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THE JOYS AND TRIBULATIONS OF A CONTINUOUS SURVEY

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Abstract

This paper reports on the conduct of the continuous Household Travel Survey (HTS) which has been conducted in Sydney, Australia since June 1997. Prior to that date household travel surveys had been conducted in Sydney on a 10 yearly cycle since 1971.

The continuous Sydney HTS is conducted by the NSW Department of Transport and provides important information for understanding the trends in travel behaviour in the Greater Sydney Metropolitan Region and as input to the Sydney Strategic Travel Model for forecasting travel patterns. It is conducted using a face to face interview of all members of selected households with full trip details being collected for a 24 hour period.

The paper will discuss the methodology used for the survey as well as the methods used for processing and analysing the data. It will discuss the logistical issues of maintaining a survey of this nature from a funding and staffing perspective in a government organisation. Other issues to be discussed will range from the control of fieldworkers so as to maintain a high quality of fieldwork in terms of response rate and data quality, to those relating to handling the databases in terms of expansion and pooling of data over successive waves of the survey.

The paper will also report on a non-response component of the survey which has been incorporated in the fourth wave of the survey due to concern with the declining trend in the response rate. The continuous survey methodology has also been used in the fourth wave as a vehicle for conducting a special interest survey, in this case the impact of the use of the internet on the travel behaviour of households.

1. Introduction

A continuous Household Travel Survey has been conducted by the NSW Department of Transport in the Greater Sydney Metropolitan Region since June 1997. This is an area of approximately 25,000 square kilometres with a population of 4.9 million, which includes the capital city of Sydney and the regional centres of Newcastle and Wollongong.

Sydney is predominantly a private car city. In 1998, 71 per cent of trips on an average weekday were by private vehicle, either as a driver or passenger. Sydney is a low density sprawling urban area. Low population densities and dispersed employment locations make the outer suburbs in particular, difficult to serve by public transport. In the past public transport infrastructure has not kept pace with the growth of residential areas and the spread of commercial and industrial land uses. Thus this type of development favoured the use of the private motor vehicle. As a result the level of car ownership is high at 1.46 vehicles per household with 44 per cent of households having two or more cars.

The NSW State Government is responsible for the planning and construction of the urban transport system. One of the major aims of the current transport plan is to increase the use of public transport along with safeguarding the environment from the detrimental effects of private vehicle use. To monitor the use of transport modes and other aspects of personal travel as a basis for transport planning, current, high quality data is needed on the travel patterns of the residents of the Greater Sydney Metropolitan Region. The Transport Data Centre (TDC), which is part of the NSW Department of Transport, has been responsible for the collection of travel data and the estimation and application of a travel demand model for Sydney since the early 1970s.

Transport infrastructure planning in Sydney has been based primarily on the demand for commuting travel in the morning peak. While this component of travel is responsible for a large part of the transport task, off peak travel and travel for non-work purposes in both the peak and the off peak period, are becoming increasingly important. Data and modeling tools need to be available for all travel purposes and for all time periods.

2. Sources of travel data

The first home interview survey of personal travel was conducted in Sydney in 1971. Large scale household travel surveys were conducted again in 1981 and in 1991 with much improved questionnaires. These surveys were conducted using a face to face interview methodology with a household questionnaire and detailed trip diaries for all members of the selected households for a designated travel day. The survey in 1991 was carried out for a full year with data collected from respondents for a full 24 hour period. A trip based diary was used with a verbal activity recall method used in the interview to assist respondents to recall trips by associating them with activities undertaken. In 1991 a sample of 12,000 fully responding households was achieved which represented approximately 1 per cent of the population.

2.1 A Continuous Survey of Household Travel

Personal travel data was thus collected in Sydney for 1971, 1981 and 1991, however due to comparability problems only 1981 and 1991 data sets are actually used. The TDC has adopted a

policy of moving away from this ten yearly collection of data to a continuous household travel survey. This policy was one of the recommendations arising from the review of the TDC's modelling and information strategy conducted by the Institute of Transport Studies, the University of Sydney, in 1994 (TDC 1995). There are a number of reasons for this shift in approach away from point data collections to a continuous survey. These could be considered to fall into two broad areas, that is reasons related to timeliness and quality of data as input to the planning process, and administrative and institutional reasons which impact on the political climate for the operation of the survey.

2.1.1 Data timeliness and quality

A continuous survey provides data on trends in travel patterns and behaviour which reflect changing social and economic conditions. On the other hand point data reflects only those conditions at that point in time and provides no information about the intervening trends between points. This is a particular problem if those points are far apart in terms of time, and of even more concern if they happen to coincide with markedly different phases of the economic cycle. This was the case with the 1981 and 1991 travel survey data for Sydney.

A comparison of the two data sets (TDC, 1996a, Gee et al, 1996) showed only a 1.2 per cent increase in trips on an average weekday over the 10 year period, despite an increase in population of about 8 per cent. Also evident was a decline in trips to work of about 6 per cent, which was wholly due to a decline in trips by males. On the other hand the number of trips on the weekend increased by 7.8 per cent and the number of trips to work by females increased slightly.

These changes in travel patterns in part represent the very different economic conditions which prevailed in 1981 compared with 1991. The Australian economy was in recession in 1991 with an unemployment rate of around 8 per cent in Sydney compared with 5 per cent in 1981. There were also structural changes taking place in the economy with unemployment experienced most acutely in male dominated industries of construction and manufacturing. There were also severe cuts in middle management employment, which also particularly affected the male workforce. On the other hand there was a growth in part-time employment and an increase in the female labour force participation rate largely as a result of increased employment opportunities in the service sectors.

The economic cycle turned upward after 1991 and unemployment decreased. The structural changes of declining male employment in particular industries and strong female employment in expanding industries continued, shopping hours were extended and other lifestyle changes, such as eating out more frequently and an increase in the use of home services, also occurred. However by the late 1990s we were not able to comment on the implications of these changes for travel patterns since 1991. There was plenty of anecdotal evidence but no data available to measure the changes in travel patterns, the impact on mode shares or to monitor the impact of travel on the environment.

If the previous 10 yearly survey pattern had continued it would have been 2001 before another household travel survey was conducted and then possibly, if the experience of the past was repeated, a further 1 to 2 years before data was available. This is unacceptable for measuring changes in trends and monitoring policies which may have been put in place many years before. Travel patterns are becoming more complex and the demands on transport infrastructure increasing to such an

extent that current data is needed if that demand is to be managed and policies are to be kept in tune with current conditions.

The previous 10 yearly survey in 1991 had a final sample size of 12,000 households. The new continuous Household Travel Survey (HTS) targets a final sample of 3,000–3,500 households per annum so that over a 3 year period a sample size is accumulated which is comparable with the 1991 survey. An initial sample size of 3,500 households in the first year was sufficient to provide indications of broad trends. As the sample size has increased data has become available which is statistically significant at a lower geographic level and provides for sound analysis of more detailed trends and greater market segmentation.

2.1.2 Administrative/institutional environment

Towards the end of the 1980s political support for the use of data and model outputs in the planning process in Sydney was waning. There were a number of reasons for this which we will not explore here, but it is sufficient to note that, when the time came for planning the next 10 yearly household travel survey in 1991, the political climate was such that the conduct of the survey was threatened. Fortunately it was conducted, however there was no support for the processing or release of the data, which only occurred several years later.

In the second half of the 1990s support gained momentum for the need for current data and modelling tools to be part of the planning and policy decision making process. Following the review of the TDC's data and modelling strategies (Transport Data Centre 1995), it was proposed that this was best achieved by the operation of a continuous survey which could provide current, high quality data as a basis for decision making.

A critical deficiency of the earlier approach of discontinuous surveys (1971, 1981 and 1991) was that there was inevitably a loss of staff and knowledge in the inter-survey period which had to be re-established for the next survey. This applied to both project management staff in the government organisation conducting the survey, and staff in the market research organisation conducting the survey fieldwork. Apart from the cost-inefficiency of such knowledge loss, another significant problem was that the differences in organisations/staffing between surveys increased the likelihood that changes in travel recorded in time series analysis of survey results partly reflected differences in the quality of survey processing rather than true change. Measuring the general extent of this effect is difficult, and accurately quantifying it is impossible. However, the extent of the effect is undoubtedly minimised by maintaining relative continuity of staff and procedures. This is still an issue which will have to be considered when comparing the continuous survey (1997-2000) with the 1991 survey, especially at lower geographic levels, but will be much less an issue when comparing the waves within the continuous survey.

Budgetary implications were also an important consideration in deciding to move to a continuous survey. With a periodic survey there is an uneven requirement for funds so that large amounts have to be found at the time of the survey. If the political climate is not conducive to providing this funding the survey could be delayed or not undertaken at all. It is acknowledged that a withdrawal of funding could occur at any time during a continuous survey, however it was anticipated that if the survey was progressing successfully and producing relevant results its prospects of continued

financing would be enhanced. It was also expected that there might be significant economies of scale from undertaking the survey on a continuous basis.

3. The Survey Method Used

Before embarking on the new continuous HTS, the TDC conducted a review of survey methods and survey instruments. It was important in a climate of limited and tightening public sector funding, and some scepticism towards the collection of the data, that the most cost effective method was used, whilst still ensuring the highest possible data quality.

Three survey methods and two diary formats were tested giving six fieldwork options. The collection methods tested were: face to face interviewing, drop off/mail back self enumerated questionnaire and mail out/mail back self enumerated questionnaire. Each of these methods was tested using an activity diary and a traditional trip diary. Due to a limited budget the sample size aimed for in each option was 50 households (slightly smaller samples were achieved in each case). Thus only very broad indicators of each option could be evaluated. Each option was evaluated in terms of response rate, trip enumeration, data quality, range of data items and cost.

A full discussion of the results is reported in TDC (1996b) and Peachman and Mendigorin (1997). In summary it was decided that the face to face interview method using a trip diary would be used for the survey. Although the review did not conclusively demonstrate the advantage of a trip diary over the activity diary, some difficulty was found by the respondents in the review in understanding the activity diary. As the 1991 trip diary questionnaires had themselves been the subject of intensive development and had proved to be successful in the field, it was decided to stay with the trip diary format. In addition it was considered that the trip diary approach still provided the type of data which was most suitable for the Department's planned travel modelling program.

It was also decided to continue to use the face to face interview method, although in the review the response rate using this method was considerably lower than expected, and considerably lower than previously experienced (a response rate of 62 per cent fully responding households was achieved in the 1991 survey). Overall however, the cost per interview to achieve the same data quality was similar for the face to face and self enumerated methods as it was found that considerable expense was incurred in follow ups to bring the self enumerated questionnaires to the same level of completion as that achieved in a personal interview. The interviewer administered questionnaire was also considered to provide the best instrument in terms of scope of data items and type of questions that could be used. It should also be noted that Sydney, unlike many overseas large cities, is a city in which face to face interviewing is still possible. Although the ease with which interviews are obtained and the response rate varies in different parts of the city, overall a high response rate and high level of data quality can be achieved by personal interviews in Sydney households.

In the survey development phase which was undertaken from March 1996 to May 1997, reviews were also conducted by the Australian Bureau of Statistics (ABS) of the most appropriate sampling frame to be used and the sample design to achieve the required level of statistical reliability at each wave of the data collection. A consultation process with users of the data was also carried out with special consideration given to the data needs for the planned modelling improvement program for the Sydney Strategic Travel Model.

4. The Reality – Some of the Issues

4.1 Sample design

The sample for the continuous HTS is designed on a 3 yearly basis. This strategy was arrived at as an optimal solution trading off budgetary considerations for conducting the survey on an annual basis and statistical reliability of the data required at a range of geographic levels. The target is an annual completed sample size of 3,000 to 3,500 households which enables reliable trip estimates at the Statistical Division (Sydney wide) level in wave 1, Statistical Sub-division (regions within Sydney) level after wave 2 and the Statistical Local Area (local government area of which there are 50 in Sydney) level at the end of wave 3. This requires a gross sample of approximately 5,000 households. Each Statistical Local Area (SLA) across the survey area is represented in each wave of the survey, however interviews are clustered within these SLAs to reduce the fieldwork costs. Each day of the year is represented with sampled households being given a nominated “travel day” for which data will be collected. All members of the selected households are interviewed. The scope of the survey population is all residents of private dwellings in the survey area. Thus visitors, tourists and residents of institutions are not included.

The sample is drawn on a quarterly basis by a process of area address listing. From a randomly selected starting point every 7th dwelling is listed, until there is a group of 7 dwellings. These 7 dwellings are then randomly allocated a “travel day” from a pre-selected week of the year. Once the sample is selected no replacement of dwelling or “travel day” is allowed. Area address listing encounters the expected problems associated with this method such as vacant dwellings and human error in recording addresses. Approach letters addressed to “The Householder” are sent before the interviewer attempts to make contact. The sample loss due to vacant dwellings, dwelling under construction/being demolished or non-private dwelling has been around 5% over the three waves of the survey and for incorrect addresses, less than 2 %. There have been very few issues in relation to the sampling process which are a function of the continuous nature of the survey. The survey is currently half way through the fourth wave and there have only been a couple of incidences of a household being sampled twice. Given that there are approximately 1.8m households in the survey area, the probability is low, however this will increase as the survey continues.

4.2 Questionnaire design

The questionnaires used for the continuous survey were primarily the same as those used for the Sydney 1991 Home Interview Survey. There are 3 questionnaires for the survey: a Household Questionnaire collecting household, person and vehicle data for the household, a 24 hour trip diary questionnaire for members of the household aged 14 years and over and a 24 hour trip diary for members aged less than 14 years. These questionnaires were carefully reviewed before the commencement of the survey particularly in the light of the consultation with data users and consideration of the data needs for travel modeling. Some minor refinements were made, however it was considered that they were appropriate for collecting the data that was required. In addition this had the benefit of providing data which would be comparable with that collected in 1991 and to a large extent with 1981. Thus for the first time longer term trend data on travel patterns would be available. Despite the fact that, as pointed out earlier, there is no real information on the intervening trends between 1981, 1991 and 1997, the ability to compare the data at these points in time has

proved to be very valuable in providing advice for decision makers.

The questionnaire is reviewed at the end of each wave and minor changes are made, particularly to take into account any new requirements of users and suggestions for improvements by the field staff. No major changes have been made to the core questionnaires, thus ensuring the ongoing comparability of the data. However, in the fourth wave of the survey, which commenced in July 2000, the first initiative to add a supplementary survey to the main questionnaire is being tried. It was always anticipated that a potential benefit of having the processes in place for continuous fieldwork would be the ability to add supplementary surveys to the core survey at different times to collect data on particular topics of interest. The supplementary survey, which has been added in the fourth wave, collects data to try to quantify the trip substitution impact of the use of the internet. A couple of additional questions have been added to the main questionnaire concerning the use of the internet and eligible respondents are then streamed into a more detailed, though still short, questionnaire on their internet usage and potential for trip substitution. The fieldwork procedures for adding this extra questionnaire have to date run smoothly and have been accepted well by both the field team and respondents.

It is important when conducting the survey on a continuous basis that the questionnaire remains essentially the same to ensure the comparability of the data. However there is room to progressively incorporate small improvements and updates. There is also the added benefit of being able to use the existing survey strategy to collect supplementary data on relevant issues as required, at marginal cost. There is also the potential to increase the sample size in any particular area, using the same survey strategy, to provide more statistically reliable data, for example in relation to the impact of a large infrastructure project, in a time frame shorter than would be provided by the standard sampling procedures. This strategy has not yet been tried due mainly to budgetary constraints, but is being canvassed as a means of providing reliable comparable data for evaluation of projects.

4.3 Fieldwork control

At the beginning of the continuous HTS the fieldwork was contracted to a research company on an annual basis with a roll over of contract, if certain performance indicators were met, for a maximum of three years. Although the performance indicators were still being met at the end of the third year the contract was again put out to tender to test the market. However, the contract was re-awarded to the incumbent so that the same fieldwork company has held the contract for the survey over all waves.

As the HTS is a face to face interview a sizable and stable team of interviewers, specially suited and trained in personal interviewing techniques, is required. The advantage of the continuous nature of the survey for interviewers is that it provides a reliable and consistent source of work and, given the interesting nature of the topic, most find it rewarding. Consequently the majority of the team has been with the survey since the beginning of the first wave. There is however an ongoing need to keep recruiting and training a small proportion of the team which has a higher turnover rate. This is often in the parts of the city in which it is more difficult to conduct face to face interviews and hence the work is more demanding.

The interviewing team of around 22 interviewers is organised into 6 teams each with a team leader

in the field. (A minimum of 20 interviewers and 5 team leaders is prescribed in the contract.) There is also a field team manager and a project manager located in the main office. To attempt to reduce the substantial travelling costs incurred by face to face interviewing, interviewers work in the same designated areas, and as close as possible to their homes. For a discussion on strategies used for reducing interviewer costs in the HTS see Peachman et al. (1998).

Because of the continuous nature of the survey, there is the potential for interviewer fatigue and boredom or over familiarisation leading to laxity in the compliance with procedures. A great deal of effort is put in by the fieldwork company and the TDC survey management staff to ensure that the fieldwork staff are made to feel part of the team. This is done by regular team meetings every 2 months where interviewers are consulted about issues arising in the field and suggestions sought for improvements, annual retraining and debriefing days and providing information on the importance of the survey and the use of the data.

The performance of interviewers is also monitored by strict validation procedures which require that at least 10% of interviewer completed workloads are validated by telephone. The validation must be done within one week of the receipt of the workloads and before the data is clerically checked, entered and processed. Where a significant proportion of completed interviews by an interviewer (i.e. 10% below the average for a reporting period of one month) do not have the household's telephone number or have incorrect telephone numbers, the survey consultant validates using the face to face interview method by making a single visit to each household in the affected workloads. Any interviewer suspected of not following field procedures and providing incorrect data is validated at a higher rate.

The team leaders also conduct monitoring of interviewers with a minimum of 2 supervised interviews undertaken per interviewer per year. The aim of the supervised interview is to check that all interviewers are conducting the interviews using correct procedures, are clearly explaining the survey to respondents and have a clear understanding of the survey questions. An extra supervised interview is undertaken where the results of the initial supervised interview revealed that the interviewer's performance was not at an acceptable level.

There are very strict procedures for the conduct of the interviews in that information has to be collected only for the nominated travel day and that respondents must be contacted according to certain rules around this day. The team leaders maintain very close contact with the interviewers to ensure that the workloads are completed satisfactorily, on time and according to the prescribed procedures. Workloads are checked weekly to obtain immediate information on the level of response obtained by interviewers so that the survey consultant is able to act at once where an interviewer is having difficulty recruiting the respondents or specific issues are identified that require special attention. The weekly check also ensures that the workloads scheduled every week are carried out on time to ensure that households are always allocated their correct travel dates.

In addition to the wide range of data checks that are carried out on the data following data entry, response rates, trip rates, rate of sample loss and number of calls made to households are also monitored monthly on an interviewer basis so that any indications of potential interviewer bias can be detected, and rectified, at an early stage. Thus although many interviewers are very familiar with

the survey there is a constant need for monitoring of interviewers' performance and project management staff cannot become complacent assuming that the continuous process will become self managing.

It should however be emphasised that the necessity for continual vigilance of the fieldwork should not be seen as a deficiency or a negative side-effect of a continuous survey, but a recognition of the fact that a continuous survey offers the opportunity to rectify problems that a one-off survey does not. For example some problems were discovered with regard to the adherence to procedures by a few interviewers in the second wave of the HTS. It was then possible to disregard these interviews and resample them in the third wave. This would not have been possible if it had been a one off survey and these interviews would have been lost.

The continuous nature of the survey also allows for the ongoing assessment of the effectiveness and practicality of fieldwork procedures and provides the opportunity for refinement of those procedures over time. This it is believed has contributed to a continuation of the high quality of the data. For example at the commencement of the HTS very strict procedures were in place with regard to the contact periods for respondents in relation to the designated travel day, the definition of a fully responding household, the use of proxy interviewing and the requirement for only face to face interviews. In the light of some increasing difficulty with the response rate (this will be discussed further in section 5.1) some well considered and gradual changes have been made to these procedures. In particular, in response to strong information from the field that there was increasing difficulty in securing a personal interview with the last member of a household usually because they were often the most busy person, the option of a telephone interview with these respondents has now been allowed. The data from these interviews will of course be flagged so that an analysis of the impact of the different methodology on trip rates can be undertaken.

4.4 Project management staff

Perhaps the continuous nature of the survey impacts most adversely on the project management staff, both for the fieldwork company and in the TDC. A continuous study by its very nature has no end, and though for practical purposes an annual cycle of collection, analysis and dissemination is maintained the psychological reality for those working on the survey is that, unlike the one-off survey, there is no closure. Under these circumstances, the potential for staff fatigue is high, and it is essential for management to implement strategies to minimise such effects. Judicious rotation of staff and an ongoing enhancement program to maintain intellectual challenge within the continuous survey structure are two of the ways in which TDC has met this problem.

4.5 Database management and data processing

The sample data is weighted to reflect the population estimates using the following three stage process:

- Household weights
 - Initial Selection Weight – the inverse of the probability of selection of the household
 - Non-Response Adjustment – adjustment to compensate for the nonresponding households in the sample
 - Post-stratification – stratification using Statistical Local Area (SLA) by Household Type

- population benchmarks
- Person weights
 - Initial Selection Weight & Non-Response Adjustment – equal to the household weight
 - Post-stratification - stratification using Statistical Local Area (SLA) by Age by Sex population benchmarks.
- Region dayfactors – adjustment factors that allow for equal representation of each day of the week

One of the major advantages of a continuous survey is that there is continuous potential for improving procedures in the fieldwork as discussed, and also in relation to data management and processing. Though improvements can be, and are, made between one-off surveys, the reality is that the focus of such surveys is on a cut-off point that is psychological as well as administrative. Thus, despite the best will of those involved, the aspect for ongoing improvement is given a minimal emphasis, and the next survey tends to ‘start again’ rather than be an organic enhancement of the previous survey. In a continuous survey, ongoing improvement is a natural and integral part of the process.

TDC’s experience with the first three waves of the HTS clearly demonstrates this aspect of a continuous survey. Processing and expansion of wave 1 of the continuous survey was effectively no different from undertaking a new one-off survey for 1997. Though a good degree of documentation and staff experience from the 1991 survey was available to inform the process, significant setup time was still required for new database design, construction and implementation. In addition enhanced expansion procedures had to be implemented, and geocoding techniques and coverages had to be redeveloped and updated. Once this database, procedural and geocoding infrastructure was set up after wave 1, implementation of core tasks for subsequent waves was significantly streamlined, allowing for not just more timely production of output, but the production of more complex analysis and quality control procedures.

Another benefit of a continuous survey is that past data can be revisited in the light of subsequent data to produce more accurate, revised estimates. This is standard procedure for continuous surveys, such as those conducted by the Australian Bureau of Statistics, but is not practical for one-off surveys. TDC has adopted this approach with the continuous HTS. The three yearly sample design provides a point for production of estimates at a low geographical level, and also a natural reference point for a review of the annual data sets produced within the three year period.

4.6 Reporting on and using the data

The sample is designed over a three year period, but the data is processed and analysed on an annual basis with results being available at subsequently lower geographic levels with the pooling of waves of data. At the end of the first wave data was released at the Statistical Division (SD) (Sydney wide) level allowing broad comparisons with the 1991 survey. After the second wave the data from waves 1 and 2 were pooled to provide estimates at the Statistical Subdivision (SSD) level (regional level within Sydney) and after the first three waves all three years of data were pooled to provide estimates at the Statistical Local Area (SLA) level (there are 50 within Sydney).

Figure 1 shows the relative standard errors (RSEs) on trip estimates of the pooled data sets over

subsequent years at the different geographic levels, indicating that there are considerable improvements in RSEs with increasing sample sizes over the first three waves of the survey but only marginal improvement beyond that.

Figure 1. Relative Standard Errors on trip estimates at varying geographic levels

The advantage of the continuous stream of data is that it can be used as pooled waves to give longer term comparisons over time at lower geographic levels or as individual waves for shorter term comparisons at higher geographic levels. This provides the capability for users interested in tracking longer term trends in key variables, as well as for those who need to undertake more detailed analysis or modeling. This increased flexibility in the use of the data of course gives rise to greater complexities in the management of the data bases and the application of the expansion processes. However the capability of modern computer technology and staff with a high level of data base management and analytical skills make this possible.

4.7 Costs

It would be difficult to undertake a direct cost comparison of the 1991 travel survey and the continuous HTS, but it would seem that cost advantages are not one of the significant benefits of the continuous methodology over the periodic survey. There are some economies of scale in that the set up costs may be spread over a larger sample size. This however is only achieved whilst the same fieldwork firm is engaged; if the fieldwork firm were to change, at least some of the set up costs would be incurred again. The most significant cost for a large-scale survey of travel behaviour using the face-to-face interview method is the cost for interviewer time, and this does not alter significantly between a continuous and discontinuous method.

There are efficiency gains mentioned earlier in that internal processes do become more streamlined and effective, however these would be difficult to quantify. However, the expectation which may have been there in the beginning that the process once established would be self managing, is not being realised. Continuous resources and vigilance are required to ensure the continuation of a high quality output.

An apparent advantage of the continuous survey methodology is the possibility of economies of scope in that relevant supplementary surveys can be added to the core surveys at relatively marginal cost. There is scope in this strategy for raising funding from agencies outside the core sponsoring agency, which are particularly interested in specific related topics.

The most significant benefit in terms of funding is that because the continuous survey targets a smaller sample size per annum than a comparable one-off survey, the annual budget allocation is also smaller and can more readily be accommodated in agencies' budgeting strategies.

5. Tracking data quality

5.1 Response rate - unit and item nonresponse

The response rate is often used as a measure of the “success” of a survey. However there are a number of aspects to response rate and care also needs to be exercised when interpreting concepts such as “full and part response”. In the HTS a very strict definition of “full response” is used for the survey. A fully responding household is one where all core data is provided for ALL members of the household. Core data includes key demographic household and person data and key trip information such as depart and arrive times, purpose, mode and address details.

In the HTS, there are actually two response units, the household and the person. At the household level, what may be considered as *unit* nonresponse are those household units where *all* household members did not respond to the survey (“full nonresponse” in Table 1) and what may be considered as *item* household nonresponse are those households where some and not all members responded (“part response” in Table 1).

Table 1 Household unit and item nonresponse

	1997	1998	1999	1997	1998	1999
Full response	3291	3179	2743	67%	66%	57%
Part response	414	369	548	8%	8%	11%
Full nonresponse	1208	1300	1560	25%	27%	32%
Total sample (net of sample loss)	4913	4848	4851	100%	100%	100%

Household members or the persons within each household, however, may also be considered as response units. Within part-responding households where not all persons responded, there is what may be considered as *person unit* nonresponse which is the situation where the person did not provide any information at all (“persons with no response” in Table 2). There is also the *person item* nonresponse which is the case where the person provided only partial information (“persons with partial response” in Table 2).

For households the full response rate was 67% in 1997, 66% in 1998 but fell to 57% in 1999, see Table 1. In addition a further 8%, 8% and 11% respectively of households were classified as “part responding” where at least some members of the household completed the survey. This data is included in the person tables. It is interesting to note that the person response rate, Table 2, has remained very steady throughout the survey.

Table 2 Person unit and item nonresponse in part-responding households

	1997	1998	1999	1997	1998	1999
Persons with full-response	923	792	1200	62%	61%	60%
Persons with partial response (or <i>item nonresponse</i>)	307	226	376	20%	17%	19%
Persons with no response (or <i>unit nonresponse</i>)	268	274	423	18%	21%	21%
Total persons from part-responding households	1498	1292	1999	100%	100%	100%

Consultations were conducted with the interviewers to determine what might be causing the decline in the household response rate in 1999. Considerable concerns were expressed by the interviewers about the increasing difficulty of securing full responses due to the very strict procedures which required that face to face interviews had to be conducted with all members of the household. Many people were reporting that they were too busy to take part in the interview and, even if interviews were secured with most members of the household, there was often one member who was too busy to be contacted or to agree to an interview. As a result procedures were relaxed at the beginning of wave 4, but still under strict guidelines, to allow the final respondent, in an otherwise fully responding household, to be interviewed by telephone if a face to face interview is not possible. The response rate has remained steady at around 59% throughout this wave.

The changes in procedures to allow the last person to be interviewed by telephone has increased slightly the full response rate for households by reducing the level of part response for households, however there are still the continuing issues of full nonresponse and full noncontact. Full non responding households were also felt to be due to the fact that the household claimed that they did not have time to participate in the survey. Consequently a nonresponse study was introduced in the fourth wave of the survey so as to understand better the reasons for nonresponse and to collect where possible any information on the travel behaviour of nonrespondents so that their trip patterns can be compared with those of respondents. The results of that survey are not yet available, however it would seem that it has succeeded in converting a small proportion of fully non-responding households into responses and in collecting some, if not complete, information on travel behaviour from a significant proportion of nonrespondents. It has also indicated that the main reasons for nonresponse by households are that they don't want to/not interested (55%) or that they were too busy to participate (17%).

The issue of full contact is also one of concern and has increased over the years of the survey due primarily to an increase in the incidence of security dwellings in Sydney. These dwellings prevent interviewers from making any contact with respondents and therefore it is impossible to recruit them for the survey. Further consideration is being given to handling this issue.

In the HTS, item nonresponse for *every* variable is not strictly measured or monitored. The practical reason is that there are too many variables in the HTS to allow this detailed monitoring. Item nonresponse for a few selected core variables in fully responding households are, however, shown in Table 3.

Table 3 Item nonresponse for selected variables in fully responding households

	1997	1998	1999
<i>Person variables</i>			
Sex	0.00%	0.00%	0.00%
Age	0.20%	0.20%	0.20%
Marital status	0.00%	0.02%	0.14%
Language	0.00%	0.00%	0.00%
Labour force	0.00%	0.00%	0.00%

status*			
Income	6.69%	4.03%	10.38%
Relation	0.00%	0.00%	0.00%
Occupation	0.00%	0.39%	0.37%
Employment industry	0.00%	0.42%	0.57%
<i>Trip variables</i>			
Mode	< 0.1%	< 0.1%	< 0.1%
Purpose	< 0.1%	< 0.1%	< 0.1%
Type of destination	0.00%	0.00%	0.00%
Arrive	< 0.1%	< 0.1%	< 0.1%
Depart	< 0.1%	< 0.1%	< 0.1%

* Whether student, worker, or looking for work, etc.

It is interesting to note from Table 3 that, apart from the income variable which traditionally has a high unit nonresponse, all other key variables have a low unit non-response. As a result, apart from income, there is no need to impute any missing data for these key variables from the survey.

5.2 Trip rates

Another measure of the quality of travel surveys which is generally used is the “trip rate”. This is fundamental data for a travel survey and generally expected to be a steady variable so that any significant changes should be investigated. Trip rates for the total population and for those reporting travel, as well as the rate of zero trippers are shown in Table 4 for each of the regions in the survey area. It should be noted that the HTS includes ALL days of the week and also the total population including children under 5 years of age. Table 5 shows trip rates and zero trippers for an average weekday (Monday to Friday) and Table 6 shows the same data for weekend days. As would be expected trip rates are generally lower on the weekends and the level of zero trippers is higher. Children of less than 5 years also generally have lower trip rates and there is a higher incidence of zero trippers in this age group. For example removing children of less than 5 years results in approximately 0.5 to 1 percentage point reduction in the level of zero trippers.

The pooled trip rates for 1997 to 1999 show consistent across-the-board growth because 1997 and 1998 data is estimated using annualised growth rates between the 1991/92 HIS and 1999 HTS trip estimates (which were based on comparable large samples). This was done to smooth the annual variability which was found in the smaller annual sample sizes. In future, trip rate estimates will be more sensitive to annual change as *all* annual datasets from 1999 on will be based on a full 3-year HTS sample.

Table 4. Trip rates and zero trippers (average day, unlinked trips)

	Weighted ‘Annual’ Figures			Weighted Pooled Figures		
	1997	1998	1999	1997	1998	1999
<i>Overall trip rates</i>						
Sydney Region	4.44	4.25	4.34	4.30	4.32	4.34

Newcastle Region	3.85	4.31	4.39	4.15	4.15	4.17
Illawarra Region	4.18	3.94	3.78	3.82	3.90	3.99
<i>Trip rates of travellers</i>						
Sydney Region	5.22	5.15	5.24	5.14	5.17	5.20
Newcastle Region	4.66	5.13	5.14	4.95	4.96	4.98
Illawarra Region	5.04	4.84	4.70	4.69	4.79	4.90
<i>% zero trippers</i>						
Sydney Region	15.0%	17.6%	17.2%	16.4%	16.4%	16.5%
Newcastle Region	17.5%	16.0%	14.6%	16.2%	16.2%	16.3%
Illawarra Region	17.2%	18.6%	19.6%	18.4%	18.5%	18.6%

Table 5. Trip rates and zero trippers (average WEEKDAY, unlinked trips)

	Weighted 'Annual' Figures			Weighted Pooled Figures		
	1997	1998	1999	1997	1998	1999
<i>Overall trip rates</i>						
Sydney Region	4.78	4.53	4.63	4.60	4.62	4.64
Newcastle Region	4.15	4.46	4.64	4.38	4.38	4.39
Illawarra Region	4.47	4.22	4.02	4.11	4.20	4.29
<i>Trip rates of travellers</i>						
Sydney Region	5.49	5.34	5.44	5.36	5.38	5.42
Newcastle Region	4.88	5.15	5.36	5.10	5.11	5.12
Illawarra Region	5.26	5.09	4.90	4.92	5.03	5.14
<i>% zero trippers</i>						
Sydney Region	12.8%	15.2%	14.9%	14.2%	14.2%	14.3%
Newcastle Region	15.1%	13.4%	13.3%	14.2%	14.3%	14.4%
Illawarra Region	15.1%	17.1%	18.1%	16.5%	16.5%	16.6%

Table 6. Trip rates and zero trippers (average WEEKEND DAY, unlinked trips)

	Weighted 'Annual' Figures			Weighted Pooled Figures		
	1997	1998	1999	1997	1998	1999
<i>Overall trip rates</i>						
Sydney Region	3.58	3.54	3.63	3.55	3.57	3.60
Newcastle Region	3.09	3.93	3.75	3.58	3.60	3.62
Illawarra Region	3.44	3.24	3.19	3.09	3.16	3.23
<i>Trip rates of travellers</i>						
Sydney Region	4.50	4.63	4.71	4.55	4.57	4.61
Newcastle Region	4.03	5.08	4.56	4.54	4.56	4.59
Illawarra Region	4.43	4.18	4.16	4.04	4.13	4.23
<i>% zero trippers</i>						
Sydney Region	20.4%	23.6%	22.8%	21.9%	21.9%	21.9%
Newcastle Region	23.3%	22.6%	17.7%	21.0%	21.1%	21.1%
Illawarra Region	22.4%	22.4%	23.2%	23.4%	23.5%	23.6%

5.3 Representativeness of the sample

The representativeness of the sample is monitored monthly in relation to the population benchmarks from the Australian Census of Population and Housing. The monitoring of the key demographic variables over the 3 waves of the survey are reported in Table 7 for each of the regions in the survey.

The two main challenges in relation to representativeness are the difficulty of interviewing in flats and apartments and hence the overrepresentation of households that live in detached dwellings. These are more likely to be households with a higher rate of car ownership and hence a higher proportion of trips made in private vehicles compared with households in flats and apartments who are lower car owning households who have better access to public transport. The other main challenge is maintaining the response rate from males in the population. Particularly over the past 2 waves the proportion of male respondents in the workforce has declined. Both these issues are addressed in the weighting process.

6. Conclusion

The goal for the TDC in the implementation of a continuous household travel survey was to provide current, high quality data in a cost effective manner to inform the transport planning and policy making process. It was believed that this could be achieved most successfully by putting in place the management and survey procedures which provided a continuous stream of relevant data, rather than trying to mount a one-off survey on a periodic basis.

Four and a half years into the survey the value of the data is being realised and new releases are eagerly anticipated. The data is proving to be of a high quality and to be valuable in monitoring trends in travel behaviour, the achievement of policy goals and as an input to the evaluation of major infrastructure projects. It has also very successfully been used in the re-estimation of the

Sydney Strategic Travel model firstly to improve the forecasting of home based work travel and also in the estimation of new models for the forecasting of home based non-work travel and non-home based business travel. The methodology is proving to be manageable, and although particular attention needs to be given to the ongoing monitoring of performance and the alleviation of staff fatigue, it also provides the added advantages of accumulation of skills and expertise and the opportunities for future developments and enhancements.

Table 7. Representativeness of the final sample

DEMOGRAPHICS	Weighted HTS Annual Figures			Unweighted Annual Figures			Population Benchmarks*			
	1997	1998	1999	1997	1998	1999	Census 1996	1997 ERP	1998 ERP	1999 ERP
<i>SYDNEY REGION</i>										
Lone person	22%	22%	22%	18%	19%	19%	22%	NA	NA	NA
Couple family w/o children	22%	22%	22%	23%	23%	23%	22%	NA	NA	NA
Couple family w/ children	37%	37%	37%	38%	38%	36%	37%	NA	NA	NA
One parent family	10%	10%	10%	8%	7%	8%	10%	NA	NA	NA
Other	8%	8%	8%	14%	13%	14%	8%	NA	NA	NA
Household size = 1	22%	22%	22%	18%	19%	19%	22%	NA	NA	NA
Household size = 2	31%	31%	30%	32%	31%	32%	30%	NA	NA	NA
Household size = 3 to 5	44%	44%	44%	46%	46%	45%	43%	NA	NA	NA
Household size > 5	4%	3%	4%	4%	4%	4%	4%	NA	NA	NA
Household 0 vehicle	14%	15%	16%	13%	14%	16%	16%	NA	NA	NA
Household 1 vehicle	44%	43%	44%	43%	41%	42%	43%	NA	NA	NA
Household 2 vehicles	32%	31%	30%	33%	33%	31%	30%	NA	NA	NA
Household >=3 vehicles	10%	11%	10%	11%	12%	11%	10%	NA	NA	NA
Male	49.6%	49.6%	49.6%	48.2%	48.8%	46.7%	49.5%	49.6%	49.6%	49.6%
Female	50.5%	50.4%	50.4%	51.8%	51.2%	53.3%	50.5%	50.5%	50.4%	50.4%
Person 0-14 years old	20.1%	20.0%	19.8%	22.8%	21.0%	22.1%	20.2%	20.1%	20.0%	19.8%
Person 15-49 years old	54.0%	53.8%	53.6%	51.6%	51.5%	49.5%	54.3%	54.0%	53.8%	53.6%
Person 50+ years old	25.9%	26.3%	26.6%	25.7%	27.5%	28.4%	25.5%	25.9%	26.3%	26.6%
<i>NEWCASTLE REGION</i>										
Lone person	23%	23%	23%	21%	17%	23%	23%	NA	NA	NA
Couple family w/o children	25%	25%	25%	27%	26%	26%	25%	NA	NA	NA
Couple family w/ children	35%	35%	35%	33%	35%	29%	35%	NA	NA	NA
One parent family	11%	11%	11%	10%	11%	11%	11%	NA	NA	NA
Other	6%	6%	6%	8%	11%	11%	6%	NA	NA	NA

Household size = 1	23%	23%	23%	21%	17%	23%	23%	NA	NA	NA
Household size = 2	34%	35%	33%	36%	39%	35%	34%	NA	NA	NA
Household size = 3 to 5	39%	38%	41%	38%	40%	39%	40%	NA	NA	NA
Household size > 5	4%	3%	3%	5%	4%	3%	3%	NA	NA	NA
Household 0 vehicle	12%	13%	10%	12%	13%	10%	14%	NA	NA	NA
Household 1 vehicle	47%	42%	45%	45%	40%	43%	45%	NA	NA	NA
Household 2 vehicles	29%	31%	35%	31%	33%	36%	31%	NA	NA	NA
Household >=3 vehicles	11%	14%	9%	12%	15%	11%	9%	NA	NA	NA
Male	49.5%	49.5%	49.5%	47.4%	47.5%	46.2%	49.5%	49.5%	49.5%	49.5%
Female	50.5%	50.5%	50.5%	52.6%	52.5%	53.8%	50.5%	50.5%	50.5%	50.5%
Person 0-14 years old	21.1%	20.9%	20.7%	23.6%	21.6%	20.9%	21.2%	21.1%	20.9%	20.7%
Person 15-49 years old	50.0%	49.8%	49.6%	45.8%	48.3%	45.7%	50.3%	50.0%	49.8%	49.6%
Person 50+ years old	28.9%	29.3%	29.7%	30.7%	30.0%	33.4%	28.4%	28.9%	29.3%	29.7%
ILLAWARRA REGION										
Lone person	22%	22%	22%	18%	26%	19%	22%	NA	NA	NA
Couple family w/o children	27%	27%	27%	28%	29%	31%	27%	NA	NA	NA
Couple family w/ children	36%	36%	36%	39%	33%	34%	36%	NA	NA	NA
One parent family	10%	10%	10%	8%	6%	9%	10%	NA	NA	NA
Other	5%	5%	5%	7%	6%	7%	5%	NA	NA	NA
Household size = 1	22%	22%	22%	18%	26%	19%	22%	NA	NA	NA
Household size = 2	33%	34%	34%	35%	34%	39%	34%	NA	NA	NA
Household size = 3 to 5	42%	42%	40%	44%	37%	39%	41%	NA	NA	NA
Household size > 5	3%	3%	4%	3%	2%	3%	4%	NA	NA	NA
Household 0 vehicle	18%	11%	11%	15%	12%	10%	13%	NA	NA	NA
Household 1 vehicle	42%	45%	42%	40%	44%	41%	47%	NA	NA	NA
Household 2 vehicles	30%	35%	33%	33%	35%	36%	31%	NA	NA	NA
Household >=3 vehicles	10%	9%	13%	12%	9%	14%	9%	NA	NA	NA
Male	49.7%	49.7%	49.6%	50.4%	48.5%	50.3%	49.8%	49.7%	49.7%	49.6%
Female	50.3%	50.3%	50.4%	49.7%	51.5%	49.7%	50.2%	50.3%	50.3%	50.4%
Person 0-14 years old	21.9%	21.7%	21.4%	25.4%	24.2%	20.4%	22.1%	21.9%	21.7%	21.4%
Person 15-49 years old	48.7%	48.4%	48.2%	47.4%	45.2%	48.4%	49.0%	48.7%	48.4%	48.2%
Person 50+ years old	29.4%	29.9%	30.4%	27.2%	30.6%	31.1%	28.9%	29.4%	29.9%	30.4%

* Household population benchmarks are from the 1996 Census of Population and Housing conducted by the Australian Bureau Statistics, every 5 years. Annual Estimated Resident Population (ERP) figures also produced by the Australian Bureau Statistics.

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