Analysis of Peak Hour Travel Using the Sydney Household Travel Survey Data

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1 Introduction

The analysis of peak hour travel in Sydney shows that the demand on the network is not only concentrated in the peak periods but that the growth in demand is also. This results in increasing pressure on the network which in part is addressed by extensions and improvements on existing infrastructure. Peak hour travel solutions, however, can not be solely focussed on the supply-side. Building or expanding the infrastructure to cater to increasing demand is not always sensible or economically feasible because of the substantial investment usually involved. Demand-side interventions also need to be applied (Battelino and Mendigorin 1999, Twiney and Rudd 2005).

In recognition of the situation, the New South Wales Government stated in its Sydney Metropolitan Strategy (2005) document that,

> *'…the cost of meeting unconstrained travel demands, particularly in peak periods, is becoming prohibitive. Building new capacity just to meet peak needs is very expensive, and as has been demonstrated in other cities, will not solve transport problems or improve accessibility on its own.*
>
> *Demand for travel needs to be managed and sustainable travel choices and access should be maintained or improved.'*

Nationally, the issue has also been acknowledged. In response, the Productivity Commission is currently undertaking an inquiry with Commonwealth, State, Territories and Local government to determine the main contributors to urban congestion in Australia (Transit Australia 2006).

To help address this issue and inform policy, this paper examines various aspects of the peak hour travel in Sydney. The analyses are provided mainly to assist in the consideration, assessment or improvement of the different demand interventions and to demonstrate how available empirical data from the Sydney Household Travel Survey (HTS)[1] can be applied to inform this process. (For details about the HTS, the data used in this paper including scope and coverage, please refer to the Appendix.)

The paper begins with a discussion of the broad trends in travel between 1991 and 2004 focussing on the demands at various times of the day. The following section describes aspects of the peak hour travel, such as the purpose of travel and the socio-demographic characteristics of the travellers for indications on how demand can be managed. The next section looks at some of the details of the peak hour travel in relation to a number of demand-management strategies that are currently in application. Finally, trip flows to the major centres are examined to identify the main routes that absorb demand. The paper concludes with a summary of findings and conclusions.

[1] The data is based on travel undertaken by residents in the Sydney Statistical Division.

2 Broad trends

Figure 1 shows that the highest numbers of Sydney[2] residents using motorised modes travelled around 8:30am, 3:30pm and 5:30pm on an average weekday in both 1991 and 2004. During these periods, the *increase* in demand in terms of additional travellers was also the highest. In annual percentage terms, the growth was 2.4% per year around the 8:30am period, 1.8% in the 3:30pm period and 2.3% in the 5:30pm period. These rates all exceeded the average annual increase in population of 1.2% between 1991 and 2004.

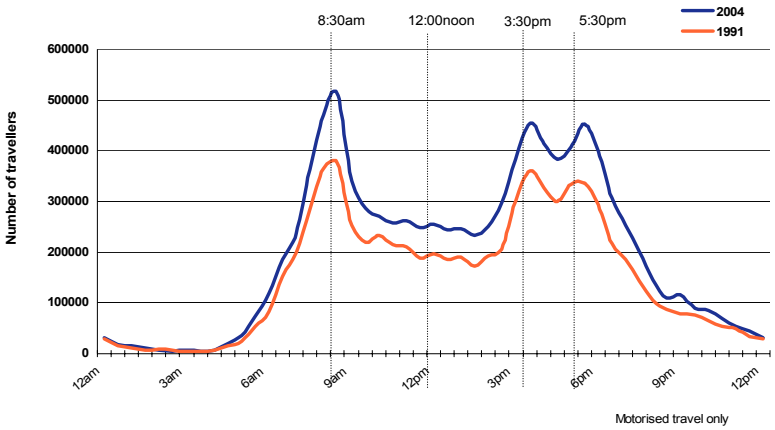

Figure 1 Number of travellers in motorised modes by time of day, average weekday

There is also evidence of peak spreading in response to the increase in demand (Figure 1). In 1991, the periods when demand exceeded 300,000 travellers occurred between 8 to 9am and 3 to 6pm. In 2004, demand was at least at this level for longer periods, 7:30 to 9:30 in the morning and 2:30 to 7:00 in the afternoon.

Figure 2 shows that the car travellers, particularly car drivers contributed the most to the increase in demand between 1991 and 2004 .

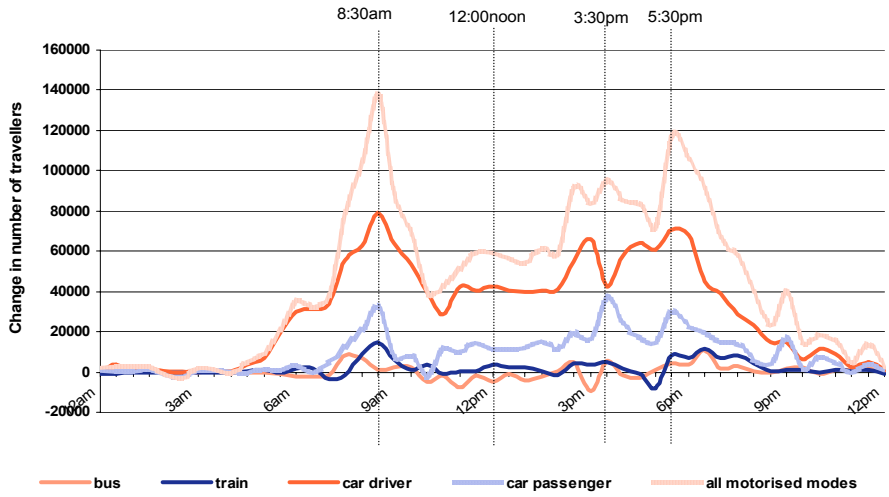

Figure 2 Change in the number of travellers between 1991 and 2004 by mode by time of day Average weekday

[2] Sydney Statistical Division (SD)

3 Characteristics of the peak hour travel

Given the strong growth in demand during the peak periods, we now turn to the analysis of the characteristics of travel during these times for indications on how demand can be managed. In particular, we examine the socio-demographic characteristics of travellers and the purpose of their travel, focussing on the level of discretionary trip-making during high demand periods.

3.1 Purpose of travel

Sixty percent of trips in the AM peak were for activities that are *non-discretionary*, that is for commuting to work or education and work-related travel (Figure 3). Over 20% were to serve passengers[3] who were predominantly travelling to a non-discretionary activity. These serve passenger trips along with those which were for *discretionary* purposes (18%), such as shopping, personal business and social and recreational activities may have the potential to be either managed or diverted to less congested periods.

In the first afternoon peak, 39% were for non-discretionary purposes. A significant proportion (23%) was to serve passenger, consistent with school students finishing and getting picked up from school. Thirty-eight percent were for discretionary purposes.

In the second afternoon peak, 41% of trips were for non-discretionary purposes, largely commuting from work. An equal proportion was for trips for discretionary activities. This is the largest share of discretionary travel among the three peak periods. This is consistent with the higher incidence of trips for social and recreational (24%) and shopping (12%) purposes which occur after the typical working hours.

The analysis of the trip purposes by time of day, in particular the understanding of the level of discretionary trip-making during the peak periods provide broad indications of the opportunity for demand-management. Further work is recommended on the occurrence of trip chaining during the peak periods which is beyond the scope of this paper. This will improve the understanding of the relationship and interaction between discretionary and non-discretionary travel during these high demand periods and how the former could be specifically managed. However, in the next section, we identify who are making most of these discretionary trips. For simplicity, we focus on the morning peak period.

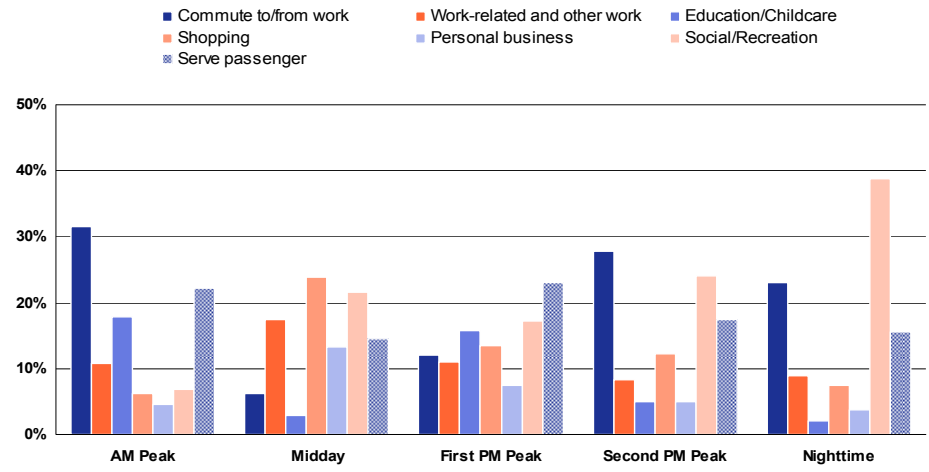

Figure 3 Distribution by trip purpose by time of day[4], average weekday (2004)

[3] To drop-off, pick-up or accompany someone.

[4] AM Peak is from 6:31 to 9:30am. Midday is from 9:31am to 3pm. First PM peak is from 3:01 to 5pm. Second PM peak is from 5:01 to 7pm. Night time is from 7:01pm to 6:30am.

3.2 Socio-demographic characteristics of peak hour travellers

Figure 4b shows that the groups that engaged in discretionary[5] travel *proportionally* the most in the AM peak were: those aged over 60 years old, the unemployed or keeping house, retired or pensioner and those in the lower income groups. For these groups, especially for those that were unemployed or keeping house, Figure 4a shows that the use of the private vehicle was also significant. These provide indications of which type of travellers may be influenced by price or other mechanisms to divert some of their discretionary travel to less congested periods.

Groups that undertook many serve passenger trips in the morning peak are also particularly interesting. These were: women; those aged between 31 to 50 years old; the unemployed or keeping house; the part-time, casual or voluntary worker; and those with lower incomes[6] (Figure 5b).

It will noted though that among the abovementioned groups that engaged in proportionally the most discretionary travel or serve passenger trips during the morning peak, not all were high contributors to the total morning peak demand (Figure 5), for example, the unemployed or keeping house (6%), retired or pensioner (7%) and those over 60 (5%). This implies that intervention may generate limited benefits from these groups for easing the morning congestion.

On the other hand, there were those groups who undertook proportionally more discretionary travel or serve passenger trips *and* also made considerable (though not the largest) contributions to the morning peak hour demand. These were the part-time, casual and voluntary workers and those aged 31 to 50 years who generated about 13% and 20% respectively of all trips in the morning peak. With the appropriate intervention, these are the groups which may produce greater impacts on the AM peak demand.

However, to produce optimum impact in reducing the demand pressures in the morning peak, effort may be best directed to those who travel the most during this period regardless of purpose. Figure 5 shows that close to 80% of the trips in the morning peak were made by workers (full-time, part-time etc.) and students, consistent with the high incidence of work and education trips during the period (Figure 3). Thus, it is justified that most demand-management strategies are focused on work and school travel. In the next section, we analyse work travel in particular using the HTS data to identify which demand management strategies are currently being applied, which may be extended, and how.

[5] For this exercise, discretionary travel is defined to include shopping, social, recreational and personal business trips which tend to be flexible in relation to the time of travel. Readers should note that this is an approximate definition as some personal business trips may also be non-discretionary, ie medical appointment, job interview, etc.

[6] Those aged 0 to 10 years and 'child not at school' were not mentioned despite having high proportions of serve passenger trips. The type of serve passenger trips undertaken by these groups are to 'accompany someone' and therefore less susceptible for intervention.

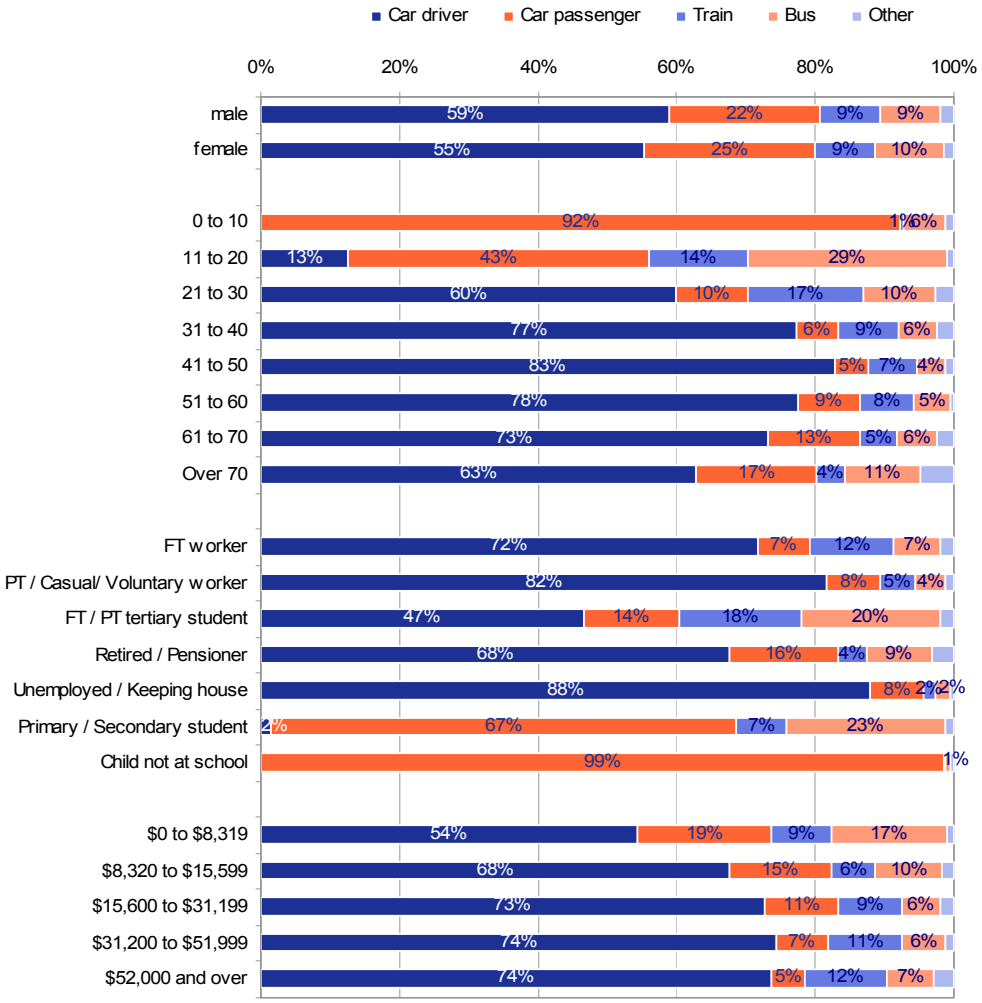

Figure 4a Distribution by trip mode in the AM peak Average weekday (2004)

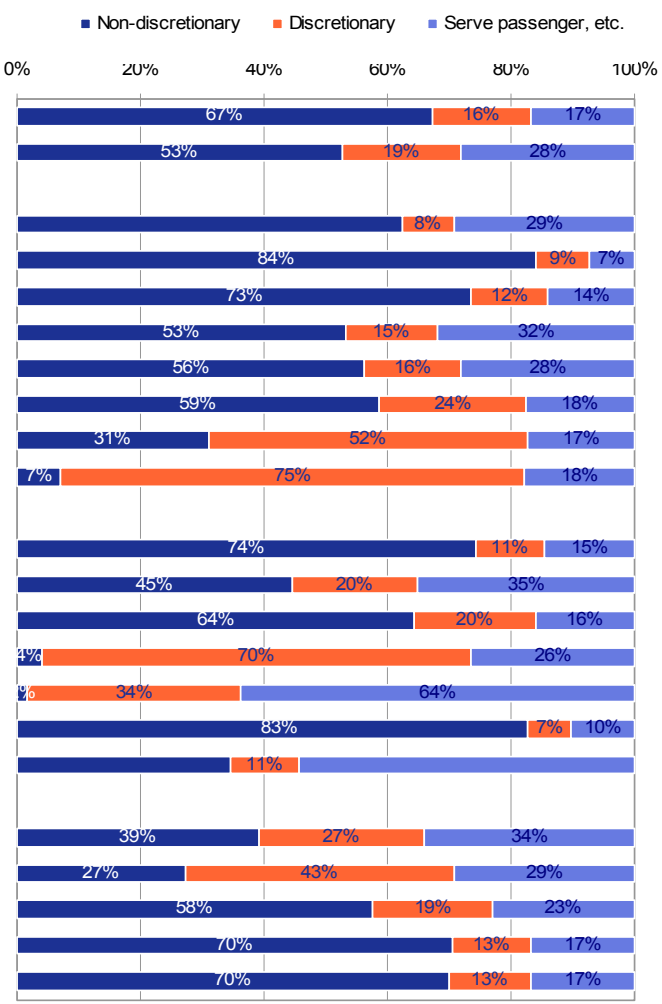

Figure 4b Distribution by trip purpose in the AM peak Average weekday (2004)

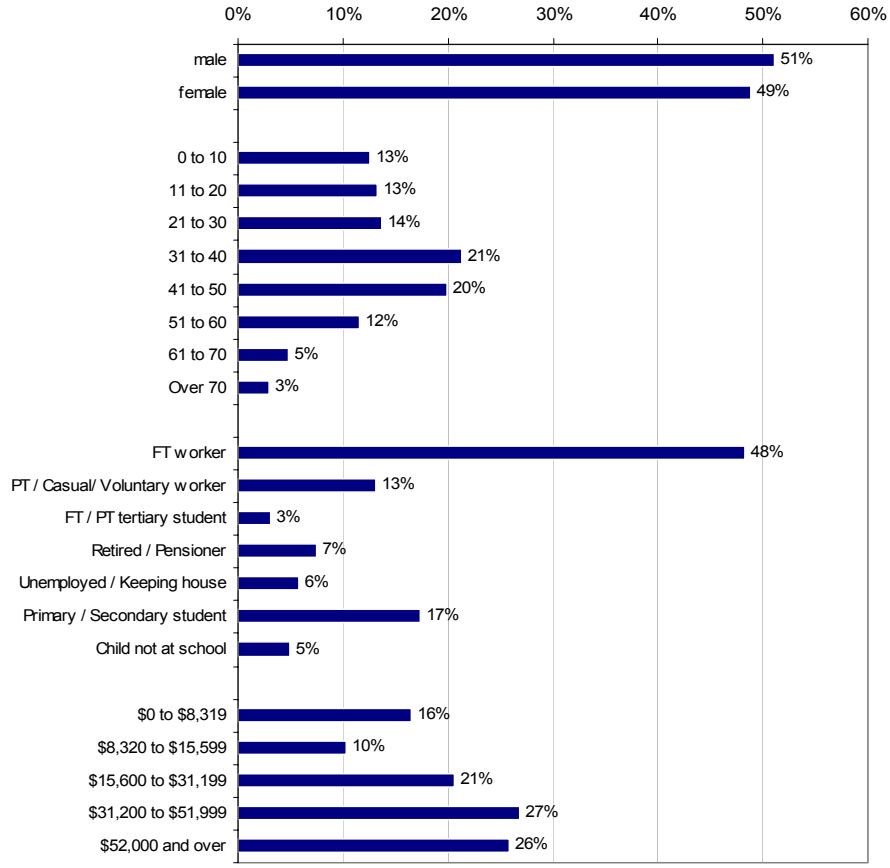

Figure 5 Distribution of trips in the morning peak by socio-demographic characteristics, (2004)

4 Demand management

Figure 6 from ACT, et al (2004) provides a useful and comprehensive summary of demand-management interventions in current application.[7] The analysis of HTS data can inform a number of these strategies. The following are discussed in the subsequent sections.

- Teleworking
- Employer-assisted transport
- Carpooling
- Vehicle occupancy
- Departure time strategies
- Flexible work scheduling
- Parking

[7] Details about these strategies and their implementation are covered widely in literature. For example, please refer to ACT et al (2004), Ewing (1997), Ferguson (1998) and OECD (1994).

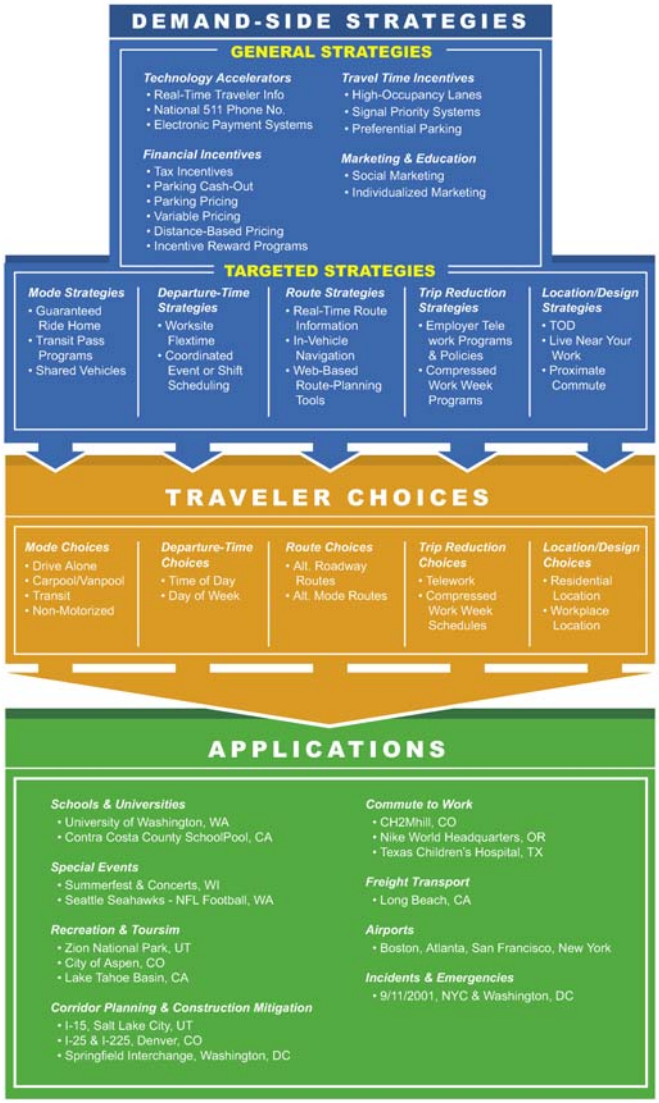

Figure 6 The three core elements of demand-side strategies
Source: ACT, et al (2004) Mitigating Traffic Congestion, The Role of Demand-side Strategies

4.1 Teleworking

Only 6% of workers[8] in Sydney were able to work at home on some days as part of their employer's teleworking policy in 2004 based on the HTS data. Ninety-three percent of these workers were employed as managers and administrators; professionals and associate professionals; or, intermediate clerical, sales and service workers. The largest proportions were in the Manufacturing (12%), Property and Business Services (32%) and Education (11%) industries. This indicates the type of occupations that tend to be most suited for teleworking and which may be targeted for this type of intervention. Compared to the total number of workers within these occupation groups, significant proportions (85% and above) did not have the facility available to them. This indicates the potential for greater application if the policy and workplace barriers are addressed.

The data also shows that most of these teleworkers (52%) already had variable working hours while only 30% had fixed start times. To maximise gains, it will be effective to target those with fixed working hours who travel during the peak hours on a regular basis.

[8] These are workers whose fixed place of work is not the home .

4.2 Employer-assisted transport

The HTS collects information on the type of assistance provided by employers for travel to and from work. Table 1 shows that over half of workers received some form of assistance, the majority of which was towards the use of a car. Of the workers who received some form of subsidy for their car use, 84% and 6% travelled to work by car as driver and passenger respectively. In comparison, only 52% used the car for their trip to work of those who did not receive any of such subsidies.

In addition, those who received subsidies for their car use generated more car trips on average (5.89 car trips per day) than those who did not receive this type of assistance (4.17 car trips).

Table 1 Type of employer assistance for travel to work, 2004

Employer assistance	**Proportion**
Provides assistance	*52%*
Provides free parking	37%
Pays parking costs	8%
Provides company car	17%
Pays any costs of the car itself	19%
Pays fuel costs	21%
Has car sharing/pooling scheme	1%
Pays public transport fares	3%
Other	3%
Does not provide assistance	*48%*

A small proportion of employer assistance supported sustainable travel methods such as carpooling and public transport. Of those who received assistance with public transport fares, 36% travelled to work by train, bus or ferry (58% by car) in comparison to only 21% (71% by car) of those who did not have this type of transport subsidy. Although assistance towards public transport appeared to be correlated with higher levels of use, the data suggests that the sensitivity of the journey to work behaviour to this type of transport assistance may not be as strong as might be expected.[9] Further analysis will be required to identify the circumstances where the impacts of this subsidy will be maximised.

4.3 Carpooling

Only 1% of workers reported to have employers that have a car-sharing scheme and about the same proportion did travel to work as part of a car pool.

The average trip distance and travel time of the trip to work in a car pool was about 13 kilometres and 25 minutes respectively. Since not many car-pool to work, the patterns in the places of residence and work of these carpoolers are not exceptionally clear. However, the biggest share of carpoolers in Sydney (22%) resided in the Fairfield – Liverpool Sub-Statistical Division (SSD).[10] The largest proportions worked in the Inner Sydney (15%), Fairfield – Liverpool (11%) and Central Western Sydney (13%) SSDs. More work, probably a dedicated study will be required outside the scope of what the available HTS data can provide to identify the factors that facilitate carpooling. If such a study is done, the abovementioned areas where carpooling was found to be most prevalent will be appropriate locations to target.

[9] The sample is small for this analysis so the figures are only indicative.
[10] There are 14 SSDs in the Sydney Statistical Division.

4.4 Vehicle occupancy

Vehicle occupancy in the AM peak (1.47) was only slightly lower than the overall weekday average (1.51). However, there were differences in the level of car-sharing during this period depending on the purpose of the trip (Table 2).

Car trips in the morning peak for work purposes (commute and other work related travel) were made with slightly over one person in the vehicle, the lowest vehicle occupancy compared to other trip purposes. Being among the longest (14 and 18 km) and the most prevalent in the morning peak, optimum benefits can be realised if vehicle occupancy is improved for these trips.

Car trips for educational purposes in the morning peak had an average vehicle occupancy of 1.28 persons which suggests a significant number of solo driver trips. There may be scope for increased car-sharing and since these trips were also among the longest in terms of trip distance (16 km), intervention will be advantageous.

In comparison to the abovementioned trips, car trips in the morning peak for shopping (1.30), personal business (1.32), social and recreational (1.47) purposes had higher vehicle occupancy, both in terms of the total number of persons and the number of household members in the vehicle. This indicates that these purposes tend to be shared, especially by household members, and may have the greatest potential for minimising car travel by trip planning which can be promoted by social marketing. The average lengths of these trips suggest that these trips tend to be close to home which means that the effect will be limited to local traffic.

Serve passenger trips had slightly over two persons in the vehicle indicating that only one passenger was usually being served in these trips. Noting the short trip distance, these trips may benefit from travel behaviour marketing schemes which encourage environmentally modes.

Table 2 Vehicle occupancy in the AM peak by trip purpose

Purpose of trip	Vehicle Occupancy (total persons in vehicle)	Vehicle Occupancy (household members in vehicle)	Average trip distance (km)
Commute to work	1.08	1.06	14
Work-related and other work	1.16	1.04	18
Education/Childcare	1.28	1.16	16
Shopping	1.30	1.24	7
Personal business	1.32	1.28	9
Social/Recreation	1.47	1.35	9
Serve passenger	2.18	2.07	6

4.5 Departure time strategies

To inform departure time strategies that aim to adjust work schedules to spread peak demand, we examine the distribution of workers by work schedule (Table 3). Fifty-four percent of workers had fixed start and finish times. Of those workers which had fixed working hours that are the same each day, about 84% had start times and over 1% had finish times that are between 6:30am and 9:30am.

Three percent of all workers had flexitime arrangements of which about 11% had an earliest possible start and 37% had a latest possible start that were outside the morning peak period. Almost 84% of workers with flexible working hours were professionals, associate professionals; or intermediate clerical, sales and service workers. They were also

concentrated in the Government Administration and Defence (41%), and Property Business Services (12%) industries.

Thirty-four percent of workers reported to have variable work schedule which is where they can work different hours each day. Depending on the extent of the flexibility, this work arrangement can also help alleviate demand pressures during the peak periods.

Table 3 Distribution of workers by work schedule, 2004

Work schedule	Proportion
Fixed start and finish times (same each day)	36%
Fixed start and finish times (each day can vary)	18%
Flexitime	3%
Rostered shifts	7%
Rotating shifts	3%
Variable hours	34%
Total	*100%*

4.6 Parking

Section 4.2 highlighted the influence of free and subsidised parking on car use. While the availability of parking appears to be associated with increased car usage, the lack of it in turn may be an effective stick that causes a mode shift to public transport for the journey to work. In Sydney, about 46% of public transport commuters chose to travel this way to avoid parking problems[11]. And since convenience was a dominant reason among those who travelled to work by private vehicle (TPDCb 2006), deterrents that impacted on this convenience such as a lack of parking may be expected to have an effect.

Table 4 shows the percentages of car driver trips for each purpose and time period where parking was not free. For a majority of vehicle driver trips, free parking was available as shown by the low proportions. The percentages of paid parking were generally consistent across the five time periods except for the slight differences between the day (AM peak, midday and first PM peak) and night (second PM peak and night time) periods. In terms of trip purpose, the highest proportions of those who paid for parking were for those who drove to work or education.

Table 4 Proportion[12] of vehicle drivers who paid for parking by trip purpose and time period, 2004

	Average weekday	AM peak	Midday	First PM peak	Second PM peak	Night time
Go to work	6%	7%	6%	6%	4%	3%
Work-related	3%	3%	3%	2%	2%	3%
Education / Childcare	19%	19%	17%	27%	22%	18%
Shopping	1%	2%	1%	1%	0%	1%
Personal business	3%	4%	3%	3%	1%	0%
Social / Recreation	3%	3%	3%	1%	3%	3%
Serve passenger	1%	1%	2%	0%	1%	2%

Table 5 summarises the parking location of driver trips whether it was paid for or not. Majority parked off street, the largest incidences of which were for work (82%), education (74%) and shopping (72%). Morning peak usage of the different parking locations did not differ to that of the entire average weekday suggesting that parking was equally available and used in the said peak period.

[11] This reason is dominant among commuters to the Sydney CBD. The situation is largely different for other centres.
[12] Proportions are relative to the total trips made in that cell.

Table 5 Parking location by trip purpose, 2004

	Av Weekday					AM peak				
	Did not park	Residential property	On street	Off street		Did not park	Residential property	On street	Off street	
Go to work	0%	1%	17%	82%	100%	0%	1%	18%	81%	100%
Work-related	2%	6%	36%	56%	100%	1%	7%	34%	57%	100%
Education / Childcare	0%	0%	26%	74%	100%	0%	1%	25%	74%	100%
Shopping	6%	0%	21%	72%	100%	7%	1%	25%	67%	100%
Personal business	1%	4%	38%	57%	100%	1%	5%	39%	54%	100%
Social / Recreation	1%	17%	36%	46%	100%	1%	15%	33%	51%	100%
Serve passenger	37%	7%	33%	22%	100%	48%	5%	31%	16%	100%

Table 6 shows the average and maximum costs for paid parking by trip purpose. The highest parking costs were paid for work and educational trips. This analysis may be extended to the socio-demographic characteristics of those who paid for parking and the amounts paid to determine the cost sensitivities and apply this when managing the car dependence of particular groups.

Table 6 Parking cost by trip purpose

	Av Weekday			AM peak		
	One off	Monthly	Annual	One off	Monthly	Annual
	Mean	***Mean***	***Mean***	***Mean***	***Mean***	***Mean***
Go to work	$ 9.72	$184.96	$575.88	$ 10.49	$202.62	$ 600.63
Work-related	$13.04	$338.27	$ 20.00	$ 12.82	$253.81	$20.00
Education / Childcare	$11.08	$ 50.00	$ 99.83	$4.21	$50.00	$ 122.54
Shopping	$ 5.10	.	.	$5.12	.	.
Personal business	$ 5.76	.	.	$4.95	.	.
Social / Recreation	$ 7.06	.	$ 27.29	$6.64	.	.
Serve passenger	$ 9.35	.	$ 46.31	$9.28	.	$55.00
	Av Weekday			**AM peak**		
	One off	Monthly	Annual	One off	Monthly	Annual
	Maximum	***Maximum***	***Maximum***	***Maximum***	***Maximum***	***Maximum***
Go to work	$40.00	$1,050.00	$6,000.00	$ 40.00	$1,050.00	$6,000.00
Work-related	$80.00	$600.00	$ 20.00	$ 56.00	$600.00	$20.00
Education / Childcare	$114.00	$ 50.00	$180.00	$ 18.00	$50.00	$ 180.00
Shopping	$24.00	.	.	$ 24.00	.	.
Personal business	$39.00	.	.	$ 11.00	.	.
Social / Recreation	$40.00	.	$ 45.00	$ 15.00	.	.
Serve passenger	$18.00	.	$ 55.00	$ 18.00	.	$55.00

Further analysis may also be undertaken to examine the use of parking in particular locations such as major centres. This is beyond the scope of this paper. Parking is a major policy in itself which warrants a more detailed analysis than can be included here. Suffice to show how the HTS data can be used to inform parking policy as a demand management strategy.

5 Major flows and routes

This section presents information about the trip flows into the five key cities in the Sydney Statistical Division (SD): the Sydney CBD, North Sydney, Parramatta, Liverpool and Penrith. The analysis identifies the areas which generated the most trips into these cities and the major routes that carried these flows. This can assist policy particularly when assessing which areas can or need to be targeted for demand-management to alleviate congestion in certain routes or corridors. For brevity, the detailed analysis will be confined to car driver trips and the top three trip-attracting of the five key cities in Sydney, sufficient to demonstrate the use of the HTS data for this application. For a more complete discussion, including flows of public transport trips, please refer to TPDCa (2006).

About 196,000 motorised trips (37,000 car driver) entered the Sydney CBD in the AM peak each weekday in 2003[13]. Parramatta attracted 53,000 (28,000 car driver) and North Sydney 46,000 trips (18,000 car driver). Penrith and Liverpool took in similar numbers with 23,000 (15,000 car driver) and 24,000 trips (13,000 car driver) respectively.

Figure 7 shows where car driver trips entering the Sydney CBD in the AM peak came from and the major routes that were taken. High volumes came from areas near and around the city, as well as north of the harbour, as far as Hornsby Statistical Local Area (SLA). Trips from the north used the M2, Pacific Highway (Route 1), Warringah and Pittwater Roads (Routes 22 and 10). From the west and northwest, significant flows came from Parramatta and Ryde SLAs and these were largely serviced by the M4 and M2. Comparatively fewer car trips originated from the southern SLAs and these were mainly taken via the M5 and the Princes Highway.

The largest volumes of car trips into North Sydney in the morning peak period originated from a relatively small number of SLAs near or north of this city, Mosman, Lane Cove, Willoughby, Ku-ring-gai and Warringah (Figure 8). These trips mostly took the Pacific Highway (Route 1), Warringah and Pittwater routes (22 and 10).

The heaviest flows of car trips into Parramatta in the AM peak came from surrounding areas, as well as areas farther out west up to Penrith and north of the city up to Baulkham Hills and Hornsby (Figure 9). Car trips originating from the western areas were largely absorbed by the M4 route. Areas north of Parramatta were serviced by Windsor Rd (Route 2), Old Northern Rd (Route 36) and the Pacific Highway (Route 1). For areas south of Parramatta, the Cumberland Highway (Route 7) and Woodville Rd (Route 55) carried the most traffic.

[13] The data is based on 2003 HTS trip estimates assigned to the Sydney road network using the Emme/2 transport planning package. This information was first published in Transfigures (TPDCa 2006). At the time of writing, the more recent 2004 data was not available. The general patterns are not expected to vary despite the use of older data.

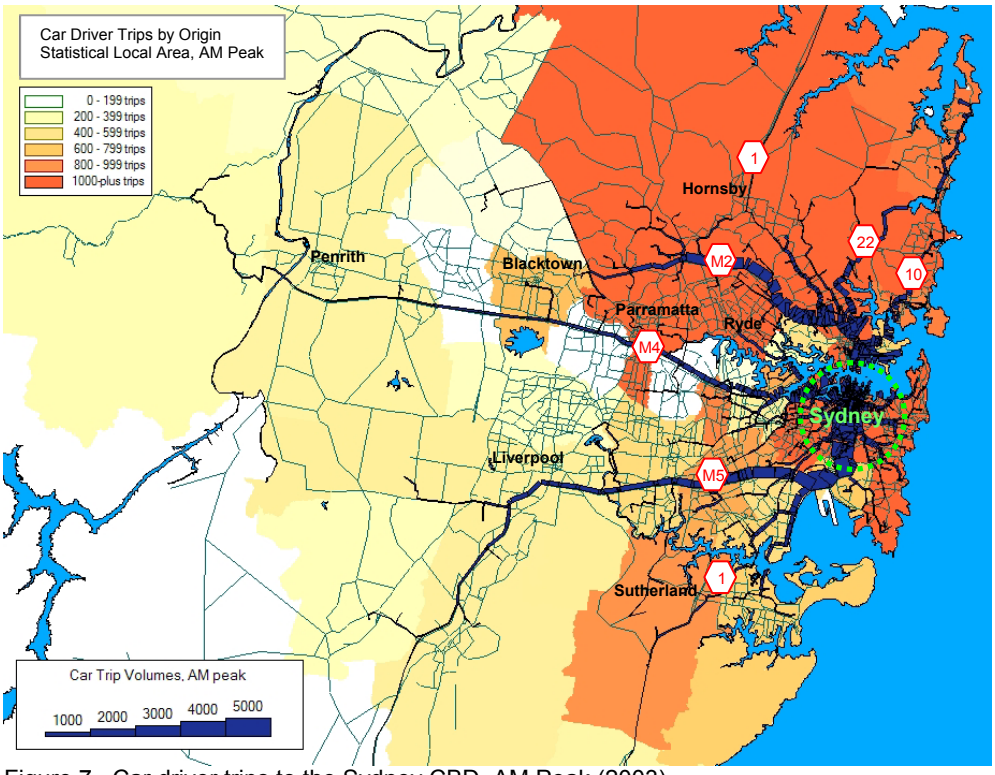

Figure 7 Car driver trips to the Sydney CBD, AM Peak (2003)
Source: TPDCa (2006) Trip Flows Into Sydney and Other Regional Cities Transfigures

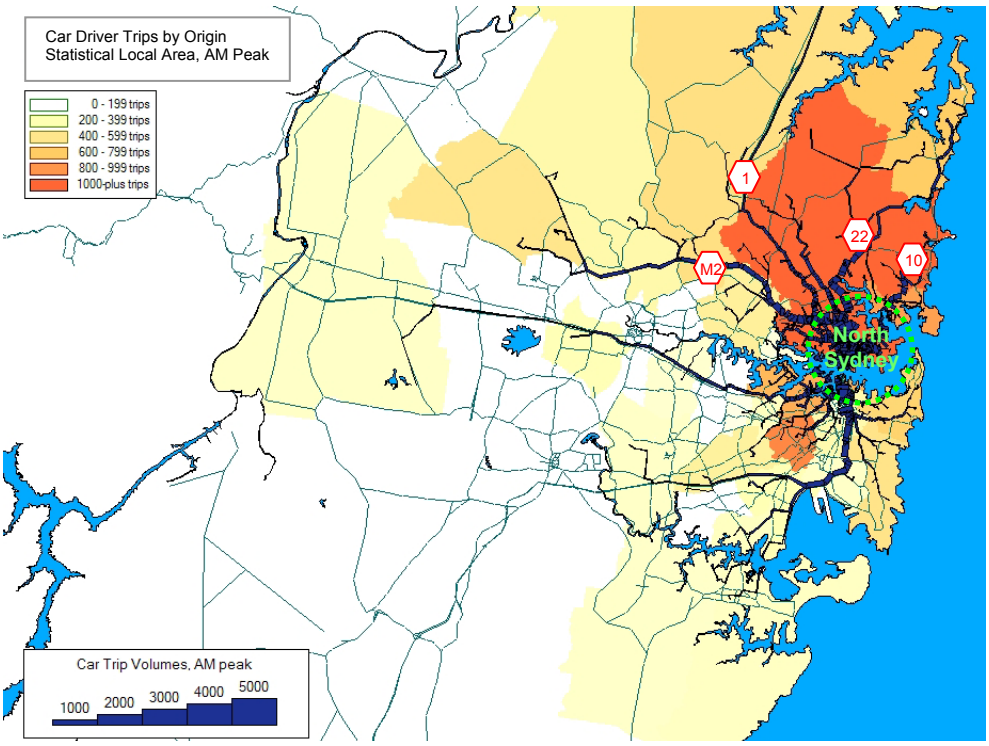

Figure 8 Car driver trips to North Sydney, AM Peak (2003)
Source: TPDCa (2006) Trip Flows Into Sydney and Other Regional Cities Transfigures

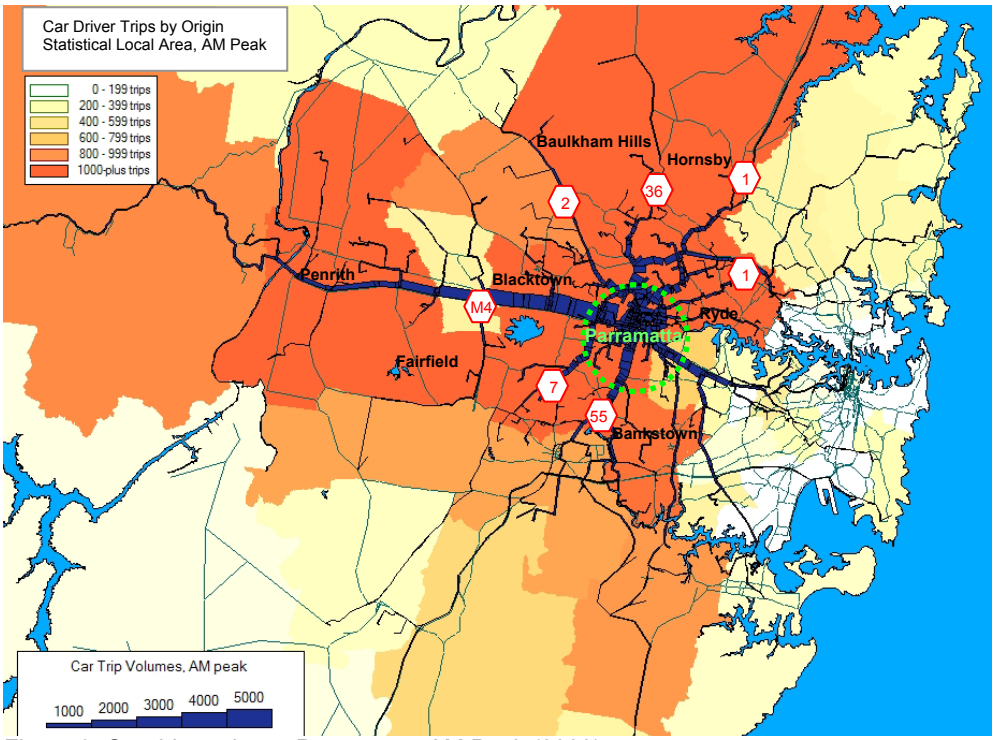

Figure 9 Car driver trips to Parramatta, AM Peak (2003)
Source: TPDCa (2006) Trip Flows Into Sydney and Other Regional Cities Transfigures

6 Summary and conclusions

The Sydney Household Travel Survey data was used to analyse aspects of peak hour travel to inform demand management policy. The broad level analysis of trends between 1991 and 2004 showed that:

- The *growth* in demand on the network was concentrated in the peak periods.
- Peak spreading appeared to be occurring in response to increase in demand.
- Car travellers were the biggest contributor to the increase in demand during the peak periods.

Further detailed examination revealed the following:

- Most trips during the peak periods were for non-discretionary purposes (work, education and childcare) but the proportion of trips which were for discretionary purposes (shopping, personal business, social, recreational) was significant, from 18% in the morning peak to 41% in the 5pm to 7pm period.
- Those who undertook proportionally more discretionary travel or serve passenger trips and also contributed significantly to the morning peak hour demand were: the part-time, casual and voluntary workers and those aged 31 to 50 years.
- The largest contributors to the morning peak demand, regardless of purpose, were workers and students.

As shown in this paper, the HTS data can be used to inform a number of demand-management strategies: teleworking, employer-assisted transport, carpooling, vehicle occupancy, departure time strategies, flexible work scheduling and parking. The data was also analysed to identify major traffic flows for application in corridor studies.

More analyses can be done using HTS data on each of these aspects than can be included in this paper. The work undertaken, nevertheless, demonstrates the extent of analyses that is possible using the available empirical data and its relevance in policy formulation and assessment.

Appendix

1991 Home Interview Survey (HIS) and the Household Travel Survey (HTS)

Up to 1991, large one-off household travel surveys were conducted in Sydney in ten-year intervals. The last of this was the 1991 Home Interview Survey (HIS) which had a sample of over 12,000 households. Beginning in 1997, a new data collection strategy was implemented that would provide personal travel data on a continuous basis in order to meet the need of transport data users for more timely data. This continuous survey was called the Household Travel Survey (HTS).

The HTS sampling methodology was developed for TPDC by the Australian Bureau of Statistics (ABS) with an annual sample of about 3500 households which can be pooled to improve statistical validity. In this paper, five waves of HTS data collected from June 1999 to June 2005 were pooled and weighted to 2004 population benchmarks to produce the 2004 HTS figures featured in this paper. This five-year pooled HTS dataset had a sample of over 15,000 households (details in Table A.1 below).

The HTS uses a similar method to the 1991 HIS, allowing for comparison over time. Both use the face-to-face interview method which is carried out every day of the survey period. A travel diary is used by each householder to record the details of all travel undertaken for their nominated 24 hour period. For each trip, the interviewer records the mode of travel, trip purpose, start and end location, and time of departure and arrival. Vehicle occupancy, toll roads used and parking is recorded for car trips and fare type and cost for public transport trips. Detailed socio-demographic information is also collected on the household, including dwelling type, household structure and vehicle details, as well as age, gender, employment status, occupation and income of individual household members.

Geographical coverage

TPDC's travel surveys are conducted over an area which includes the Sydney Statistical Division, Newcastle Statistical Subdivision and the Illawarra Statistical Division. The data presented in this paper are for the travel of residents of the Sydney Statistical Division (Figure 11).

Figure 11

Survey sampling design

The HTS, as in the HIS, uses a stratified, three-stage cluster sampling method. The stratification is by Statistical Local Area. The sample is also temporally allocated, that is distributed to the days of the week and weeks of the year as evenly as possible over the survey period. This design ensures the geographic and temporal representativeness of the dataset.

The sample

The following table summarises the sample (n) taken from the *Sydney Statistical Division* in the 1991 HIS and 2004 HTS datasets with the corresponding population counts.

Table A.1 Sample counts in the 1991 HIS and 2004 HTS

	1991 HIS Sample	1991 Population	2004 HTS Sample Five-Year Pooled	2004 Population
Households	9,956	1,293,262	13,024	1,537,520
Persons	28,402	3,568,691	33,962	4,168,555
Trips	116,599		147,370	

Methodology

The data used in the analysis of this paper is expanded (weighted) to represent the travel patterns of the total population in the survey area using a methodology developed by the ABS. This process uses ABS data on households and individuals from the latest Census of Population and Housing together with annual estimates of the resident population (ERP) in occupied private dwellings by Statistical Local Area, age and sex. This expansion method ensures that the HTS population estimates match the ABS population estimates for the survey area for 1991 and 2004.

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