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Establishing and Using a Before and After Panel Survey:
Case Study of New South Wales

By

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ABSTRACT: This paper describes the use of a panel in a pilot TravelSmart project in New South Wales. The survey was conducted using two-day diaries, for which households were initially contacted and recruited by phone, and then sent diaries in the post. The diaries were returned by post with two postcard and one phone call reminder. During recruitment, households were asked if they would be willing to do the survey a second time about 9 months later, and were recruited only if they agreed to do so. The second wave of the panel was initiated about 9 months later, and only households that had responded to the first survey were contacted again. The survey was completed in early March 2005. Out of 1107 households that completed the before survey, 776 (70 percent) completed the after survey. A significant change was found in vehicle kilometres of travel for those households that received TravelSmart tools, but there were no significant differences found in numbers of trips, or proportions of trips by either mode or purpose. However, the panel approach that was used in this study proved of considerable value. It is demonstrated in this paper that, without the panel, the same sample size would have yielded much less information about possible changes, or alternatively that a much larger sample would have to have been used, with concomitantly higher survey costs.

KEY WORDS: ***Sample Size, Panel, Travel Survey, TravelSmart, Voluntary Travel Behaviour Change.***

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1. Introduction

Since the mid-1990s, voluntary travel behaviour change (VTBC) has emerged in Australia as a potentially significant policy initiative, with promise to reduce dependence on the car, and to contribute to some degree to the reduction of greenhouse gas emissions from transport, and to a reduction in local traffic congestion (Ampt and Rooney, 1998; James, 1998; Ampt, 1999; James *et al.*, 1999; Rose and Ampt, 2001; James, 2002). While this policy has been introduced in pilot and full-scale versions in Perth, Adelaide, Melbourne, Brisbane, Canberra, and Townsville, it has only recently been considered for the Sydney region. VTBC has also been implemented elsewhere in the world, especially in Europe, the UK, and now the USA. However, it is a policy that appears to have been initiated in Australia (James *et al.*, 1999).

Known generally by the name that was registered for it in Western Australia, TravelSmart® consists of voluntary travel behaviour modification tools that provide information that may influence people's travel choices. TravelSmart projects convey information about travel and activity alternatives and attempt to motivate people to change their travel behaviour. TravelSmart typically focuses on helping individuals to identify travel options that are realistic, achievable, and convenient, and that provide personal benefits. The alternatives promoted can include finding alternative activity locations, combining travel with other family members, eliminating some travel altogether, and changing from solo drive to car passenger, public transport, bicycling, and walking. In some instances, mode change is the primary focus of the strategy, while in others, the focus is on reducing overall travel.

The NSW Department of Planning (formerly part of the NSW Department of Infrastructure, Planning and Natural Resources) initiated pilot testing of the implementation of a TravelSmart Households program in New South Wales in April 2004. Implementation of TravelSmart was undertaken by the consulting firm of Steer Davies Gleave (Steer Davies Gleave, 2005). Evaluation of the effectiveness of the TravelSmart program was undertaken by the Institute of Transport and Logistics Studies, The University of Sydney. This paper describes the evaluation of the pilot TravelSmart Households implementation in the suburbs of Ermington in the Parramatta Local Government Area, and Woy Woy in the Gosford Local Government Area.

2. Background

The objectives of the project were to:

- Implement a voluntary travel behaviour change program for 3,600 households in Ermington and 2,000 households in Woy Woy
- Achieve increases in public transport patronage, walking and cycling and decreases in car trips and car kilometres in Ermington and Woy Woy without restricting personal activity
- Measure at a high level of confidence (95%) the extent to which travel behaviour has changed
- Identify benefits from the program
- Obtain a factual basis to assess the potential for further application of voluntary travel behaviour change in NSW.

2.1 Parramatta Local Government Area and Ermington

Ermington is located within the Local Government Area of Parramatta. In 2001, the Parramatta Local Government Area (LGA) had a population of approximately 143,000 people. The city of Parramatta employs about 86,000 people, including the second largest Central Business District in New South Wales. Parramatta City is well served by public transport. Regular train services operate to the Sydney Central Business District as well as other major suburban centres. Bus services are operated into and out of Parramatta. At present, the Parramatta Transport Interchange is being constructed to allow inter-modal transport to be more efficient and convenient for employees, residents, and visitors to the Parramatta area.

Ermington is located 18.3 kilometres west of the centre of Sydney, and almost 6 kilometres east of Parramatta City. In 2001, the suburb of Ermington (SSC) had a population of 10,318 and an average household size of 2.7. Thus, there were around 3,820 households in the area. Compared to the Sydney Statistical Division (SSD), in Ermington the median age at 37 years was higher, the median weekly income range of $700-799 for people over 15 years was lower, the percentage of people over the age of 65, at 15.5%, was slightly higher, the rate of non-car ownership, at 15 %, was greater, and employment rates were the same as the SSD average. The level of public transport in Ermington is extensive, and includes regular bus, train and ferry services to the Sydney CBD.

2.2 Gosford Local Government Area and Woy Woy

The Local Government Area of Gosford is located north of Sydney and is part of the Central Coast of New South Wales. Its resident population in the 2001 Census was approximately 155,000. The F3 freeway and the railway provide direct links to Sydney, as well as to the North Coast of New South Wales. There are bus services to major local service centres, such as shopping centres, and links to railway services.

The suburb of Woy Woy (SSC) is located almost 86 kilometres north of Sydney, in the Central Coast of NSW. In 2001, the resident population was 9,925 and average household size was 2.2, meaning that there were around 4,500 households in the area. This lower average household size probably reflected the larger proportion of retirees in the area and the higher rates of unemployment. In comparison to the Sydney Statistical Division, in Woy Woy the median age at 44 years was much higher, the median weekly income range of $500-599 for people over 15 years was much lower, the percentage of people over the age of 65, at 26%, was much higher, the rate of non-car ownership, at 22% percent, was much greater, and employment rates were lower than the SSD average.

The lower rate of car ownership reflected the lower income and employment rate of the population in Woy Woy. It is interesting to note that public transport is used by almost 30 percent of trips to work in Woy Woy and that this was much higher than that reported for Sydney (19.7 percent). Woy Woy is serviced by buses and inter-city trains connecting residents to Sydney and Newcastle.

3. Methodology

3.1 Control Groups

Control groups are necessary for this type of evaluation, so that one can separate out the travel behaviour changes that take place as a result of various outside influences from those caused by the TravelSmart project itself. When selecting control groups for this type of evaluation, it is particularly important to compare similar suburbs or households for assessing the level of change brought about by efforts to modify travel behaviour. More specifically, the selected control group should have a similar socio-demographic and geographic profile to the main study area. Important demographics including accessibility to public transport; car ownership levels; age structure; income; and employment levels all have a major impact on household travel activity and should be as similar as possible.

Two control areas were selected:

- For Ermington, Dundas was the control area
- For Woy Woy, Ettalong Beach was the control area.

The region northwest of Ermington represented the best area from which to choose a control suburb. Dundas was selected because it has a very similar socio-demographic profile to Ermington. The only major difference between the two areas is that Ermington has a noticeably higher percentage of single parent families. This appeared to be a unique characteristic of Ermington not reflected in any of its surrounding suburbs. Dundas and Ermington also have very similar levels of car ownership, which is an important consideration. To minimise any possible contamination of the control group, the eastern part of Dundas was excluded from the study because of its proximity to the target area of Ermington.

The relative isolation of Woy Woy means the area is geographically unique, and made selecting a control area somewhat difficult. However, Ettalong Beach has a very similar socio-demographic profile to Woy Woy. Like Woy Woy, the suburb has a substantial percentage of residents over the age of 65. Car ownership levels and public transport use are also quite similar between the two areas. Ettalong Beach does not share a common boundary with Woy Woy, which minimised potential for contamination of the control group. However, it is also important to note that Woy Woy contains a rail station, with direct express service to Sydney, while Ettalong Beach does not.

3.2 The Sample

To measure change accurately and cost-effectively, we employed a panel design, i.e., the same households were asked to complete both the before and after surveys. A panel reduces the sampling error of the results and, therefore, allows a smaller sample to be used. The specific type of panel used in this case was a subsample panel.

Because a panel survey was employed, it was important to estimate accurately the sample size and account for panel attrition. Attrition is expected in any panel survey, not only because respondents decide that they no longer want to take part, but because of death, changing eligibility of respondents (e.g., moving out of the survey area), and household

break-up. Before executing the before survey, we estimated that panel attrition would be around 25 percent.

We decided that the most cost effective way to deal with sample attrition was to increase the before sample size so that, after attrition, the after sample size would be sufficient for measuring change in travel behaviour. It was calculated that a sample for initial recruitment of 1,950 households from Ermington, 1,500 from Dundas, 990 from Woy Woy and 700 from Ettalong Beach would be required to account for attrition and allow the desired confidence in the measures of change. Household addresses were obtained from local councils, and households were drawn at random from these lists.

3.3 The Survey Instrument

There were two primary survey instruments; a two-day travel diary for each household member and a household and vehicle information form. The diary was to be completed by every individual over 14 years for themselves, and by an adult for each child in the household. The household and vehicle information form collected information about household size and age structure, education and employment status of each household member, household income, and the number and type of vehicles available to the household, including the odometer readings from each household vehicle at the beginning and end of the diary period.

When household members change their travel behaviour, their options include moving some activities from one day to another, especially moving activities between weekdays and weekend days, and also reducing the frequency of some activities. Because of this, the ideal instrument would probably be a diary to be completed over multiple weeks. However, such an instrument would be extremely burdensome, the response rate would be likely to be extremely low, and the accuracy of self-reporting is known not to be as high as would be desirable. Even a one-week instrument would be likely to be too burdensome for most households to complete.

Therefore, it was decided that a two-day diary would be used for the evaluation of household travel behaviour change. However, a two-day diary is not without its problems; it is still subject to a drop off in reporting on the second day compared to the first, and also does not allow for any measurement of potential changes that may occur across an entire week. Despite this, it is preferable to a one-day diary which might measure an unusual day, and provides no information about shifts in behaviour across days.

3.4 The Recruitment Process

Recruitment involved three steps. Household addresses were obtained from local councils, and households were drawn at random from these lists. The selected households were then matched with phone numbers to allow for telephone recruitment. Enough addresses were drawn to obtain approximately 1,950 households from Ermington, 1,500 from Dundas, 990 from Woy Woy and 700 from Ettalong Beach to be matched with phone numbers.

The second step was to send each sampled household with a known telephone number a pre-notification letter. The letter was sent to inform prospective respondents of the purpose of the study, for whom it was being done, and to provide a contact phone number if there were any concerns. None of the survey materials made mention of the

TravelSmart intervention, nor did they include any reference to the firm undertaking the intervention. Pre-notification letters were mailed to 5,182 prospective households across the four suburbs. We opted for a mail out followed by telephone recruitment, this being more cost-effective than a combination of mail and face-to-face recruitment.

The third step was to call households to recruit them for the survey. Households in the four suburbs were called over a period of three weeks, starting on 26 May 2004 and continuing until 16 June 2004. On the basis of information about household size retrieved in the recruitment call, diary packages were assembled and sent to recruited households.

Diary packages included:

- A covering letter reminding respondents of the purpose of the study
- A two-day travel diary for each member of the household
- A household and vehicle information form
- A household consent form and subject information statement
- Travel day cards – each household was assigned specific days of the week so that travel behaviour across the week would be captured.

The same procedure was applied again in the after survey when households were recontacted during March 2005. In an effort to reduce respondent burden in the after survey, the household and vehicle information forms were customised for each household. The data provided by the respondent in the before survey were printed on the form, and respondents were asked to correct and/or update them if necessary.

3.5 Quality of the Survey Data

Before proceeding to an analysis of the data, it is important to review the quality of the data obtained from the diary surveys. There are several accepted measures of data quality, three of which - survey response, non-mobility, and trip rates – were used in this study. The results of these are reported in detail elsewhere (Stopher et al., 2005d). Only the response rates are included in this paper.

3.5.1 Survey Response

Table 1 illustrates the total number of households contacted in each of the four suburbs surveyed. It also provides the actual numbers of households that were recruited and the number of those households that returned data in each of the before and after surveys.

Table 1: Responding Households for the Before and After Surveys[1]

Suburb	House-holds Contact-ed [2]	Eligible Households Contacted (Percentage of Total Households)	Households Recruited (Percentage of Eligible Households)	Households Returned Information in "Before" Survey (Percentage of Eligible Households)	Households Recruited for "After" Survey (Percentage of "Before")	Households Returned Information in "After" Survey (Percentage of "Before")
Ermington (t)	1,973	1,314 (66.6%)	670 (51.0%)	406 (30.9%)	310 (76.4%)	277 (68.2%)
Dundas (c)	1,507	985 (65.4%)	523 (53.1%)	328 (33.3%)	262 (79.9%)	219 (66.8%)
Woy Woy (t)	993	727 (73.2%)	360 (49.5%)	232 (31.9%)	189 (81.5%)	181 (78.0%)
Ettalong Beach (c)	709	487 (68.7%)	245 (50.3%)	141 (29.0%)	110 (78.0%)	97 (68.8%)
Total	5,182	3,513 (67.8%)	1,798 (51.2%)	1,107 (31.5%)	871 (78.7%)	774 (69.9%)

(c)= control, (t)= target

As a benchmark, postal surveys usually record response rates in the region of 20 to 25 percent for a one-off survey, based on known and estimated[3] eligible households (using the definition of response rate of the American Association for Public Opinion Research). In this survey, we succeeded in obtaining a complete response (meaning that household and vehicle forms and diaries were filled out and returned) from 31.5 per cent of known eligible households and 28 percent of the estimated and known eligible households. Given that households were recruited to a two-wave panel, this response rate is considered to be significantly higher than would usually be expected for such a survey. The other measures of quality also showed satisfactory results.

4. Results

The analysis is restricted to those households that constitute the panel, i.e., households that answered the survey in both the before and after waves, and provided complete answers for the relevant statistics. Excluded are those households that dropped out of the survey after wave 1, and any households that provided incomplete data in wave 1 and complete data in wave 2. In all of the following tables, we show the difference between before and after, the sampling error for the difference and the 95 percent confidence range. If the difference between the before and after values is less than the 95 percent confidence range, then the difference is not statistically significant, and could have arisen by chance. If the difference is greater than the 95 percent confidence range, then it is considered to be statistically

[1] Note that while this table shows *responding* households, different combinations of these are used in other tables, depending on their relevance (e.g. weekday, weekend, receiving tools, etc).

[2] Includes no contact after 5 attempts (449), ineligible households (128), invalid numbers (809), and households not in the sample area (65) for a total of 1,451 non-contactable and ineligible households. In addition, there are 147 households with a language barrier (therefore ineligible) and 71 for which there were still outstanding call backs.

[3] Estimated eligible households are determined by calculating the proportion of eligible households from the telephone numbers of known eligibility, and applying this rate to the telephone numbers for which eligibility was never established.

significant and that the true value of the difference lies somewhere within the 95 percent confidence range.

4.1 Trips per Household

First, we looked for differences for each target area (participating and non-participating households combined) and for each control area (Table 2). We found no significant differences in overall weekday trips for any area, but a significant decrease in overall weekend trips in Ermington.

Table 2: Comparison of Daily Trips per Household Before and After by Suburb

Days	Suburb	Sample	Trips/ Day		Difference in Trips	Sampling Error	95% Confidence
			Before	After			
Weekdays	Ermington (P and NP)	222	10.71	9.96	-0.75	±0.41	±0.80
	Dundas (C)	181	10.03	9.45	-0.58	±0.36	±0.70
	Woy Woy (P and NP)	133	9.14	8.44	-0.7	±0.54	±1.05
	Ettalong Beach (C)	86	6.07	5.78	-0.29	±0.44	±0.87
Weekends	Ermington (P and NP)	107	10.36	8.86	-1.50	±0.57	±1.11
	Dundas (C)	84	6.90	6.81	-0.09	±0.54	±1.06
	Woy Woy (P and NP)	85	7.81	7.39	-0.42	±0.63	±1.24
	Ettalong Beach (C)	36	4.47	3.44	-1.03	±0.74	±1.45

C=control; P=participating; NP=non-participating,

To ascertain whether changes in particular areas were due to unique interactions between suburbs and due to TravelSmart participation, we compared the results across the following six groups, as shown in Table 3. We found no significant differences in overall weekday trips, but a significant decrease in overall weekend trips among households in Ermington who participated in the TravelSmart program.

Table 3: Comparison of Daily Trips per Household Before and After

Days	Suburb	Sample	Trips/Day		Difference in Trips	Sampling Error	95% Confidence
			Before	After			
Weekdays	Ermington (P)	145	11.14	10.61	-0.53	±0.38	±0.75
	Ermington (NP)	77	9.9	8.71	-1.19	±0.94	±1.84
	Dundas (C)	181	10.03	9.45	-0.58	±0.36	±0.70
	Woy Woy (P)	69	10.78	9.96	-0.82	±0.97	±1.90
	Woy Woy (NP)	64	7.36	6.8	-0.56	±0.41	±0.81
	Ettalong Beach (C)	86	6.07	5.78	-0.29	±0.44	±0.87
Weekends	Ermington (P)	74	11.41	9.86	-1.55	±0.72	±1.41
	Ermington (NP)	33	7.98	6.59	-1.39	±0.90	±1.76
	Dundas (C)	84	6.90	6.81	-0.09	±0.54	±1.06
	Woy Woy (P)	48	8.40	8.19	-0.21	±0.76	±1.49
	Woy Woy (NP)	37	7.05	6.36	-0.69	±1.08	±2.11
	Ettalong Beach (C)	36	4.47	3.44	-1.03	±0.74	±1.45

C=control; P=participating; NP=non-participating

We looked for differences in travel mode use by target area, as shown in Table 4. We found a few significant changes: a decrease in weekday public transport trips in Ermington and Dundas; a decrease in weekday car driver trips in Woy Woy; an increase in weekday walk/cycle trips in Woy Woy; a decrease in weekend public transport trips in Ermington; and a decrease in weekend car driver trips in Ermington.

Table 4: Comparison of Daily Trips by Mode per Household Before and After by Suburb

Days	Suburb	Mode	Sample	Trips/Day		Difference in Trips	Sampling Error	95% Confidence
				Before	After			
Weekdays	Ermington (P and NP)	Car Driver	221	4.96	5.16	0.20	±0.24	±0.47
		Car Passenger	221	2.49	2.42	-0.07	±0.24	±0.47
		Public Transport	221	1.05	0.79	-0.26	±0.10	±0.20
		Walk/Cycle	221	1.26	1.08	-0.17	±0.13	±0.26
	Dundas (C)	Car Driver	181	4.79	4.97	0.18	±0.22	±0.43
		Car Passenger	181	1.79	1.89	0.10	±0.17	±0.32
		Public Transport	181	1.07	0.83	-0.24	±0.11	±0.21
		Walk/Cycle	181	1.48	1.27	-0.21	±0.15	±0.30
	Woy Woy (P and NP)	Car Driver	133	3.73	3.12	-0.61	±0.28	±0.55
		Car Passenger	133	1.97	1.94	-0.03	±0.28	±0.54
		Public Transport	133	1.11	0.90	-0.21	±0.12	±0.24
		Walk/Cycle	133	1.62	2.06	0.44	±0.21	±0.41
	Ettalong Beach (C)	Car Driver	86	2.36	2.82	0.46	±0.25	±0.49
		Car Passenger	86	1.22	1.03	-0.18	±0.22	±0.43
		Public Transport	86	0.56	0.61	0.05	±0.15	±0.29
		Walk/Cycle	86	0.99	0.92	-0.07	±0.24	±0.46
Weekends	Ermington (P and NP)	Car Driver	105	4.51	3.90	-0.62	±0.32	±0.62
		Car Passenger	105	3.50	3.37	-0.13	±0.30	±0.59
		Public Transport	105	0.40	0.22	-0.19	±0.08	±0.16
		Walk/Cycle	105	1.06	1.05	-0.01	±0.19	±0.38
	Dundas (c)	Car Driver	82	3.10	3.58	0.48	±0.28	±0.54
		Car Passenger	82	2.32	2.03	-0.29	±0.40	±0.78
		Public Transport	82	0.27	0.35	0.08	±0.12	±0.23
		Walk/Cycle	82	0.49	0.69	0.19	±0.21	±0.40
	Woy Woy (P and NP)	Car Driver	84	3.46	3.39	-0.07	±0.37	±0.72
		Car Passenger	84	2.55	2.40	-0.16	±0.35	±0.69
		Public Transport	84	0.40	0.40	0.00	±0.15	±0.30
		Walk/Cycle	84	0.92	0.92	0.00	±0.18	±0.36
	Ettalong Beach (c)	Car Driver	35	1.59	1.71	0.13	±0.47	±0.92
		Car Passenger	35	1.09	0.46	-0.63	±0.38	±0.74
		Public Transport	35	0.14	0.24	0.10	±0.16	±0.31
		Walk/Cycle	35	0.93	0.57	-0.36	±0.31	±0.61

C=control; P=participating; NP=non-participating

In our investigation of whether there were any changes in trips by mode due to participation in TravelSmart, as shown in Table 5, we found a significant decrease in weekday public transport trips among participating households in Ermington, and Dundas; a significant increase in weekday walk/cycle trips among participating households in Woy Woy; and a significant decrease in weekend public transport trips among participating households in Ermington.

Table 5: Comparison of Daily Trips By Mode per Household Before and After

Days	Suburb	Mode	Sample	Trips/Day		Difference in Trips	Sampling Error	95% Confidence
				Before	After			
Weekdays	Ermington (P)	Car Driver	144	5.17	5.54	0.36	±0.27	±0.53
		Car Passenger	144	2.66	2.90	0.25	±0.24	±0.47
		Public Transport	144	1.03	0.71	-0.32	±0.13	±0.26
		Walk/Cycle	144	1.32	1.07	-0.25	±0.16	±0.30
	Ermington (NP)	Car Driver	77	4.56	4.45	-0.11	±0.47	±0.91
		Car Passenger	77	2.18	1.53	-0.66	±0.51	±1.00
		Public Transport	77	1.08	0.94	-0.14	±0.15	±0.30
		Walk/Cycle	77	1.14	1.11	-0.03	±0.25	±0.49
	Dundas (c)	Car Driver	181	4.79	4.97	0.18	±0.22	±0.43
		Car Passenger	181	1.79	1.89	0.10	±0.17	±0.32
		Public Transport	181	1.07	0.83	-0.24	±0.11	±0.21
		Walk/Cycle	181	1.48	1.27	-0.21	±0.15	±0.30
	Woy Woy (P)	Car Driver	69	4.43	3.63	-0.80	±0.48	±0.95
		Car Passenger	69	2.32	2.35	0.03	±0.50	±0.98
		Public Transport	69	1.38	1.04	-0.35	±0.19	±0.37
		Walk/Cycle	69	1.75	2.46	0.71	±0.29	±0.57
	Woy Woy (NP)	Car Driver	64	2.97	2.56	-0.41	±0.27	±0.53
		Car Passenger	64	1.59	1.49	-0.10	±0.21	±0.41
		Public Transport	64	0.82	0.75	-0.07	±0.16	±0.32
		Walk/Cycle	64	1.48	1.63	0.16	±0.29	±0.57
	Ettalong Beach (c)	Car Driver	86	2.36	2.82	0.46	±0.25	±0.49
		Car Passenger	86	1.22	1.03	-0.18	±0.22	±0.43
		Public Transport	86	0.56	0.61	0.05	±0.15	±0.29
		Walk/Cycle	86	0.99	0.92	-0.07	±0.24	±0.46
Weekends	Ermington (P)	Car Driver	72	4.67	4.13	-0.54	±0.41	±0.80
		Car Passenger	72	4.22	4.21	0.00	±0.39	±0.76
		Public Transport	72	0.40	0.20	-0.20	±0.06	±0.13
		Walk/Cycle	72	1.26	1.21	-0.05	±0.24	±0.47
	Ermington (NP)	Car Driver	33	4.17	3.39	-0.77	±0.49	±0.96

Days	Suburb	Mode	Sample	Trips/Day		Difference in Trips	Sampling Error	95% Confidence
				Before	After			
		Car Passenger	33	1.95	1.56	-0.39	±0.42	±0.83
		Public Transport	33	0.42	0.26	-0.17	±0.22	±0.42
		Walk/Cycle	33	0.62	0.71	0.09	±0.32	±0.62
	Dundas (c)	Car Driver	82	3.10	3.58	0.48	±0.28	±0.54
		Car Passenger	82	2.32	2.03	-0.29	±0.40	±0.78
		Public Transport	82	0.27	0.35	0.08	±0.12	±0.23
		Walk/Cycle	82	0.49	0.69	0.19	±0.21	±0.40
	Woy Woy (P)	Car Driver	48	3.60	3.57	-0.03	±0.39	±0.77
		Car Passenger	48	2.74	2.88	0.14	±0.44	±0.86
		Public Transport	48	0.49	0.36	-0.13	±0.24	±0.48
		Walk/Cycle	48	0.98	0.95	-0.03	±0.27	±0.52
	Woy Woy (NP)	Car Driver	36	3.26	3.13	-0.14	±0.68	±1.33
		Car Passenger	36	2.31	1.74	-0.56	±0.58	±1.14
		Public Transport	36	0.28	0.44	0.17	±0.15	±0.30
		Walk/Cycle	36	0.83	0.87	0.04	±0.23	±0.46
	Ettalong Beach (c)	Car Driver	35	1.59	1.71	0.13	±0.47	±0.92
		Car Passenger	35	1.09	0.46	-0.63	±0.38	±0.74
		Public Transport	35	0.14	0.24	0.10	±0.16	±0.31
		Walk/Cycle	35	0.93	0.57	-0.36	±0.31	±0.61

C=control; P=participating; NP=non-participating

The net results by area suggest that significant changes occurred in the travel behaviour of households in Ermington between the before and after survey periods, regardless of whether or not they participated. A decrease in public transport trips in Ermington might suggest the influence of the intervention, but this does not explain the decrease in weekday public transport trips in Dundas, which was a control suburb. Instead, the lack of such findings in either Woy Woy or Ettalong Beach suggests that the decrease in public transport trips may have been unique to the geographical location encompassing Ermington and Dundas. In contrast, households in Woy Woy exhibited a decrease in weekday car driver trips and an increase in weekday walk/cycle trips, suggesting the influence of the TravelSmart intervention. However, it is important to note that the difference in season between the before and after surveys could have masked some of the effects of TravelSmart.

The disaggregated results by area suggest that participation may have partially had the desired effect in increasing walk/cycle trips in Woy Woy. A slight trend towards a decrease in car trips was also observed. These results also suggest that, at first glance, the TravelSmart intervention in Ermington appeared to have the opposite of the desired effect – a reduction in the number of public transport trips regardless of weekday or weekend. However, because the control group also experienced an equivalent, significant reduction in public transport trips it is more likely that the results reflect factors external to and

independent of the TravelSmart intervention. Seasonal differences may again have had an effect of masking some of the changes due to TravelSmart.

Overall, the results appear to show that the TravelSmart intervention had different effects on Woy Woy and Ermington. Woy Woy exhibited travel behaviour changes partially consistent with TravelSmart expectations, while Ermington exhibited changes inconsistent with TravelSmart expectations. The trip rate analysis shows relatively little impact of TravelSmart on trip rates for participating households. Partly, this is a result of what became rather small sample sizes once we split the sample by geographic area and further split by mode. Partly, it is a result of high variability in trip making, part of which almost certainly is a result of conducting the before and after surveys in different months of the year. Partly, it is also a function of the lack of accuracy in self reporting of travel. Had the before and after surveys been conducted in the same month of the year, it would be easier to determine if TravelSmart had the desired effects on trip rates. The fact that there is a lack of pattern in the changes for households that were in the control group areas, as well as for non-participating households within Ermington and Woy Woy suggests that other effects may have obscured our ability to measure changes in travel behaviour resulting from TravelSmart interventions. An examination of Tables 2 through 5 also shows that a number of measured changes are only slightly below the 95 percent significance level, suggesting that either a modest increase in sample size, or undertaking the surveys exactly one year apart may have shown a number of more significant changes in trip behaviour.

4.2 Vehicle Kilometres Travelled (VKT)

In examining the data for the odometer readings, we found three data quality issues. First, there were households that only reported a beginning or an ending reading, but not both. No information could be deduced from these reports on average daily VKT. Second, there were households who reported both readings, but did not report dates for either or both of the start and end reading. For these households, we could only use the odometer readings by inferring a period for the readings. Third, there were households that reported both beginning and ending odometer readings and dates.

By inferring that the number of days reported by respondents that gave only a start or finish date was equal to the average number of days reported by those that reported both a start and finish date and time, (that being 1.8 days), data from the second and third cases above were included in the panel results.

From Table 6, we can see that there was a significant decrease in VKT per vehicle in Ermington (both project participants and non-participants) and in Woy Woy (among project participants only). From Table 7, we can see that among people in the target areas combined (i.e., project participants and non-participants in Ermington and Woy Woy), VKT per household was significantly reduced in the After Survey.

When analysing VKT per vehicle, we can see that all suburbs except Ettalong Beach showed a decrease in VKT. It is particularly interesting to note that, in Woy Woy, the households that did not participate were apparently driving less already. In summary, the VKT findings are a

- 24 percent (± 13 percent) reduction in VKT per vehicle in Ermington, which is the unweighted net result from a combination of:
    - 18.5 percent (±14 percent) reduction in VKT per vehicle by project participants
    - 36 percent (±27 percent) reduction in VKT per vehicle by project non-participants
- 30 percent (± 27 percent) reduction in VKT per vehicle in Woy Woy (project participants)
- 23 percent (± 11 percent) reduction in VKT per vehicle overall
- 13 percent (± 13 percent) reduction in VKT per household overall.

The difference between the last two figures arises from sample differences between vehicles and households. Some vehicle data may be included in the per vehicle analysis for households that were too incomplete to be included in the household data, and vice versa. There are major differences in vehicle ownership among the suburbs and suburb categories, also. Because the overall figures are based on sample data, we do not expect the differences in VKT per vehicle to track with those in VKT per household.

Table 6: Vehicle Kilometres Travelled per Vehicle

Group	Sample	Before Mean	After Mean	Difference Between Means	Sampling Error	95% Confidence
Dundas	234	38.4	34.4	-4.0	±3.81	±7.48
Ettalong Beach	66	44.6	49.8	5.2	±9.94	±19.48
Ermington (P)	204	38.9	31.8	-7.2	±2.79	±5.46
Ermington (NP)	70	45.5	29.0	-16.6	±6.28	±12.30
Ermington combined (unweighted)	274	40.6	31.1	-9.6	±2.63	±5.15
Woy Woy (P)	85	46.5	32.4	-14.0	±6.35	±12.45
Woy Woy (NP)	67	44.5	39.0	-5.5	±8.79	±17.22
Woy Woy combined (unweighted)	152	45.6	35.3	-10.3	±5.25	±10.29
Control combined	300	39.8	37.8	-2.0	±3.69	±7.23
Target combined (P & NP)	426	42.4	32.6	-9.8	±2.52	±4.94

P=participating; NP=non-participating

Table 7: Vehicle Kilometres Travelled per Household

Group	Sample	Before Mean	After Mean	Difference Between Means	Sampling Error	95% Confidence
Dundas	153	62.0	57.6	-4.4	±6.18	±12.11
Ettalong Beach	64	51.9	52.7	0.8	±12.91	±25.30
Ermington (P)	126	59.3	53.5	-5.8	±4.02	±7.89
Ermington (NP)	50	62.6	53.4	-9.2	±11.83	±23.20
Ermington combined (unweighted)	176	60.2	53.5	-6.8	±4.45	±8.71
Woy Woy (P)	58	61.48	45.6	-15.9	±10.61	±20.80
Woy Woy (NP)	59	52.1	49.5	-2.6	±9.66	±18.93
Woy Woy combined (unweighted)	117	56.7	47.5	-9.2	±7.16	±14.04
Control combined	217	59.0	56.1	-2.9	±5.77	±11.31
Target combined (P & NP)	293	58.8	51.1	-7.7	±3.91	±7.66

P=participating; NP=non-participating

Three exogenous factors may have influenced the survey results. First, Sydney weather is usually cooler in May than in March, however the effect of this was outside the scope of this study. Second, March travel is usually higher than May travel and, third, the median price for unleaded petrol rose from $0.992 per litre in May 2004 to $1.073 in March 2005 in the Sydney Metropolitan area. (AAA, 2005). School holidays take place in April and would therefore not have been likely to affect the results of either the March or the May surveys. There was no significant public transport service change in any of the four suburbs.

4.3 Value of the Panel

One of the important lessons from this research is to demonstrate the value of the panel. We can do this by examining what would have been the sampling error if the before and after surveys had been two independent surveys (with different, non-overlapping samples), as opposed to the panel of the same households. In the trip rate analysis shown in Table 2, the comparison of results for the suburb level of analysis is shown in Table 8.

Table 8: Comparison of Daily Trip Differences per Household Before and After by Suburb by Panel versus Independent (Non-Panel) Samples

Days	Suburb	Difference in Trips	Sampling Error		95% Confidence	
			Panel	Non-Panel	Panel	Non-Panel
Weekdays	Ermington (P and NP)	-0.75	±0.41	±0.81	±0.80	±1.60
	Dundas (C)	-0.58	±0.36	±0.85	±0.70	±1.66
	Woy Woy (P and NP)	-0.7	±0.54	±1.06	±1.05	±2.07
	Ettalong Beach (C)	-0.29	±0.44	±0.63	±0.87	±1.24
Weekends	Ermington (P and NP)	-1.50	±0.57	±1.26	±1.11	±2.46
	Dundas (C)	-0.09	±0.54	±1.13	±1.06	±2.21
	Woy Woy (P and NP)	-0.42	±0.63	±1.12	±1.24	±2.19
	Ettalong Beach (C)	-1.03	±0.74	±0.96	±1.45	±1.88

C=control; P=participating; NP=non-participating,

As can be seen, if a panel had not been used, the sampling error and the 95 percent confidence bounds would have been substantially larger and no changes would have been considered significant. A similar result would have been obtained with the further breakdown of Ermington and Woy Woy, as was done in Table 3, where again, none of the measured differences would have been statistically significant, nor even closely so. This is shown in Table 9. As with Table 8, it is now clear that the use of independent samples in this case would have led to the result that no significant differences could be detected between the before and after surveys, and the measured differences are not even close to being determined with 95 percent confidence with this sample size.

A final illustration of this is shown in Table 10, which compares the panel to an independent sample for the VKT per vehicle, which showed five significant differences for the panel data in Table 6. In Table 10, only three of these cases remain significantly different, if the results had been derived from two independent samples, and the confidence bounds would have been substantially larger in this case.

It should also be noted that the costs of the survey would have been markedly higher if two independent samples had been drawn. This arises for two principal reasons. First, a second sample would have to have been drawn, telephone-matched, sent pre-notification letters, and recruited. Full data on the household and vehicle characteristics of this second sample would then have to have been entered into a database. Instead, the after survey, run as the second wave of a panel, required only re-contacting households that had already been recruited and only entering data from the household and vehicle forms that had changed. Another way to look at the contrast between a panel and two independent samples would be to determine the sample size that would have been needed to obtain the same sampling error as was obtained in the panel. This would require separate estimations for each suburb and each situation. However, for purposes of illustration, we consider only the target suburbs of Ermington and Woy Woy, taking both participating and non-participating households together. Considering the VKT analysis, where most of the significant differences were found, it would have been necessary to increase the sample size in Ermington from 274 to 366 households, and the sample size in Woy Woy from 152 to

212 households. All of these computations in this section are based on the assumption that the variances would have been the same in the two independent samples.

Table 9: Comparison of Daily Trip Differences per Household Before and After by Panel versus Independent (Non-Panel) Samples

Days	Suburb	Difference in Trips	Sampling Error		95% Confidence	
			Panel	Non-Panel	Panel	Non-Panel
Weekdays	Ermington (P)	-0.53	±0.38	±1.00	±0.75	±1.97
	Ermington (NP)	-1.19	±0.94	±1.39	±1.84	±2.72
	Dundas (C)	-0.58	±0.36	±0.85	±0.70	±1.66
	Woy Woy (P)	-0.82	±0.97	±1.62	±1.90	±3.17
	Woy Woy (NP)	-0.56	±0.41	±1.27	±0.81	±2.49
	Ettalong Beach (C)	-0.29	±0.44	±0.63	±0.87	±1.24
Weekends	Ermington (P)	-1.55	±0.72	±1.63	±1.41	±3.20
	Ermington (NP)	-1.39	±0.90	±1.70	±1.76	±3.34
	Dundas (C)	-0.09	±0.54	±1.13	±1.06	±2.21
	Woy Woy (P)	-0.21	±0.76	±1.46	±1.49	±2.87
	Woy Woy (NP)	-0.69	±1.08	±1.73	±2.11	±3.40
	Ettalong Beach (C)	-1.03	±0.74	±0.96	±1.45	±1.88

C=control; P=participating; NP=non-participating

Table 10: Comparison of Vehicle Kilometres Travelled per Vehicle by Panel and Independent Samples

Group	Difference Between Means	Sampling Error		95% Confidence	
		Panel	Non-Panel	Panel	Non-Panel
Dundas	-4.0	±3.81	±4.20	±7.48	±8.23
Ettalong Beach	5.2	±9.94	±12.23	±19.48	±23.97
Ermington (P)	-7.2	±2.79	±3.22	±5.46	±6.31
Ermington (NP)	-16.6	±6.28	±7.35	±12.30	±14.41
Ermington combined (unweighted)	-9.6	±2.63	±3.04	±5.15	±5.96
Woy Woy (P)	-14.0	±6.35	±7.45	±12.45	±14.60
Woy Woy (NP)	-5.5	±8.79	±10.45	±17.22	±20.49
Woy Woy combined (unweighted)	-10.3	±5.25	±6.20	±10.29	±12.15
Control combined	-2.0	±3.69	±4.25	±7.23	±8.32
Target combined (P & NP)	-9.8	±2.52	±2.95	±4.94	±5.79

P=participating; NP=non-participating

5. Conclusions

Based on the results reported, we can draw several conclusions from the evaluation of the TravelSmart Pilot in NSW. They fall into two categories: those that relate to the testing of the evaluation methodology, and those that relate to behaviour change.

The evidence appears to suggest that TravelSmart had an effect on trip making in both Ermington and Woy Woy. Specifically, it appears to have had a significant effect in decreasing vehicle kilometres of travel (by 18.5 percent in Ermington participating households, and 30 percent in Woy Woy participating households), although it does not appear to have affected significantly either the number of trips made, or public transport ridership. A decrease in vehicle kilometres travelled was the key goal of the TravelSmart project in NSW. There is also no clear evidence of substantial changes in trip-making behaviour as a result of TravelSmart, although there appears to be a trend towards more walk and bicycle trips in Woy Woy. Given that the tools provided were aimed more at improving the efficiency with which people travel by providing a local focus, rather than necessarily achieving a mode shift, it appears that the tools have been successful in this regard.

The results reported here appear to have suffered from the potential problems of seasonal difference, because the before survey was undertaken in May and the after survey in March. The resulting fluctuations in trip behaviour observed in the control groups and for the population members who did not participate in each of the target suburbs indicate this potential problem. Had it been possible to undertake the before survey in March 2004, or the after survey in May 2005, it might have been clearer as to what effects TravelSmart has had on people's travel behaviour.

The use of a panel for evaluating the results appears to have worked well. In most cases, the sample size obtained was sufficient to produce sampling errors of a reasonable magnitude. Better results would have been obtained if all households in the after sample had complied with the survey task in both the before and the after waves of the survey. However, this is one of the problems inherent in using self-report methods of surveying. Since undertaking this pilot evaluation, the use of GPS devices to overcome some of these issues has been shown to be valuable (e.g., in Adelaide, Stopher et al., 2005). The comparative advantages of the panel has been shown in this paper, where it is seen that two independent cross-sectional surveys would have produced substantially larger sampling errors and, hence, greater uncertainty about whether or not there had been changes. Also, two independent samples would have been more expensive to survey, using the same sample sizes as were used in this research, and sample sizes that were about 40 percent larger or more would have been required to get the same results from two independent samples.

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