Sydney, in connection with the Olympic Games, and the second has been in Adelaide. The Sydney test was a small-scale pilot test, and statistical analysis of the results has not been published. The test in Adelaide, reported by Rose and Ampt (2001), concerned 100 households.

Travel Blending® is aimed more at reducing trips overall, as well as reducing the use of car driver. It is also aimed at reducing the time spent in travel, and the distance travelled. This can be contrasted to the statistics of Table 5, which shows that Perth, at least, maintained total distance travelled and time spent in travel. While Indimark® is applied on a community-wide basis, through contacting all households in a traditional household travel survey mode, Travel Blending® targets specific groups in the community, such as Primary Schools, Neighbourhood Watch groups, small businesses and shops, larger businesses, and activity groups, such as churches (Ampt, 1999).

Compared to Indimark®, there is relatively little published on the results of the application of this method. In a paper in 2001 (Rose and Ampt, 2001), some figures are provided from a trial in Adelaide that involved 96 households. These were households drawn from four government departments, so do not represent a representative sample of the community. This experiment resulted in significant change in car driver behaviour, with trips being reduced by nearly 14 percent of all households approached, and car driver kilometres decreasing by 11 percent, and time in the car by 19 percent. Because of the nature of the sample, these figures cannot be generalised. Rose and Ampt conclude that “These results, while very encouraging, must be interpreted cautiously. Further research will be required to explore the generalisability and magnitude of the effect of the Travel Blending® Program on travel behaviour.” We concur with this conclusion. A much more recent document (SDG, 2003) outlines the approach to a more widespread test in Adelaide, but does not provide results of the programme at this time. It would therefore appear that Travel Blending® is being promoted more cautiously at this time. Some lessons can probably be learned for the assessment of results on a larger scale, by looking at the findings of this paper.

5. THE SYSTEM CONTEXT

In addition to the somewhat biased statistics that have been provided on Indimark®, resulting from problems with household size, trip making, and non

mobility, there are two further problems with the assumptions of the effectiveness of Indimark®.

5.1 INDUCED TRAVEL AND CAR DRIVER SHIFTS

Any time that a transport policy is implemented that results in reduction of car travel, there is the probability that this reduction by a part of the population will give rise to increases in travel by those in the population not affected by the policy change. In the Perth case, there are only just less than 28 percent of households that were interested in participation in the pilot, 40 percent in the large-scale application, and probably 30 percent in Brisbane. If there were a shift out of car by this portion of the population, the reduction in car travel would result in some improvement to travel speeds on the road system in the local area. Reductions in car driver trips can be expected to operate in a similar manner to increases in capacity, because both have the same effect – an improvement in travel speeds. The effect that can be anticipated is that there will be an increase in travel, resulting from induced demand. Because 9 percent of the population in Perth were public transport users already, and 28 to 40 percent were interested in participating in Indimark®, there is a pool of 50 to 63 percent of households that could contribute to the induced demand. In Brisbane, the figures are almost identical with 9 percent using public transport, and 30 percent interested in participating in Indimark®, resulting in a pool of 61 percent of the population who are not using public transport and who are not interested in Indimark®. This segment of the population is likely to take advantage of improved travel speeds by travelling more.

While there has been no such measurement to date, it seems implausible to suppose that the changes anticipated to arise from implementing Indimark®, by itself, would result in any noticeable reduction in congestion levels, or overall car use. Instead, it would appear most likely that the results of implementing Indimark® would be roughly as follows:

In the short term, there may be a shift from car driver to EFMs by the approximately 35 percent of the population that may volunteer to participate in the program. Using optimistic figures, one might expect that this group could shift as much as 20 percent of their car driver trips from car driver into other modes, such as public transport, ride sharing, walk, or bicycle. This would result in an overall drop in car driver trips of about 7 percent. Evidence from Perth and Brisbane indicate switching *to* car driver *from* other modes by the general population, without any induced traffic, or other effects. For example, James *et al.* (1999) indicate that, in eleven years in South Perth, car driver increased by 5 percent, while other modes decreased by a total of this amount, with most of the losses coming from walking. Prorating this, one could assume that the annual change to car driver in the population at large is about 0.5 percent. Thus, within about fourteen years, with no other effects than the continuing shift into car driver travel, the gains of Indimark® would be eliminated by the rest of the population.

Assuming population growth of between 1 and 2 percent per annum, the 7 percent shift of car driver trips will be taken up by growth in about four years. In addition, before that is complete, it could be expected that induced travel would also result in increased car driver travel from the 60 percent of the population that is not interested in Indimark® and is not already riding public transport. In contrast to the 20 percent shift out of car driver, it would take less than a 10 percent increase in trip making by those not participating in Indimark® to wipe out the gains of the programme.

5.2 CHOICE OF SUBURBS

It is also important to note here that the Perth experiment chose one suburb – South Perth – as the basis of the experiment, and Brisbane chose a group of inner north suburbs comprising the Ward of Grange. This is both understandable and expected – one would usually apply an experimental programme of this type in locations where it would be easiest to show success, and where it is also relatively easy to get people to shift mode. In neither case was there an attempt to draw a representative sample from the entire region, although claims were subsequently made about what this program would do for the entire region, based on applying the figures for the interested subgroup to the full population. For example, Marinelli and Roth state:

> "The enormous social and economic benefits support its wide scale application in the Queensland urban context. [Indimark®] could be a major tool in holding current private vehicle growth in check for several years to eliminate or delay the need to spend several billion dollars on road expansion and technology solutions." (Marinelli and Roth, 2002).

In the case of Perth, the suburb chosen was South Perth. This is an inner city suburb that is not representative of the Perth region. On median income, workforce participation, and median age, it is similar to Perth as a whole. However, it has smaller households, lower car ownership, and higher use of environmentally friendly modes of travel, as shown in Table 6. It also has a smaller proportion of children and a larger proportion of persons over 65. Clearly South Perth is not representative of Perth, and extrapolation of results from South Perth to the Perth Metropolitan Region is not a valid procedure. The use of Victoria Park as a control community for the large scale application also seems somewhat odd, after reviewing the statistics in Table 6. Victoria Park is geographically adjacent to South Perth and also an inner city area. However, it has even smaller households, fewer children, more elderly, lower employed workers, much higher proportion of non-car-owning households, and much lower percentage driving to work than South Perth, let alone the entire Perth region. Using this community as a control seems open to considerable question.

Similar statistics compiled for the Grange Ward in Brisbane are shown in Table 7. There appears to be a very similar pattern here to that of Perth. Grange Ward has smaller households (identical in size to those of South Perth), fewer children, more elderly, substantially more non-car-owning households, fewer cars per household, many fewer persons driving to work, and substantially higher public transport use than the entire Brisbane region.

Table 6: Comparative Statistics for Perth and South Perth

Statistic	Perth	South Perth	Victoria Park
Average Household Size	2.6	2.2	2.0
Median Weekly Household Income	$800-$999	$800-$999	$600-$699
Median Age	34	35	34
Percentage of Persons Aged Under 15	20.7%	13.7%	12.7%
Percentage of Persons Aged Over 65	11.3%	14.0%	17.3%
Percentage of Single Parent Families	15.5%	15.9%	17.4%
Percentage of Workforce Employed	92.3%	93.2%	90.0%

Percentage of Non Car Owning Households	7.8%	9.7%	16.1%
Average Car Ownership per Household	1.57	1.38	1.17
Percent Driving to Work	63.2%	61.5%	57.0%
Percent Using Public Transport to Work	8.4%	9.8%	14.0%
Percent Walk or Bicycle to Work	2.7%	4.0%	4.6%

Source: ABS (2002a), (2002b), (2002c)

Table 7: Comparative Statistics for Grange Ward and Brisbane

Statistic	All Brisbane	Grange Ward
Average Household Size	2.6	2.2
Median Weekly Income	$800-$999	$800-$999
Median Age	34	34
Percentage of Persons Aged Under 15	20.9%	16.5%
Percentage of Persons Aged Over 65	11.0%	13.1%
Percentage of Single Parent Families	16.4%	16.3%
Percentage of Workforce Employed	92.2%	93.4%
Percentage of Non Car Owning Households	9.8%	14.7%
Average Car Ownership per Household	1.46	1.25
Percent Driving to Work	58.2%	51.5%
Percent Using Public Transport to Work	11.4%	19.1%
Percent Walk or Bicycle to Work	3.4%	4.3%

Source: ABS (2002d), (2002e)

Because the suburbs chosen for the experiment are inner city suburbs with lower car ownership than average, smaller households, fewer children, more elderly persons, and already a more public transport orientated workforce would tend to suggest that there would be much greater likelihood that persons in these suburbs would be likely to be influenced to change from driving cars. Although it is very difficult to quantify such things, it is likely that these areas – South Perth, Victoria Park, and Grange Ward – have better public transport service because of their proximity to the CBD, and it is also more likely that workers in these two areas will tend to work where bus routes provide travel options. The issue surely must be whether a similar result to that reported for South Perth and Grange would occur in a suburb that is some distance from the CBD, has relatively poor bus service, has larger households with more children present, and has many fewer people travelling to the CBD for work.

6. EFFECTS OF SAMPLING ERROR

Another matter for concern in all of this is that the effects of sampling error appear to be ignored in looking at the shifts in mode use. It appears that the population of South Perth is 18,626 households (Goulias, 2001). In the original work of James (1998), a sample of 498 households was planned. The actual sample realised was 383 households. However, the statistics on modal shifts for those participating in the Indimark® programme are based on 138 households, which is the number that is important for estimating sampling errors. Furthermore, the results are based on determining a difference between two occasions. The sampling error for a difference between two occasions has a variance that is equal to the sum of the variances on each of the two occasions, less twice the covariance between the two occasions (Yates, 1965). Because variances and covariances are not provided, they

must be assumed. Because change has taken place, and different households are likely to have behaved differently, the assumption is made that the correlation between the before and after surveys is 0.9. It is also assumed here that all of the 138 households responded on both occasions (which is probably not the case), which will give the lowest sampling error estimate. Given the population of 18,626 and a sample of 138, the finite population correction can be ignored.

The specific interest here is in a change in proportions. In other words, the sampling error should be estimated for $(p_2 - p_1)$ where p_2 and p_1 are the proportions using a particular mode in the after and the before survey, respectively. The sampling error of the change in a particular mode is:

$$s.e.(p_2 - p_1) = \sqrt{\frac{(V(p_2) + V(p_1) - 2r\sqrt{V(p_2)V(p_1)}}{n}}$$

The variance of a proportion is $p(1 - p)$. Therefore, assuming the n is 138, and r is 0.9, the sampling errors for the modal share differences for the Perth experiment are shown in Table 8.

Table 8: Sampling Errors for the Perth Initial Sample

Mode	Before		After		Change	Sampling Error	95% Confidence
	No.	Percent	No.	Percent			
Walk	70	6.03%	85	7.33%	1.29%	±0.97%	1.90%
Bicycle	232	20.00%	241	20.78%	0.78%	±1.53%	3.01%
Car Driver	696	60.00%	629	54.22%	-5.78%	±1.88%	3.69%
Car Passenger	23	1.98%	44	3.79%	1.81%	±0.76%	1.49%
Public Transport	139	11.98%	161	13.88%	1.90%	±1.29%	2.52%
Total	1160	100.00%	1160	100.00%			

By comparing the last column of this table with the column headed “change”, it can be seen that the change in walk is not statistically significantly different from zero at 95 percent confidence, nor is the change in bicycle. The change in car driver could be anywhere from 2.09 percent to 9.47 percent, that for car passenger between 0.32 percent to 3.3 percent, and that for public transport is also not significantly different from zero. Changing the correlation between the two occasions from 0.9 to 0.95 or to 0.85 does not change the conclusions on statistical significance, although it does change slightly the bounds of the 95 percent confidence interval on car driver and car passenger.

Even in the larger scale application in South Perth in 2000, the sample from which change is estimated is still only a sample of 706 households. While this size of sample improves the statistical reliability of the measurement of change, it still leaves some considerable degree of uncertainty in the actual figures as shown in Table 9.

Again, these figures are based on the assumption of a 0.9 correlation between the before and after figures, which may not be reasonable. Also, it is more likely, in this case that the two samples are independent, because the before sample was from the pilot study, and the after sample is from households that were not included in the

original pilot study. In that case, the errors change rather significantly, as shown in Table 10. Now, only the car driver and walk changes are statistically significant, with the former ranging from a change of 2.87 to 13.19 percent, and the latter changing between 0.37 and 7.61 percent.

Table 9: Sampling Errors for the Perth Initial Sample

Mode	Before		After		Change	Sampling Error	95% Confidence
	No.	Percent	No.	Percent			
Walk	237	12.02%	582	16.01%	3.99%	±0.60%	1.18%
Bicycle	39	1.98%	109	3.00%	1.02%	±0.28%	0.56%
Car Driver	1183	60.02%	1890	51.99%	-8.03%	±0.83%	1.63%
Car Passenger	394	19.99%	800	22.01%	2.02%	±0.69%	1.35%
Public Transport	118	5.99%	254	6.99%	1.00%	±0.42%	0.82%
Total	1971	100%	3635	100%			

Table 10: Sampling Errors Assuming Two Independent Samples

Mode	Before		After		Change	Sampling Error	95% Confidence
	No.	Percent	No.	Percent			
Walk	237	12.02%	582	16.01%	3.99%	±1.84%	±3.62%
Bicycle	39	1.98%	109	3.00%	1.02%	±0.83%	±1.62%
Car Driver	1183	60.02%	1890	51.99%	-8.03%	±2.63%	±5.16%
Car Passenger	394	19.99%	800	22.01%	2.02%	±2.17%	±4.25%
Public Transport	118	5.99%	254	6.99%	1.00%	±1.31%	±2.57%
Total	1971	100.00%	3635	100.00%			

One must, therefore, conclude that there is great uncertainty in the claimed results, based on the sampling errors that have been estimated here. Indeed, it may be suggested that the changes to walking, bicycling, and public transport found in the two surveys could have occurred purely by chance, although there is evidence that there has been a non-zero change in each of car driver and car passenger.

7. SUSTAINABILITY OF THE CHANGES

Little has been written to date about the sustainability of Indimark®. In their paper, Marinelli and Roth (2002) suggest that the South Perth experiment has shown sustainability for a period of two and one half years, although the report on which this is based does not appear to be a published source. They also suggest that reports from Germany indicate sustainability over a period of four years. No references are provided to back up this claim. There is also no indication as to whether the Indimark® behaviours have been sustained through further individualised marketing to the participants, or whether they have maintained the behaviours without further reinforcement. Given the mobility of people generally in countries such as Australia, the U.S., and elsewhere, it seems likely that these behaviour changes might be threatened once people move out of the area where they first participated in

Indimark®. It also seems likely that, as households change through births, deaths, divorce, children leaving home, and other such changes, these behaviour changes may not be sustained, unless the programme is repeated periodically with the population. Cost-benefit calculations reported on the programme do not appear to take into account any repetition of the Indimark® programme to reinforce the behaviour changes.

8. CONCLUSIONS

Both Indimark® and Travel Blending® appear to be capable of causing change in car driver behaviour. Indimark® appears able to result in shifts from car driver to more environmentally friendly modes of travel, while Travel Blending® appears to result in both shifts in travel mode and decrease in the amount of travel undertaken. The two approaches are significantly different in what is done and in the results that are sought, except that both aim to reduce car driver travel.

In assessing Indimark®, there appear to be several areas in which the results that have been reported in the literature, and that have been offered to policy makers may be over-stated. In analysing the results that have been presented in the literature, and also in reports and private communications, several conclusions can be drawn about Indimark®.

1. The large-scale surveys done to evaluate Indimark® appear to be biased towards smaller households with lower travel than the general population in the suburbs in which it has been applied.
2. The surveys appear also to have under-reported travel, especially when compared to similar surveys in Adelaide and Sydney, with identical response rates, where trip rates are 15 to 20 percent higher than reported from the Indimark® surveys
3. These two factors together – lower trip rates and smaller households – probably should result in a reduction of the claimed impacts of Indimark® from 10 to 14 percent reduction in car driver trips to around 7 to 9 percent.
4. Taking into account non-contacts and non-respondents, the total population-wide impact of Indimark® should be further reduced to a figure in the region of 5 to 7 percent.
5. It is clear that the suburbs in which these results have been obtained are atypical of the urban area. It suggests that either Indimark® will have less effect if applied in outer suburbs, or that its applications should be concentrated on certain types of suburbs, where the chances of significant shifts will be largest. It is not, as suggested by Marinelli and Roth (2002), a procedure that could be applied metropolitan-area wide with the same results as found in these tests.
6. No account has been taken of the potential for other residents of the region to take advantage of the improvements in traffic resulting from Indimark® to increase their car driver travel, and eliminate the improvements from Indimark® in a relatively short time.
7. Sampling error has not been taken into account in reporting out the results of Indimark®. Because the samples are always only a few hundred households, the sampling errors for change in behaviour are rather large, and make it even less clear what the actual magnitude of the shifts is that can be expected.
8. Some of the data used to substantiate independently the behaviour changes appears to be suspect, or could be interpreted to show no impact.

9. The sustainability of the changes from Indimark® is yet to be proved. This suggests that a somewhat more cautious approach should be used for the present.

In the case of Travel Blending®, claims of its success have been more subdued than for Indimark®, and the approach taken appears to be more consistent with the limited applications to date. Much could be learned for evaluating both Indimark® and Travel Blending® by paying attention to some of the issues that have been highlighted in this paper. For example, care should be taken to ensure representativeness of household size in the samples both for evaluation and benchmarking. Also, benchmark surveys should not only be undertaken in similar suburbs, but also in dissimilar suburbs, to check to see to what extent there may be under-reporting of travel. Larger samples are needed for evaluation, in order to move away from the large sampling errors, or a panel approach should be taken.

TravelSmart – both Indimark® and Travel Blending® – has been shown to have the potential to change behaviour. However, the actual magnitude of the shifts that can be achieved, and the extent to which these will be achieved in the entire metropolitan area, remain yet to be clearly established, as does their sustainability over time. Claims that Indimark® will shift 10 to 14 percent of car driver trips out of that mode and into other more environmentally friendly modes must be treated with considerable caution.

Finally, as noted in a recent review for the UK Department for Transport (Department for Transport, 2002):

> "It is clear that the techniques will generally only work 'on their own' where there is a large gap in perception between what exists and what people believe exists. For public transport, where services and travel quality is much higher than is perceived, personalised approaches can have very large effects, but where such a gap does not exist the travel behaviour effects could be negligible. For walking and cycling encouragement, the factors that will lead to increases are more complex, but the concept of a 'perception gap' is still of relevance."

The same report also notes that these approaches are likely to work best when "…patronage on services … is lower than would be expected given the quality of those modes in the area and the journey demands that exist." (Department for Transport, 2002). This is an important point, and may be the reason for the success in South Perth and Grange, and equally well may be a reason for the method being markedly less successful in more distant suburbs.

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