



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

"Statistics of understanding" for demand management transport planning – the Sydney Household Travel Survey

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Abstract

Travel demand in Sydney and most other major cities continues to grow strongly at a rate greater than the growth in population. Active and more complex lifestyles of the population result in more trips and longer trips. This increasing travel activity puts pressure on the supply of infrastructure creating congestion and increased travel times, and pressure on the environment with increased noise and air pollution.

In the past the role of transport planning was to provide the infrastructure to cater for the continually growing demand. Now the emphasis has shifted to managing that demand and to attempting to redress the imbalance in the use of the infrastructure between public and private transport.

Managing demand requires an understanding of the demand for travel beyond that previously found in basic travel demand forecasts. The Household Travel Survey conducted by the NSW Department of Transport on a continuous basis since June 1997 provides detailed, comprehensive data on the travel patterns of selected households in the Greater Sydney Metropolitan Region. The HTS, which uses a travel diary, face to face interview methodology, provides very detailed data on person and household trip patterns. This paper analyses the data from the first wave (1997/98) of that survey to give an understanding of the market segments for travel and the factors that influence the travel decision.

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Introduction

Demand for travel by urban residents continues to grow strongly despite complaints about increased traffic congestion and the public transport system. We tolerate seemingly longer travel times to work, sitting in our cars in a constant stream of traffic which edges slowly towards our destination. We will accept using public transport, in some cases, for our trip to work but on the weekend we again abandon it for our private car and the increasingly congested road system which has difficulty in coping with our demand for recreational travel.

Travel, as we all know, is only a means to an end, that is an activity in which we really want to participate. Although, according to the Australian Bureau of Statistics (1997) we are spending more time working and there is greater participation of both partners in the household in the workforce, demand for non-work travel is also continuing to increase considerably. This is partly in response to the increased demands of the household's working routine. We travel more for purposes to eat out, pick up take away meals and take children to childcare. But we are also travelling more to participate in an increasing range of recreational and leisure activities, participating in and watching sport, music and other cultural activities and generally being "out and about". For although we may be working more and have less leisure time, we have more money to spend in that time on a greater array of consumer goods and recreational activities and to pay for services to support the higher level of work activity.

How are our cities coping with this apparently unstoppable trend? The answer, if nothing is done to manage this demand, is not very well. Our preference for undertaking the bulk of this travel in the private motor vehicle has adverse impacts on the environment in terms of air and noise pollution and demands investment in vast tracks of road infrastructure, which could not be argued are an attractive addition to the urban landscape. This view is shared by Button and Nijkamp (1997, p217) who state that "notwithstanding the central role that transport plays in modern societies, it is increasingly recognised that current and predicted trends in personal mobility and freight transport, on local, regional and global levels pose severe threats to the environment and more stringent regulations of transport seem inevitable if policy goals related to global environmental sustainability are to be pursued."

To be able to plan to accommodate this demand for participation in activities and ensure the sustainability of the city requires an understanding of the travel patterns of persons and households and what motivates those patterns. "Efforts in the past that have largely relied on engineering approaches to confront conflicts between social and environmental sustainability have failed, but nothing has yet emerged to fill the gap. Thus, there is a clear need for research into behavioural responses in terms of mobility" (Button and Nijkamp 1997, p217).

Over the past decade much discussion has taken place in Australian metropolitan areas as to the need for travel survey data and the type of data which is required for policy and planning purposes. The balance of opinion has swung from regular large scale surveys at quite long time intervals, through to questioning the need for surveys at all, and now

in Sydney and Melbourne to the continuous survey. This paper will draw on analysis of data from the 1991/1992 and 1997/1998 Sydney Household Travel Surveys and will demonstrate, at least to a small extent, some of the benefits of a continuous detailed survey of personal travel in providing information on travel behaviour trends. This analysis will provide evidence of the trends in travel behaviour as outlined in this Introduction. It is not the role of this paper to consider approaches to bringing about changes in this behaviour, to which it is recognised that there are many. It is hoped that the knowledge and understanding of that behaviour which is provided by the data will assist policy makers in determining the most appropriate approach to travel demand management.

Travel surveys in Sydney

Surveys prior to 1997

Prior to June 1997 large scale household travel surveys were conducted in Sydney in 1971, 1981 and 1991/92. These were the legacy of the 1971 Sydney Area Transportation Study, which in accordance with transport planning practice at that time, was an indepth study which produced a blueprint for the development of transport infrastructure to accommodate the city's rapidly growing population.

The 1981 and 1991/92 surveys provided rich databases which, allow for comparison of travel between these two points in time. Information on the 1991/92 survey is reported in Peachman (1992) and for a comparison of travel for the period 1981 to 1991 in Sydney see Transport Data Centre (1996) and Gee, Hay and Bell (1996).

In the mid 1990's discussion turned to the need for a new survey and there were many arguments as to why a continuous, rather than a one-off survey, would better serve the needs of stakeholders. If the previous 10 yearly pattern had been followed, the next large one-off survey would have been in 2001. It was already beginning to be felt that the 1991 data was dated. It had been collected at the trough of the economic cycle, which had been in an upward growth phase since that time, and there was a perception that travel patterns had changed. There was a need for current data and it was considered that a continuous survey would provide ongoing current data for policy and planning purposes. Transport planning is no longer the subject of isolated large-scale exercises. While strategic plans are developed at periodic intervals, there is continual assessment and reassessment of infrastructure needs and travel demand policy options. Also the growing involvement of the private sector in infrastructure provision has necessitated more current data for financial assessment of projects.

Large scale household travel surveys are expensive projects to mount and resource intensive to manage. They also require a considerable amount of inhouse expertise in the design and management of the survey and the processing and analysing of the data. Setting up such a team requires substantial investment in recruitment, training and development of staff. Much greater value from such an exercise can be derived if that team is employed on an ongoing basis rather than for the one-off large scale survey. It is

also easier in a climate of budgetary restraint, to maintain a smaller scale single line item rather than have to find the much larger amounts required to fund the large scale survey

The continuous Sydney Household Travel Survey

The survey method: Following a review of data collection methods which is reported in Peachman and Mendigorin (1997) it was decided that a face to face interview method would be used for the continuous survey. The survey instrument is a 24 hour travel diary which, while focusing on collecting travel information, does so in the context of the respondent's activities using a "verbal activity recall framework". This technique was developed for the 1981 Sydney travel survey and was also used in the 1991/92 Home Interview Survey. The questionnaire for the 1997/98 survey was changed only marginally from that of the 1991/92 survey, thus providing the basis for sound comparisons over time.

The data collected: The travel diary, which is completed by all members of the household, (including children of all ages) collects detailed information on all trips made over a 24 hour period. The data collected on each trip, which is defined as a movement of over 100 metres in a public place, is very detailed. Some 20 possible variables are asked for each trip which include time of departure and arrival, address of origin and destination, purpose and mode of travel. For private vehicle trips, vehicle occupancy, toll roads used and parking details are collected. For public transport trips type of fare and type and cost of ticket are collected.

In addition detailed socio-demographic information is collected on all members of the household and details of all vehicles used by the household are collected. The face to face interviewing method, which allows for only very limited proxy interviewing, ensures that respondents can be lead through their travel for the day being prompted by their participation in activities to enhance their recall of all trips. This is particularly important for the collection of short trips which tend to be forgotten, and hence underenumerated, particularly in self completion travel diaries.

This information provides a very detailed database of trips undertaken by individuals. The data can be analysed at the level of the "unlinked trip", which is every movement, which could include for example all access modes to public transport, all short walk trips and all "other purpose" trips which may be undertaken on the way to the workplace. Alternatively trips can be aggregated in a number of combinations of "linked trips" so that more general analysis by primary trip purpose or primary mode can be undertaken. In addition this trip data can be examined in the context of the individual's socio-economic situation as well as that of the household and the household's lifecycle stage. The travel patterns of individuals in a household are directly influenced by the activity demands of other members of the household, the vehicle availability and access to public transport. All these factors can be considered with the data that is being collected in the Household Travel Survey.

The sample size and statistical significance: The sample is designed so that it covers all days of the week and every day of the year. The continuous survey sample was designed on a three yearly basis so that at the end of the third year the combined sample size will be roughly comparable with that achieved in the 1991/92 Home Interview Survey. A sample of 3,700 households was sampled in the first annual wave (1997/98) of the continuous survey, which represented 9,900 persons and 43,000 trips. If this sampling rate is continued the combined sample size will be 11,100 at the end of the third wave, (see Table 1) compared with 12,000 households in the 1991/92 survey.

Table 1. HTS cumulative sample sizes

HTS Wave	Households	Persons	Trips
June 1997-1998	3,700	9,900	43,000
June 1998-1999	7,400	19,800	86,000
June 1999-2000	11,100	29,700	129,000
June 2000-2001	14,800	39,600	172,000

The survey is conducted over an area which includes the Sydney Statistical Division, Newcastle Statistical Subdivision and the Illawarra Statistical Division as shown in Figure 1. This area has a population of 4.6 million people. The sample has been designed so that its statistical significance increases at lower geographical levels with each pooled wave of data. As Figure 1 illustrates the data is reliable at the 95% confidence level at the Statistical Division level after the first wave. This same level of reliability is achieved at the Statistical Local Area level by the end of the third wave.

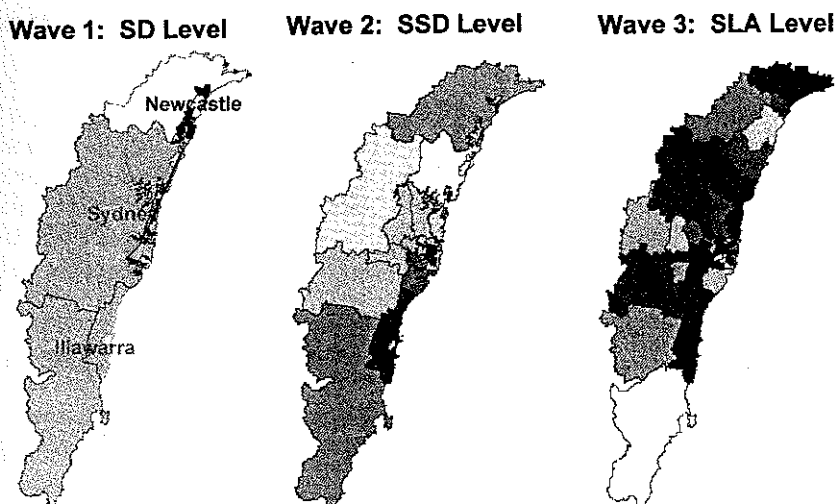


Figure 1. Levels of reliability of the data from the continuous Household Travel Survey

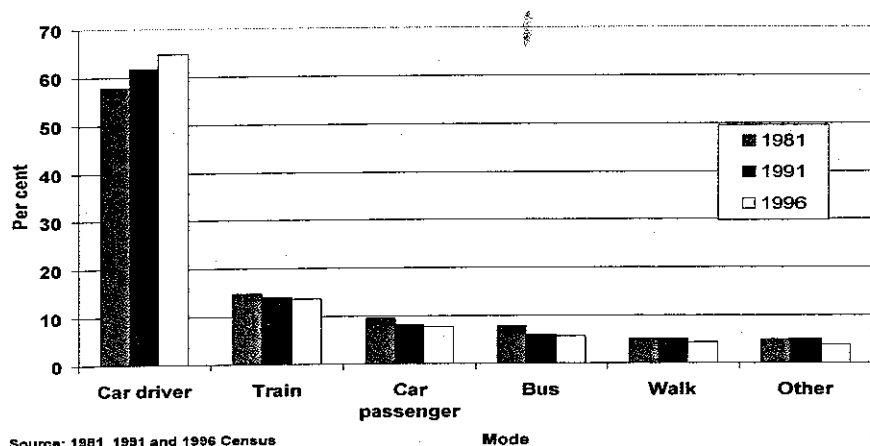
Data for environmental assessment

Detailed understanding of travel patterns is required for planning of transport infrastructure and policy formulation to provide a more efficient and equitable transport system. However another important motivator in designing transport systems and managing transport demand is the need to reduce the adverse impact of transport on the environment.

In the United States environmental legislation in the form of the Clean Air Act and Clean Air Act Amendments was the trigger for the renewed collection of travel data and for the program of improvements in travel demand modelling "The United States Department of Transportation, despite a difficult current financial situation, has pooled limited funding from several sources in order to undertake a Travel Model Improvement Program, having the goal of fundamentally revolutionising the state of practice in transportation modelling" (Wachs, 1996). All major metropolitan planning organisations are required to report on the level of travel demand so that its impact on the environment through vehicle emissions can be measured and monitored. They therefore have to collect the data and develop models of travel demand to be able to meet these obligations.

In Sydney there is also growing concern about the adverse impact of the unchecked growth in private vehicle transport on air quality. Transport, particularly motor vehicle transport, is the most significant source of many of the pollutants that damage air quality (EPA, 1998).

The 1996 Census of Population and Housing shows that for the journey to work 71% of trips are by private motor vehicle in the Sydney Region. The mode share of the private vehicle has increased steadily from 1981 to 1996 as shown in Figure 2.



Source: 1981 1991 and 1996 Census
Figure 2. Mode share of trips to work in Sydney – 1981, 1991 and 1996 Census of Population and Housing

The use of the private car is also growing faster than the growth in population. That is we seem to be making more trips and perhaps longer trips by car. This expansion in mobility is illustrated in Figure 3, which shows a 20% growth in population for Sydney in the period 1981 to 1997 but a 34% increase in car trips, a 47% increase in the number of household cars and a 58% increase in the use of private cars measured as vehicle kilometres travelled, over the same period.

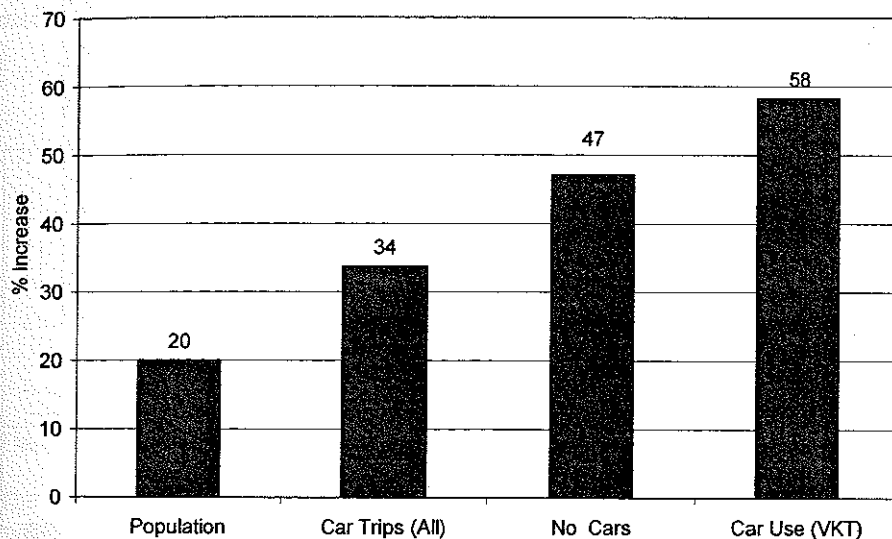


Figure 3. Mobility expansion in Sydney 1981-1997

The recently released Air Quality Management Plan from the Environment Protection Authority (EPA, 1998) includes targets for the reduction of VKT growth over the next 20 years. The monitoring of the achievements of these targets and the evaluation of policies which will most effectively allow them to be achieved, will require an ongoing source of reliable data and an improved capability in strategic travel demand modelling, both of which are commitments of the New South Wales Government.

Trends from the 1991/92 and 1997/98 Sydney Travel Surveys¹

The transport task is traditionally measured in a number of dimensions. The total number of trips made, trips by mode and the length of trips both in terms of travel time and distance travelled.

¹ The data was collected over the financial year of 1991/92 and 1997/98, however, it was expanded to represent the estimated resident population as at June 30, 1991 and June 30, 1997 respectively. Thus, the data represents the years 1991 and 1997 and it is labelled as such.

Number of trips

Between 1991 and 1997 the number of trips by people in the Sydney metropolitan region has increased by nearly 14%, this is in relation to a 7% increase in population over that time. This indicates that each person is making more trips and the average trip rate per person has increased from 3.6 to 3.8 over that period. The main purposes where there was an increase in trips made were for social and recreational trips which increased by 23% and serve passenger trips which increased by 26%. Overall the share of these trips increased as is illustrated in Figure 4.

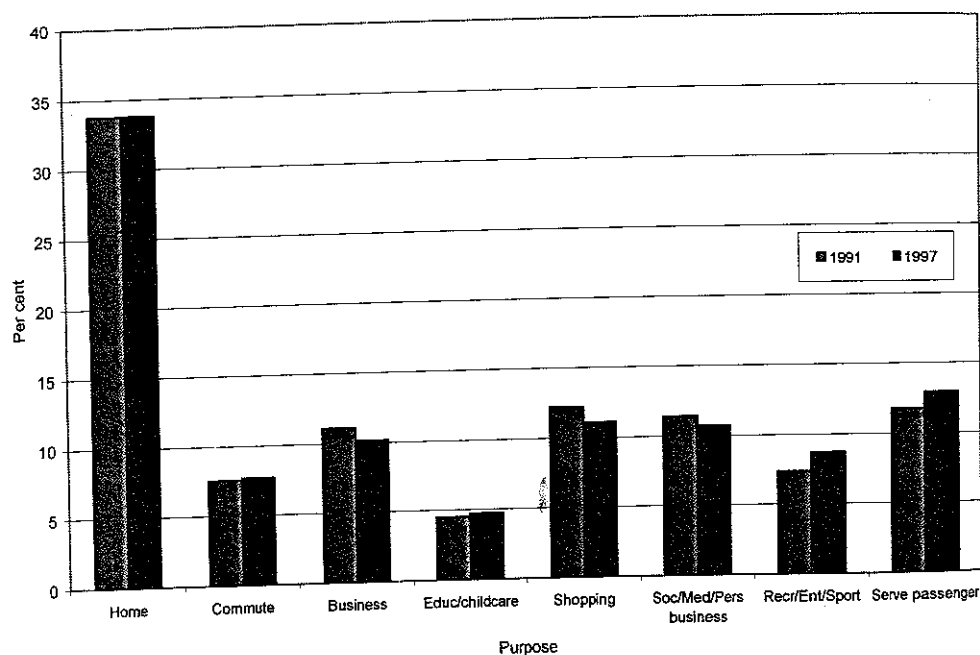


Figure 4. Proportion of trips by purpose 1991 and 1997

Mode of travel

The number of trips by all modes, with the exception of walk only trips, has increased. However car trips have increased at a faster rate with vehicle driver trips increasing by 19% and vehicle passenger trips by 24%, compared with increases of 11% in the number of train trips and 8% in the number of bus trips. Hence the mode share for car travel has continued to increase with car trips now representing 71% of all trips on an average weekday (Monday to Friday) compared with 67% in 1991 as is shown in Figure 5.

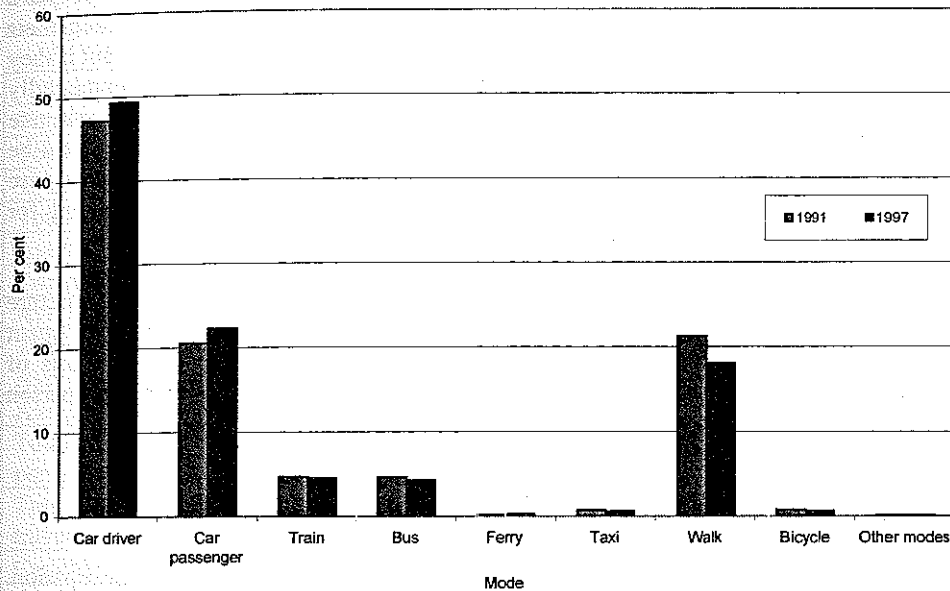


Figure 5. Proportion of trips by mode, Sydney Statistical Division, 1991 and 1997

The message coming out of the data is that overall we are becoming an increasingly mobile society and that we are still preferring to undertake that travel in the private car. Understanding what activity choice patterns are behind this travel outcome, may help us in devising policies to deal with this demand. There is a range of policy options available to address travel demand management. These can include changing behaviour through economic incentives or other regulatory means, providing better information on travel choices, better public transport services, providing new infrastructure, pricing policies for infrastructure, land use decisions affecting the relative location and hence accessibility of activities, or technological solutions such as more environmentally friendly vehicles. The solution is unlikely to lie in any one of these options alone but in a combination or package of strategies. For a discussion of some preliminary results of a study of sustainable transport policies in European cities see Bratzel (1999) and for a general discussion of policies aimed at replacing the private car see Wootton (1999).

As Goodwin (1995, p152) points out "exhortations on their own would have limited effect, and policy sticks – unaccompanied by carrots – would generate resistance, because they do not take sufficiently sensitive account of why people are using their cars." He also quite perceptively points out that there is an underlying distinction "between car dependent *people* and car dependent *trips* – which will be essential to get right in any consideration of changing circumstances or policies: as a general principle, seeking to persuade large numbers of people totally to change their attitudes to car use is likely to be less successful (at least in the short term) than seeking to achieve a change in choices about how – and whether – to make specific targeted journeys "

Further examination of the data may be useful in providing an insight into people's travel needs. It is unlikely that people will readily be persuaded to reduce their participation in activities for travel which they deem to be non-discretionary. But if they could continue to participate in activities as desired, but in a more environmentally friendly manner, that is by reducing the kilometres consumed to achieve the same rate of activity participation, this may present a more acceptable solution. This could be achieved, for example, if less private car kilometres were driven because activities were more accessible or public transport is more readily available and convenient for participation in the desired activities.

Figures 4 and 5 have looked at the number of trips undertaken. But what is the picture when we look at the transport task in terms of kilometres travelled and time spent travelling? In the following sections we will look at the travel task in terms of kilometres travelled by purpose, by trip length, by per head of population and by person travelling which reveals some interesting trends in travel patterns

Kilometres travelled

The Household Travel Survey collects the address of every trip origin and destination. This information is then coded to one of the 1,100 travel zones in the survey area. The straight line distance was then calculated from zone centroid to zone centroid. This is considered to provide a reasonable estimate of kilometres travelled which is valid for comparisons, even though it is an approximation of the actual network distance. Special consideration however needs to be given to intrazonal trips, which would be calculated as zero distance using this method. In these cases we have imputed a distance of 0.5 kilometres for walk and bicycle trips and 1 kilometre for all trips by all other modes

Table 2 summarises the overall picture of travel patterns in the Sydney Statistical Division between 1991 (based on the Home Interview Survey) and 1997 (based on the first annual wave of the 1997/98 Household Travel Survey). It is apparent from this information that the rate of growth in travel continues to increase strongly. While population has increased by 7 % and the total number of trips has increased by 14% total kilometres travelled has increased by 18%. This indicates that all aspects of travel have increased as each person is making more trips, and travelling further so that overall average kilometres per person has increased by 10 %.

A note of caution should be mentioned here in relation to the comparison of the two data sets over this period. It is likely that some increase in the number of people travelling may reflect an improvement in survey methods, that is there were less zero trippers recorded in the 1997 survey than in 1991. Also in comparing the data from 1991 and 1997 it must be remembered that we are comparing two very different points in the economic cycle, that is the trough in 1991 and a point after a period of very strong growth in 1997.

Table 2. Travel patterns in Sydney Statistical Division, 1991 and 1997 on an average weekday

	1991	1997	% Change
Total number of trips	13,108,000	14,948,000	14%
Total kilometres travelled	80,959,000	95,783,000	18%
Total population	3,569,000	3,822,000	7%
Total number of travellers	2,977,000	3,296,000	11%
Average trip length (kms)	6.2	6.4	4%
Trip rate per person	3.7	3.9	6%
Ave. km per person	22.7	25.1	10%
Trip rate per traveller	4.4	4.5	3%
Ave. km per traveller	27.2	29.1	7%
Ave. trip duration (minutes)	20	21	4%
Total time spent travelling per person (minutes)	73	81	11%
Total time spent travelling per traveller (minutes)	87	93	7%
Car kms travelled as driver	43,788,000	53,460,000	22%
Car kms travelled as passenger	17,044,000	20,686,000	21%

Why are we travelling?

The period since 1991 to 1997 has been a period of strong growth in the economy with a growth in employment of 7.4% over that time. It might therefore be expected that the growth in travel may be reflected primarily in growth in commuting and work related travel. However analysis of the data in terms of kilometres travelled by mode and purpose suggest that the main areas of growth in travel are in recreation and entertainment trips and serve passenger trips (accompanying and dropping off other passengers). These trip purposes are a function of increased disposable incomes and also changes in household lifestyles as a result of the increasing incidence of two worker households. As female work force participation continues to rise there is a demand for more trips for dropping off/picking up other members of the household from childcare and after school care activities and for eating out or picking up take away meals. Trips to take away food outlets represent a measurable proportion of total trips in the 1997/98 Household Travel Survey.

Figure 6 shows the change in the number of trips and the kilometres travelled by purpose which further illustrates the increasing travel for participation in recreation/entertainment and sporting activities and for serve passenger purposes.

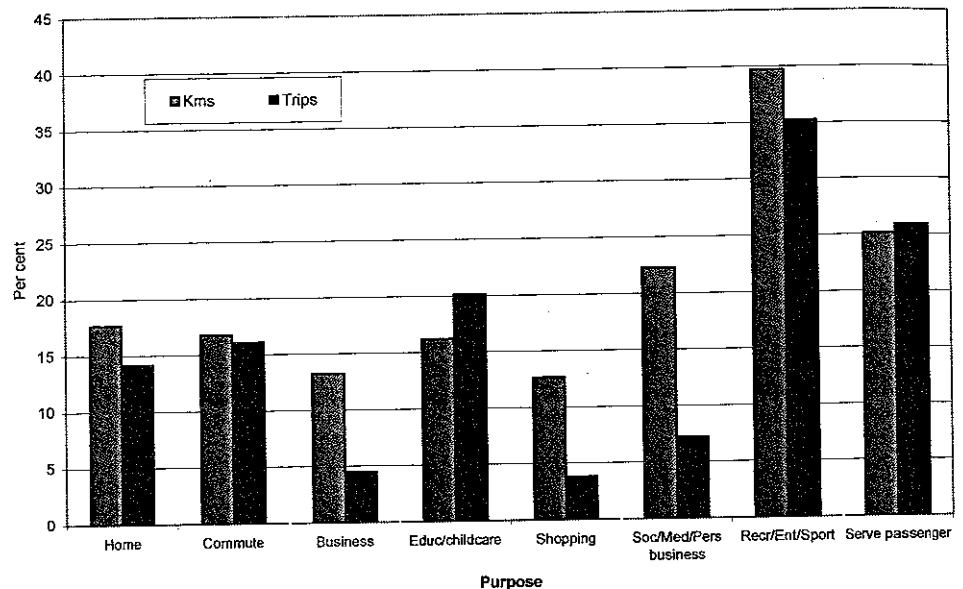


Figure 6. Change in kilometres travelled and number of trips, Sydney Statistical Division, 1991 - 1997

It is also interesting to note the changes in travel pattern for some of the other purposes. For example the number of trips for shopping and social/medical/personal business purposes have increased but at a significantly lesser rate than the number of kilometres consumed in making those trips. Thus indicating that the trip lengths for these purposes has increased suggesting that we may be travelling further, perhaps to larger regional centres to undertake these activities. The reverse appears to be the case for education and childcare trips where the trip length seems to have decreased. This may be a function of an increase in trips for childcare rather than children attending school, which may be expected to be shorter. However further exploration of the data with a larger sample size will be necessary to refine these trends further.

How far and for how long are we travelling?

These changes in average trip lengths by trip purpose are shown in Figure 7. It is also apparent from this analysis that travel distance to work has changed very little between 1991 and 1997. This is consistent with the findings of Milthorpe and Raimond (1998) who examined trip lengths in Sydney between 1981 and 1996 using the Journey to Work data from the Australian Bureau of Statistics Census of Population and Housing. Average trip lengths for most other purposes have increased, in some cases such as social/medical and personal business by up to one kilometre. Overall the average distance per day travelled, by all persons who are travelling, has increased from 27 kilometres to 29 kilometres, ie we are travelling 2 kilometres further each day.

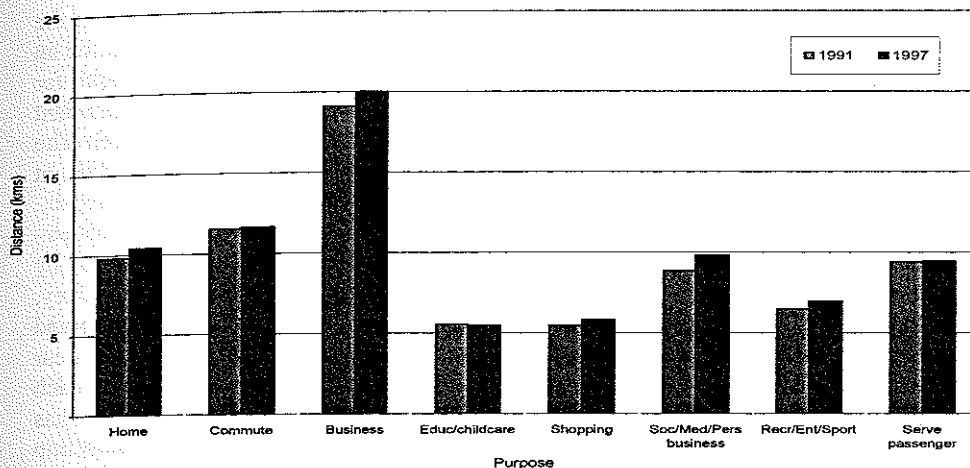


Figure 7. Average trip lengths by purpose 1991 and 1997

In terms of time spent travelling, those extra 2 kilometres travelled translate into an extra 6 minutes on average of travel time per day, with the average person spending 93 minutes each day travelling in 1997 compared with 87 minutes in 1991. (This is for travel for all purposes and by all modes.) The average trip duration has changed very little from 31 to 32 minutes for the trip to work and from 19 to 20 minutes for trips for all non-work purposes. The fairly constant commute time budget is consistent with other work in this field which has been conducted in Australia such as Brothie (1995) and overseas Levinson (1998). This suggests that on average we are not necessarily travelling longer to participate in activities, but that we are making more trips thus increasing the distance travelled and the amount of time spent travelling. However, as discussed above there appear to be some trip purposes for which travel distance is increasing.

The car, travel and the future

The main consequence of this increase in travel, which is primarily for non-work purposes, is that it is predominantly undertaken in the private car. On an average weekday nearly 90 % of all serve passenger trips are undertaken by car and for nearly 60% of all entertainment and recreation trips the car is used. Walk is the other predominant mode for these trips, obviously for shorter trips. However where walking is considered unacceptable the car is the next option, public transport is used for only a small proportion of these trips. This pattern is even more pronounced for weekend travel.

It is not surprising then that, given that the number of trips and kilometres travelled have increased in total, the rate of increase in car kilometres has increased at a faster rate than that for other modes. Over the period 1991 to 1997 vehicle kilometres travelled increased by 22% in total or by 14% per person.

If current attitudes towards travel and current travel behavioural patterns persist, the growth in vehicle kilometres seems set to continue while ever there is scope for an increase in household car ownership. For while an additional car may be purchased for a specific trip purpose, for example getting to work or maybe for a new student attending university, that car then becomes increasingly used for other travel. The convenience which the car offers, and the perceived inexpensiveness of car travel, at least at the margin, induces more travel by members of the household.

This impact of car ownership on the propensity to travel has been demonstrated by Wootton (1999) and Potter (1997) in the UK. This same effect is evident in Sydney. Figure 8 shows the kilometres travelled for each person living in a zero, one two and three car household. On an average weekday in 1997 a person living in a zero car household travels 14 kilometres, this rises to around 33 kilometres per day for each person in a 3 car household. The distance for each person in each type of household has increased since 1991. Conversely the use of public transport by higher car ownership households decreases with 11% of trips by one car households being by public transport compared with 6% for households with 3 or more cars (1997 HTS). The proportions of higher car ownership households also continue to edge upwards and given that new car registrations in New South Wales are currently running at a seasonally adjusted 9% per annum (ABS 1999), it would seem that household car ownership has not yet reached saturation levels. Thus there seems little prospect of a slowing in the growth of vehicle kilometres travelled unless very significant policy steps are taken to have some impact on the underlying demand for travel.

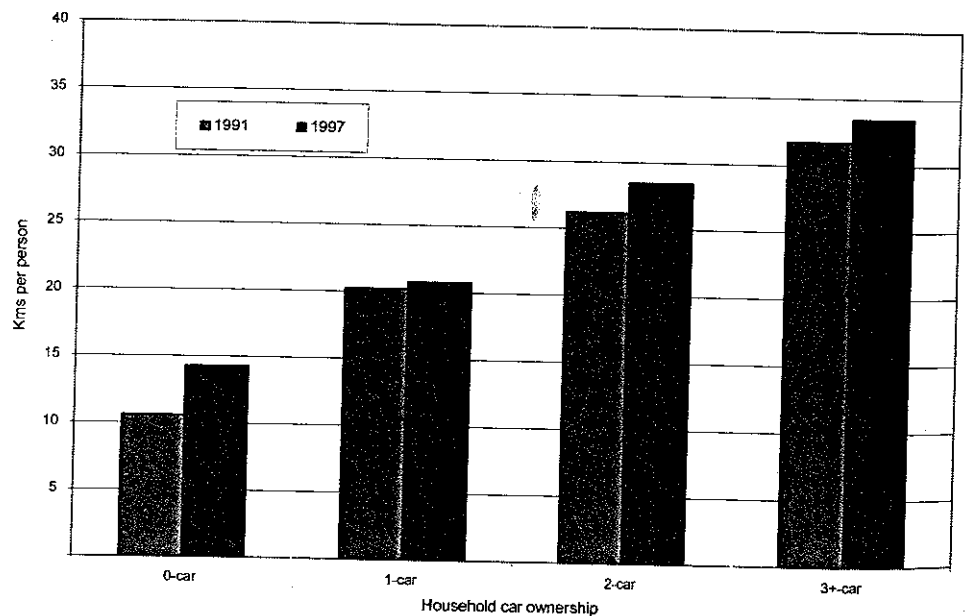


Figure 8. Average kilometres per person by household car ownership, Sydney Statistical Division, 1991 and 1997

The issue of car dependency therefore cannot be ignored. The majority of Sydney residents have settled into a clear pattern of making the car their first choice of travel. This choice becomes reinforced by the social environment and land use planning and development which accommodates this preference. However returning to Goodwin's (1995) argument that there is a distinction between car dependent *trips* and car dependent *people* may assist in targeting policies which may break this cycle of dependence.

Conclusion

Which ever measure of travel is used personal travel has increased significantly for persons living in Sydney over the period 1991 to 1997. There is a direct relationship between the increase in travel and the growth in population, but in addition each person is travelling more to participate in activities. The growth in travel appears to be related to an increase in the participation of particular activities due to changing household lifestyles and income levels. There is clear evidence that we are making more non-work trips, which are predominantly car dependent, and for some of those purposes trip lengths have increased suggesting a transport/land use issue.

The analysis in this paper has only scratched the surface of the potential for exploration of travel demand which is possible in the data collected in the Household Travel Survey. To some extent it has identified trip purposes which seem to be car dependent. More detailed examination can be undertaken of the trip chaining of activities, particularly in relation to household structure and lifecycle stage. It is also planned to undertake further analysis of travel patterns by mode in relation to the accessibility of activities and the density of residential dwellings to determine which people are truly car dependent due to lack of viable alternative modes.

The discussion in this paper, hopefully, illustrates the need for detailed data on household travel patterns to be able to explore the complexity of travel and activity decisions made by household members. The simple travel demand solutions of the past to build more roads are no longer a viable option for modern cities. We need to understand the travel demand needs of the travelling public and provide solutions which meet those needs.

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