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The Temporal Distribution of Travel in Adelaide - A Policy Perspective

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Abstract:

Altering the temporal distribution of travel has been viewed in the past as a useful policy instrument which can be used to reduce the demand for travel during peak periods in an effort to reduce congestion on both the road and public transport systems. Policy instruments such as the shifting of work, school and shopping hours have been proposed at various times with limited success. The paper focuses on the temporal distribution of travel in Adelaide and provides some insight into the reasons why such policy instruments are likely to be unsuccessful and proposes a different approach based on an appreciation of the complexity of the travel market and an understanding of the impact on mode and activity choice.

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Introduction

Altering the temporal distribution of travel in urban areas has been viewed in the past as a desirable policy objective, an objective aimed at reducing the intensity of travel demand during morning and evening peak periods and reducing congestion on both the urban road and urban public transport systems (National Transport Planning Framework (1995)).

Since the service levels and capacity of the urban public transport system and the capacity and level of service of the urban arterial road system (and the associated traffic management and control facilities) are primarily determined by the level of travel demand which is expected to occur during the morning and evening peak periods, it would seem (at first glance) that introducing policies which would lead to a reduction in the intensity or a spreading of peak travel demand would have merit. Economies could be made in the provision of transport infrastructure and services while at the same time achieving improved efficiency in the utilisation of the transport system, reduced congestion and delays and improved environmental performance (through reductions in emissions, noise and energy consumption).

Policy instruments such as the shifting or staggering of work, school and shopping hours have been proposed at various times for Adelaide and other capital cities as a travel demand management strategy.

The work reported in this paper was an extension of some earlier research (Oxlad, (1984)) conducted using 1977 data (Metropolitan Adelaide Data Base Study (1978))and was undertaken to determine whether there would now be merit in the Government introducing policies which achieved a temporal shift in travel demand for particular purposes or modes of transport as part of the travel demand management strategies called for in the Planning Strategy for metropolitan Adelaide (AUSTROADS (1995) The Premier of South Australia (1994)).

The data base produced during the 1986 Adelaide Household Travel Survey (Director General of Transport, SA (1990)) was used and the analysis focussed on average weekday travel for all trip purposes by all modes of transport, viz,

Trip Purpose

Home Based Work (HBW)
Home Based Shopping (HBS)
Home Based Education (primary, secondary and tertiary) (HBE)
Home Based Social/ Recreational (HBSR)
Home Based Other (HBO)
Non-Home Based Other (NHBO)
Non-Home Based Employer's Business (NHBEB)

Mode of Transport

Automobile	*Public Transport*	*Other*
car driver	*school bus*	*walk*
car passenger	*other bus*	*bicycle*
	train	*motor cycle*
	tram	
	taxi passenger	

To obtain the temporal distribution of average weekday travel, tabulations of trips by start time, mode of transport and trip purpose were extracted from the relevant database files (Director-General of Transport, SA (1990)). The resulting distributions are shown in Figures 1 to 9.

Temporal Distribution Of Travel - Overview

Before discussing the distributions associated with each trip purpose it is worth spending a little time considering the main factors which influence the temporal distribution of travel in metropolitan Adelaide:

1. *The starting and ending time of the work, school and shopping period and their relationship to each other.* For white collar employment the working day spans between 8 am and 6 pm with the actual start and end times determined by individual employers throughout the metropolitan area. Daytime shopping hours extend from 9 am to 5 pm and primary and secondary school hours extend from 8.30 am to 3.30 pm;
2. *The spatial distribution of workplaces, schools and shops in relation to their catchment areas.* Like many Australian capital cities, metropolitan Adelaide is a multi-centred city with a dominant Central Business District (CBD) and strong regional centres in the north, north west, north east, south west and south. The Planning Strategy for Metropolitan Adelaide (The Premier of South Australia (1994)) reinforces the fact that the Government's short and long term urban development policies and strategies are directed at ensuring that Adelaide continues to evolve as a multi- centred city with the regional centres forming major nodes for the surrounding catchment areas and a focus for employment location and growth;
3. *The mode of transport used by people (be it the only mode available or the one chosen from a set of alternatives).* The metropolitan area is served by a comprehensive private and public transport system which caters for the travel choices of its citizens at modest cost (in both monetary and non monetary terms);
4. *The accessibility offered by the various modes of transport and the transport system itself to workplaces, schools, shops, social/ recreational facilities, etc.* The metropolitan arterial road system comprises a radial system of major arterials overlaid on a lattice of north-south and east-west arterial roads. Although primarily radial in nature, the (train, tram and bus) public transport system provides regular services to schools, district and regional centres and the CBD. It does not however provide extensive cross town services nor does it provide local, community transit (the latter generally being provided by local Councils);

5. *The degree to which trips for various purposes (by various modes) are linked or chained*;
6. *The activity patterns of households*. The Household Activity - Travel Patterns in Adelaide Study (Director-General of Transport SA (1986b)) identified how the different activity patterns associated with households in different lifecycle classes influenced their travel patterns;
7. *The relative shares of each trip purpose in the overall level of travel demand*. While two decades ago home based work and shopping trips combined to form the majority of trips during the day, over the past decade home based work trips have declined in proportional terms. Total daily travel demand is now roughly evenly split between home based work and shopping trips and non-home based (employer's business and other) trips, a feature which is expected to become more marked in the future (Office of Transport Policy and Planning (1994), Bray (1995)).

Figures 1 and 2 show the combined effects of the above factors on travel in terms of trip purpose and mode of transport respectively.
Figure 1 highlights the inter-relationships of the various trip purposes and shows that:

- the morning and evening peak periods were by no means the domain of work travel alone but included travel for all other purposes despite differing start and end times for the various activities involved;
- the morning and evening peaks occurred at 8 am and 3 pm respectively with the peaks for work travel occurring at 7 am and 4 pm respectively;
- the morning peak extended from 6 am to 9 am while that for the evening extended from 2 pm to 6 pm;
- although small in the morning peak, non-home based travel was a significant proportion of travel in the evening peak and in the inter-peak period;
- for all trip purposes combined the level of demand in the evening peak exceeded that in the morning peak in intensity and extent.

Figure 2 presents similar information in terms of the mode of transport used and shows that:

- while travel by car (as driver or passenger) dominated with travel by public transport next most important, a significant proportion of travel was undertaken by walking and cycling throughout the day;
- the morning and evening peaks for public transport occurred at 7 am and 3 pm while that for other modes occurred at 8 am and 3 pm respectively;
- there was evidence of significant peak spreading of car travel in both the morning and evening peak periods and a significant level of demand for car travel in the period between the two peaks (reflecting the influence of non-home based travel demand).

From an activity perspective, travel is seen as a derived demand - the means by which people move through space in order to take part in a sequence of primary activities at different sites. Travel behaviour may thus be modified either by policies *directly* affecting supply aspects of the transport system (eg parking restraint, peak surcharges, etc) or *indirectly*, by affecting the timing or location of the destination activities that generate trip-making (eg changes to work, school, shopping, etc hours). Because of the inter-relationships of the various factors which influence the timing of trips, the policies

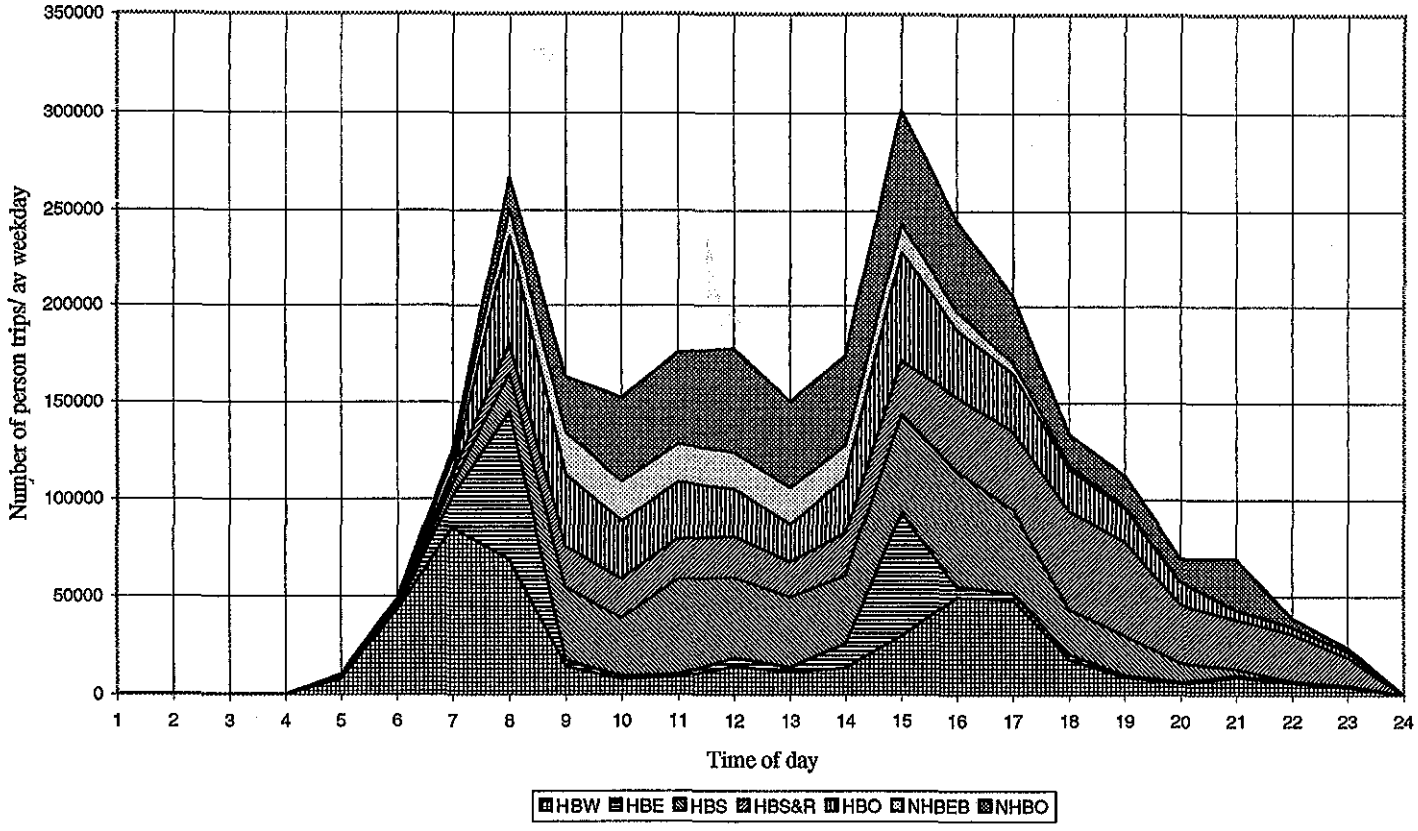

Figure 1 Temporal distribution of trips by trip purpose, Adelaide (1986)

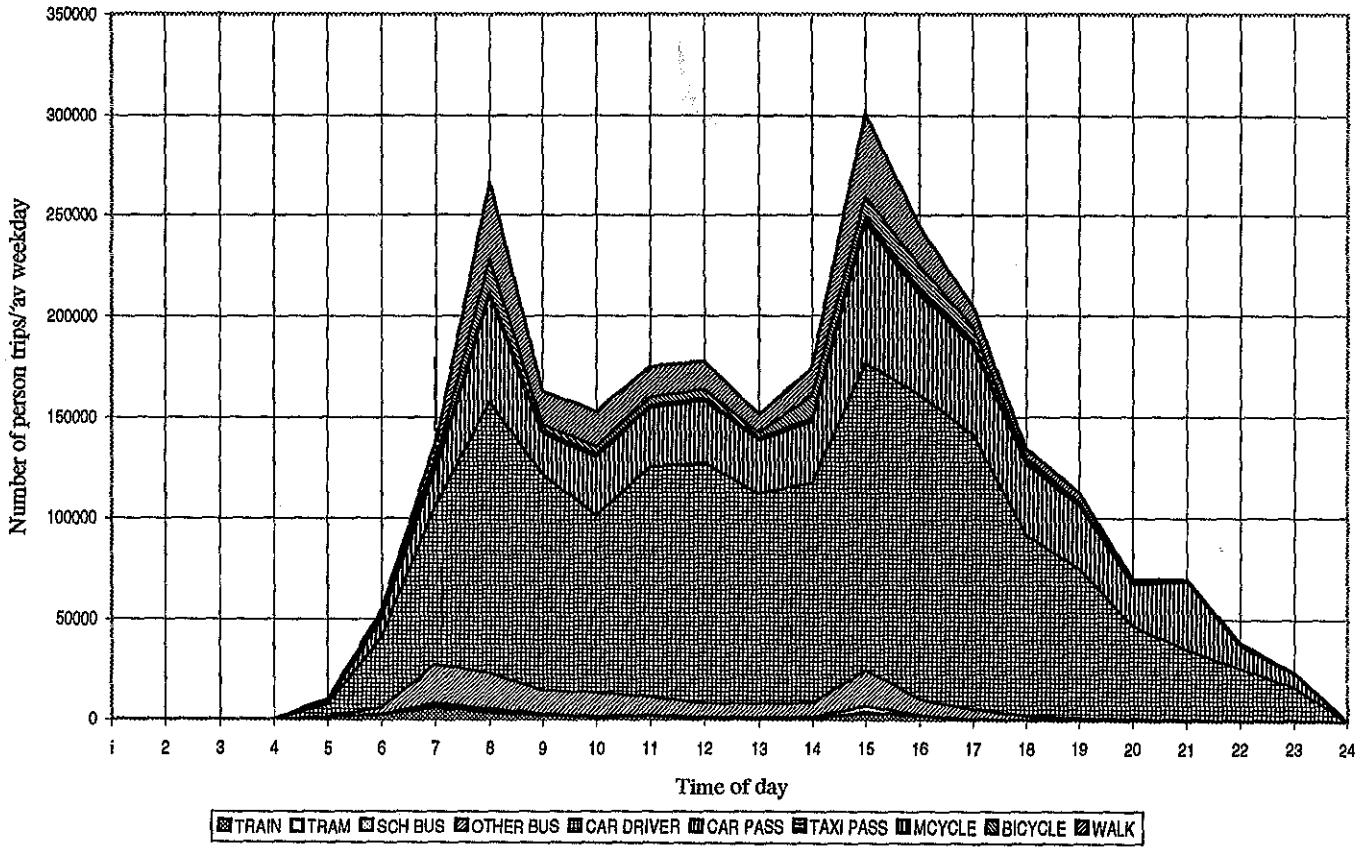

Figure 2 Temporal distribution of trips by mode of transport, Adelaide (1986)

themselves are more complex (and in some cases more perverse) in their impact than is generally acknowledged.

The Household Activity - Travel Patterns in Adelaide Study (Director-General of Transport SA (1986b)) involved an examination of the merits of policies to shift school start times earlier or later. The activity patterns of a range of households were defined and the views of respondents were sought about a number of timing options for school hours in the context of the household's activity patterns. The study concluded that shifting school start times 90 minutes earlier was preferred to shifting them 90 minutes later but that doing so would lead to fewer school-work linked trips and that many of those may be replaced by pre-work two-way serve passenger trips, so increasing traffic volumes and energy consumption (especially in winter when parents may be unhappy about their children walking or cycling to school in the half light).

Using *direct* transport policies to alter the temporal distribution of travel tends to be very difficult because quite Draconian measures are required. Measures such as the introduction of differential fares for peak and off-peak public transport travel are only truly effective if the fare differential is large (ie between 100% and 150% difference). The introduction of differential peak and off-peak fares coupled with a general fare increase in Adelaide in 1983 had some interesting impacts. A "before and after" survey conducted by the then State Transport Authority (State Transport Authority, (1983)) indicated that:

- despite an increase of 39% in the average cost per journey to passengers there was less than a 1% decrease in the total number of passengers using the public transport system;
- there was a 7% reduction in the total number of child and student journeys and a 14% increase in the total number of pensioner journeys (over one third of whom travelled in the free off-peak period);
- there was a 9.6% increase in the total number of peak journeys (and a corresponding decrease in the total number of off-peak journeys) in spite of the fact that peak fares were increased and off-peak fares remained unchanged.

In summary, the conclusions which can be drawn from Figures 1 and 2 are:

- because of the coincidence between the morning and evening peaks for all trip purposes any policy aimed at changing trip timing for one purpose will need to take account of its impact on the overall temporal distribution of travel. For example shifting the start time for work trips one hour later in the morning would have an adverse impact on the morning peak because it would add to the peak demand for other trip purposes;
- for any trip purpose, shifting morning start times later will adversely affect the level of peak demand in the evening thereby increasing congestion on the road and public transport systems rather than relieving it;
- the spread of peak demand in the morning is such that only a large (eg 2 hour) shift in the starting times for one or more purposes would be required to have any significant impact on the intensity of peak demand for any mode of transport;

- the extent of the evening peak would make it difficult to introduce measures to alter the timing of trips and further spread demand;
- the activity patterns of households appear to be playing a major role in dictating trip timing and therefore determining the temporal distribution of travel. This raises the question of the merit of introducing policies which focus on only one or two activities (eg work and school travel, etc) which, when implemented, can cause more problems than they solve.

Temporal Distribution Of Work Travel

Figure 3 shows the temporal distribution of home based work (HBW) trips for the various modes of transport and shows that:

- the morning and evening peaks occurred at 7 am and 4 pm for all modes of transport and extended from 5 am to 9 am and 2 pm to 6 pm respectively;
- the level of demand in the morning peak was considerably greater than that in the evening peak;
- car was the dominant mode of transport used (as car driver or car passenger) with public transport (mainly other bus) the next most important;

The conclusions which can be drawn from Figure 3 are:

- the relatively narrow spread of start times for trips in the morning and evening peaks suggest two things. Firstly, the overall accessibility offered by the road and public transport systems for work travel in general are satisfactory. Secondly, despite the introduction of flexible working hours over the 1977 to 1986 period, people still preferred to start work between 8 am and 9 am (as though they were working fixed hours) and adopt a more flexible approach in the time that they leave work.
- the similarity of the spread of start times for public transport and car trips suggests that introducing policies aimed at achieving a major shift in start times would be successful but, as Figure 1 shows, such policies would need to shift work start times at least 2 hours earlier if adverse impacts on overall peak demand in the morning and the evening are to be avoided;
- the more extensive introduction by employers of flexible working hours coupled with an increase in casual and part time employment at the expense of full time employment may have had the effect of spreading demand not only in the peaks but in the inter-peak period as well.

Temporal Distribution Of Education Travel

Figure 4 shows the temporal distribution of home based education (HBE) trips for the various modes of transport and shows that:

- the morning and evening peaks occurred at 8 am and 3 pm and extended from 7 am to 9 am and 2 pm to 4 pm respectively;
- the morning peak was more intense than the evening peak which is the reverse of the situation which existed in 1977 (Oxlad (1984)) where the morning peak dominated;
- the sharp peaks in the morning and evening reflect the effects of the fixed starting and ending times for primary and secondary school travel;

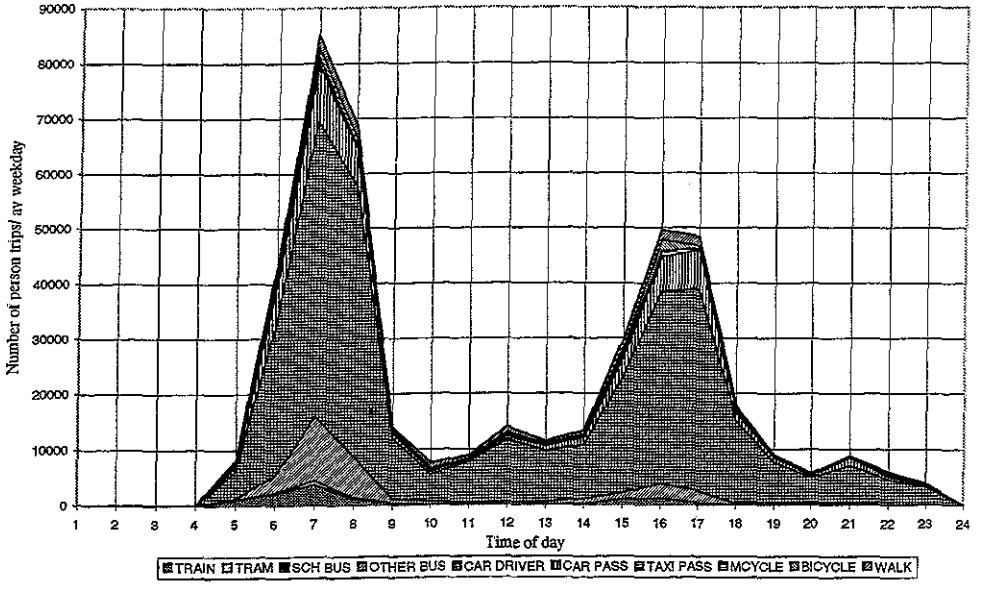

Figure 3 Temporal distribution of trips by mode - home based work, Adelaide (1986)

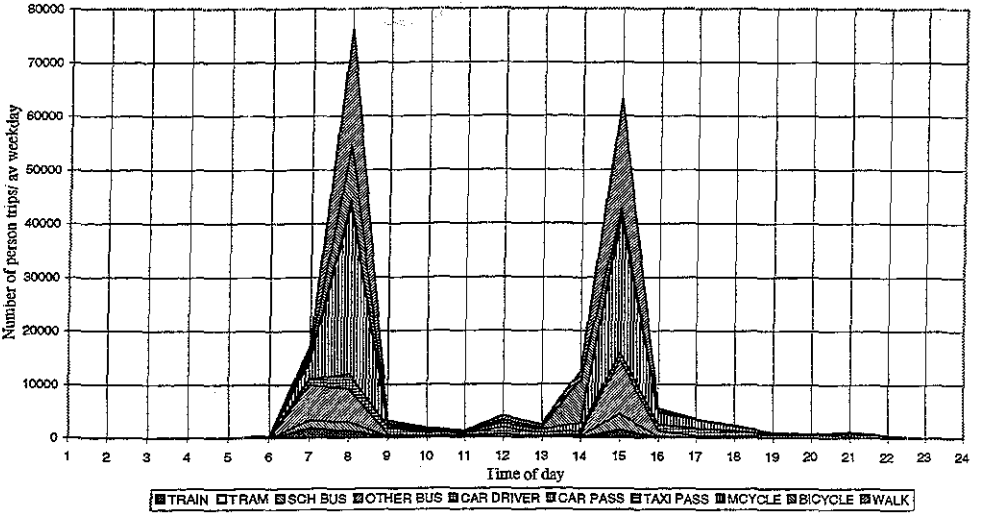

Figure 4 Temporal distribution of trips by mode - home based education, Adelaide (1986)

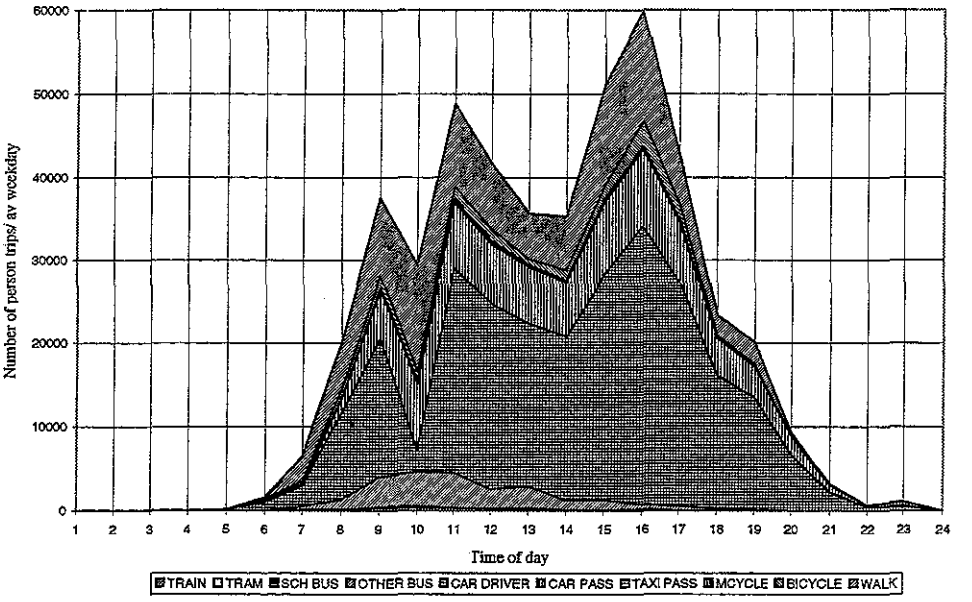

Figure 5 Temporal distribution of trips by mode - home based shopping, Adelaide (1986)

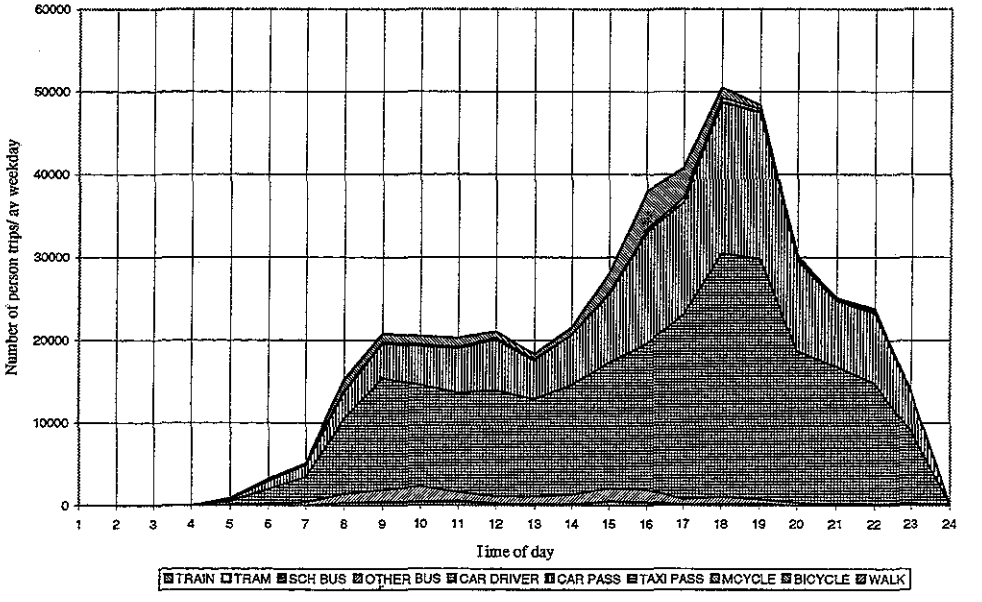

Figure 6 Temporal distribution of trips by mode - home based social/ recreational, Adelaide (1986)

- the dominant modes of transport used, in order of priority, were car passenger, walk, bicycle and other bus. It is noteworthy that far more education trips were undertaken on regular route bus services (other bus) than on special school buses.

The conclusions which can be drawn from Figure 4 are:

- the temporal distribution of education trips is dominated by primary and secondary school travel and it is characterised by sharp morning and evening peaks (regardless of the mode of transport used) between 7 am and 9 am and 2 pm and 4 pm;
- because the peak demand for primary and secondary school travel is localised due to the spatial distribution of primary and secondary schools throughout metropolitan Adelaide, it would tend to exacerbate the morning peak load on the local street system and the morning peak loads on the bus services which, at that time, are also used by work commuters;
- Figure 1 shows the coincidence of morning and evening peak education trips with those for work, shopping and other trip purposes;
- Figure 4 reinforces the findings of the Household Activity - Travel in Adelaide Study (Director-General of Transport (1986)) that, in order to prevent adverse impacts occurring in the evening peak, primary and secondary school starting times should be shifted so they are at least 90 minutes earlier not later.

Temporal Distribution Of Shopping Travel

Figure 5 shows the temporal distribution of home based shopping (HBS) trips for the various modes of transport and shows that:

- there are two morning peaks (at 9 am and 11 am) and an evening peak at 4 pm;
- the dominant modes of transport used were, in order of priority, car driver, car passenger and walking with trips by public transport concentrated in the period between 9 am and 1 pm;
- the evening peak is more intense than either of the morning peaks (for all modes of transport except public transport) and extends from 2 pm to 6 pm;
- the temporal distribution of shopping travel differs markedly from that which existed in 1977 (Oxlad (1984)) due most probably to the land-use changes which occurred over the period.

The conclusions which can be drawn from Figure 5 are:

- the significant change in the temporal distribution of shopping travel compared to 1977 and the dominance of the car as the preferred mode of transport, reflects the impact of the growth in the major regional centres in the metropolitan area since 1977 and the relative decline in importance of the CBD despite its good accessibility by car and public transport;
- despite marked morning and evening peaks, Figure 5 shows that the start time for home based shopping trips is fairly uniformly spread across the day which suggests that the major regional shopping centres are easily accessible by car and that ample short term car parking is available on site throughout the day. This contrasts with 1977 when major regional centres did not exist in the southern suburbs and those in

the northern, north western and north eastern suburbs were only in their early stages of development;

- the spread of shopping travel between the peaks is a desirable outcome from a traffic management perspective and suggests that it would be counter productive to introduce policies to shift starting or ending times during that period since doing so would in all probability cause an adverse impact on the level of demand in the morning and evening peak periods;
- because the evening peak for shopping trips (by all modes) occurs at the same time as that for work trips and because a similar number of work and shopping trips start during the evening peak, demand for the two activities combine to maximise the load on the arterial road and public transport systems. Any policy which caused the distribution of shopping trips to spread more uniformly across the afternoon and evening would have a beneficial effect on the transport system;
- the evening peak for shopping trips may (at least as far as families are concerned) reflect the need for all members of the family to arrive home at a particular time, for cars to be available to allow family members to travel to other activities, etc.

Temporal Distribution Of Social/ Recreational Travel

Figure 6 shows the temporal distribution of home based social/ recreational (HBSR) trips for the various modes of transport and shows that:

- the peak occurs in the evening at 7 pm and extends from 5 pm to 8 pm;
- the dominant modes of transport used were, in order of priority, car driver, car passenger and bicycle. Public transport usage was negligible;
- the intensity and spread of the evening peak demand for social/ recreational travel adds to and exacerbates the effects of the evening peak demand for other trip purposes and adds to the pressure on the road and public transport systems.

The conclusions which can be drawn from Figure 6 are:

- the high usage of bicycle transport suggest that many of the social/ recreation activities pursued by households were located within easy reach of their home;
- the low usage of public transport coupled with the high usage of the car and the clear bias in the distribution towards the afternoon and evening reflects the availability of cars to households at that time rather than an inherent defect in the services provided by the public transport system;
- the spread of the distribution suggests that households pursue social/ recreational activities across the metropolitan area rather than at one or two major nodes or venues.

Temporal Distribution Of Other Home Based Travel

Other home based travel comprises travel for personal business, serve passenger trips and the myriad of other activities pursued by households. It is characterised by being largely discretionary travel and the timing constraints which apply are more related to the activity patterns of households than to the timing of the destination activity.

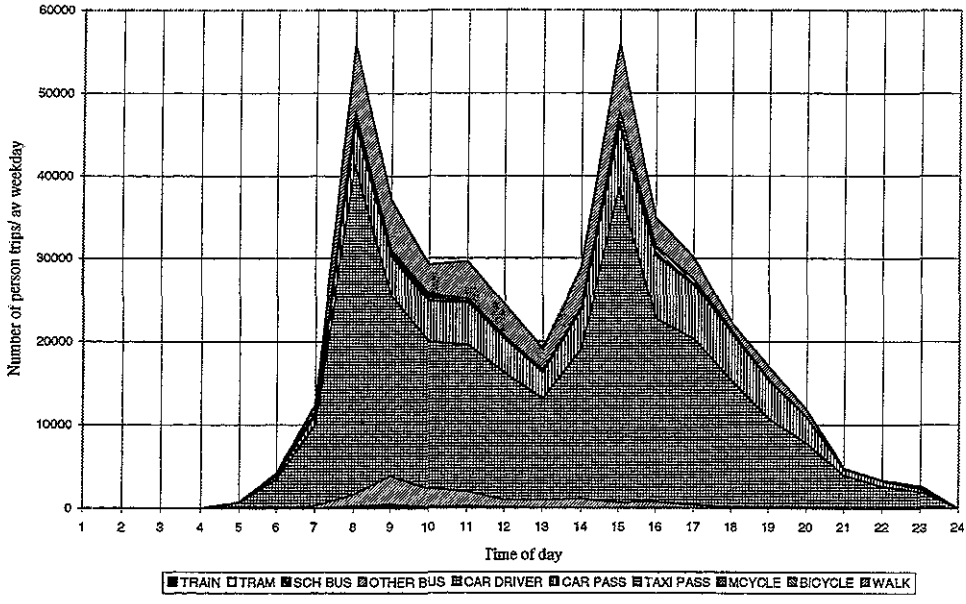

Figure 7 Temporal distribution of trips by mode - home based other, Adelaide (1986)

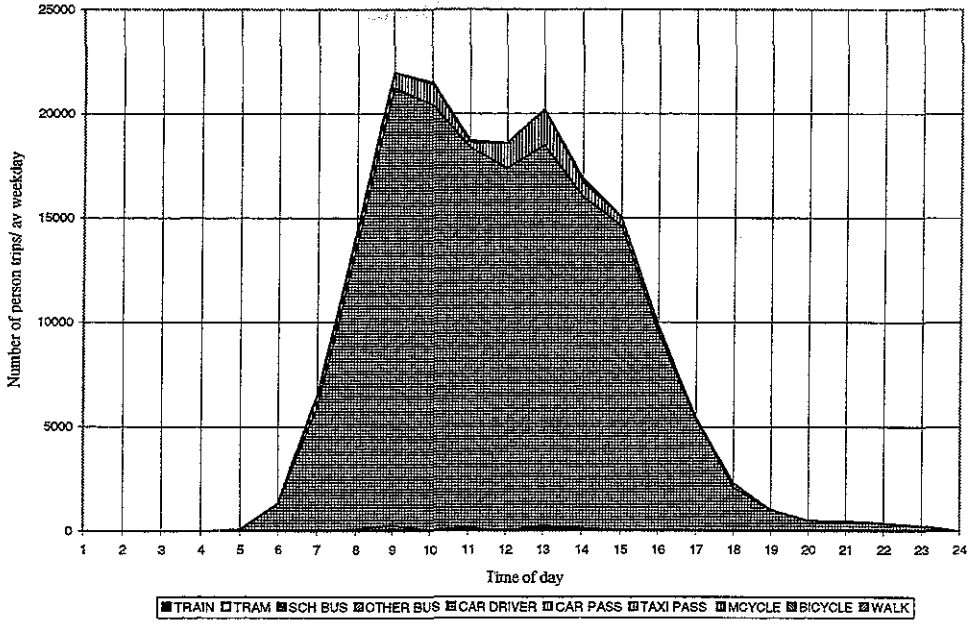

Figure 8 Temporal distribution of trips by mode - non home based employer's business, Adelaide (1986)

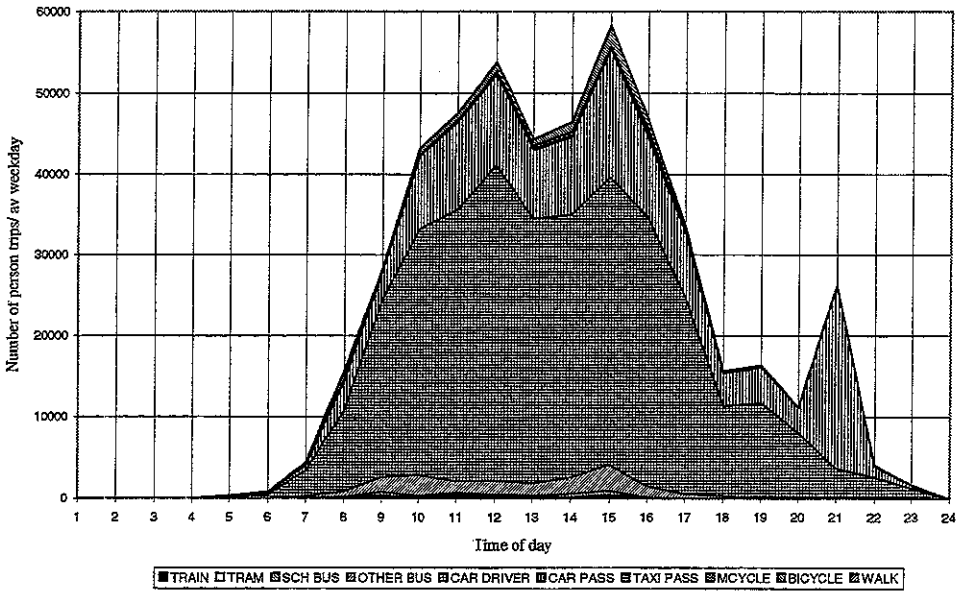

Figure 9 Temporal distribution of trips by mode - non home based other, Adelaide (1986)

Figure 7 shows the temporal distribution of other home based (HBO) trips for the various modes of transport and shows that:

- the morning and evening peaks occur at 8 am and 4 pm for all modes of transport used and extend from 7 am to 10 am and from 2 pm to 6 pm respectively;
- the dominant modes of transport used were, in order of priority, car (as driver and passenger) and bicycle.

The conclusions which can be drawn from Figure 7 are:

- the dominance of the use of the car is a reflection of the need for flexibility and the fact that timing constraints are dictated by the activity patterns of households;
- the coincidence between the morning and evening peaks with those for school travel suggests that a large proportion of other home based trips are chained as serve passenger trips.

Temporal Distribution Of Non Home Based Employer's Business Travel

Figure 8 shows the temporal distribution of non-home based employer's (NHBEB) business trips for the various modes of transport and shows that:

- while a morning peak occurred at 8 am , non home based employer's business travel extended fairly uniformly across the business day (from 7 am to 5 pm);
- it added to the morning and evening peak demand for other trip purposes and therefore exacerbated traffic congestion and delays on the arterial road system;
- the dominant modes of transport used were car (predominantly as driver) with negligible use of other modes.

The conclusions which can be drawn from Figure 8 are:

- the dominance of travel by car for business travel highlights the sensitivity of such travel to traffic congestion and delays;
- influencing the temporal distribution of non home based employer's business travel would be difficult using the sort of policy instruments which could be used to alter the timing of work trips. However because it is largely constrained to occur during working hours any shift in the latter would be likely to flow on to the former thereby achieving the desired spreading of demand.

Temporal Distribution Of Other Non Home Based Travel

Non home based other travel typically comprises travel undertaken while at work (or shopping) for personal business, shopping, social/ recreational activities, etc and for this reason tends to be concentrated in the middle of the day/ early afternoon.
Figure 9 shows the temporal distribution of other non-home based (NHBO) trips for the various modes of transport and shows that:

- the morning and evening peaks occur at 11 am and 3 pm and extend from 8 am to 12 noon and from 1 pm to 6 pm;
- the dominant modes of transport used were car (as driver or passenger) with travel by public transport (bus) and bicycle the next most important;

- by its nature non home based other travel is confined to the period between the morning and evening peak periods for other trip purposes.

The conclusions which can be drawn from Figure 9 are:

- although it was most intense in the inter-peak period, the demand for non home based other travel adds to the morning and evening peaks for the other trip purposes because it also extends into those morning and evening peak periods;
- notwithstanding the dominance of travel by car, the nature of non home based other travel is such that travel by public transport and bicycle was feasible. This suggests that time constraints are not as significant as those which existed for home based other travel.

Conclusion

Figures 1 to 9 highlight the influence of the seven factors mentioned previously (particularly the impact of household activity patterns on the timing of trips) on the temporal distribution of travel demand and go some way to dispelling some of the myths about the composition of demand in the morning and evening peaks.

The implications for transport policy are very important, particularly for the travel demand management policies and strategies called for in the Planning Strategy (The Premier of South Australia (1994)) viz:

- any policy which seeks to significantly increase the capacity of the urban arterial road system is likely to result in an increase in the intensity of morning and evening peak demand for all trip purposes (not just work) and a reduction in the spreading of that demand;
- because of the existing spread of morning and evening peak demand, measures to alter working, school and shopping hours will need to achieve significant (ie at least 2 hour) shifts if they are to avoid causing more problems than they solve. Their success will to a large extent be determined by the capacity of households to accommodate such shifts within their activity patterns without experiencing hardship;
- because work travel comprises but one part of the demand for travel in the morning and evening peaks, policies which focus in changing working hours are likely to only have a marginal impact on the overall level of peak demand. The growth in casual and part time employment at the expense of full time employment (where employees are likely to work for a number of different employers at different locations in the metropolitan area throughout the week) is likely to result in a significant change in the temporal distribution of work travel (and possibly also education travel); possibly far greater than that which would be achieved by the widespread introduction of flexible working hours. Such an occurrence would also have a significant impact on the level of usage of public transport;
- the dominance of travel by car for all trip purposes suggests that policies which seek to reduce the level of car usage are likely to be resisted (ie to be politically unpalatable) because of the adverse impacts that they would have on household activity patterns and travel choices;
- while Figures 1 to 9 and other research (Office of Transport Policy and Planning (1994)) indicate that the travel demand management measures which are likely to be

the most successful in reducing the level of car usage are those which lead to an increase in car occupancy, introducing car pooling and similar ride sharing schemes for work travel alone is only likely to have a marginal effect because work travel comprises a relatively small proportion of overall demand;

- equally the introduction of telecommuting for work as a travel demand management strategy is, at best, likely to have only a marginal impact on the overall level of travel demand. At worst, it could lead to an increased level of travel because the availability of a car during the day allows additional activities to be pursued which were precluded before.

To ensure that such policies achieve their desired outcomes it is necessary to have a clear understanding of the activity patterns of households now and in the future since it is largely those patterns which determine the temporal distribution of travel and provide guidance on how it can be influenced.

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