THE TEMPORAL DISTRUBUTION OF TRAVEL IN ADELAIDE

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ABSTRACT: *The paper reports on some work recently undertaken by the author on the temporal distribution of travel demand in Adelaide for various trip purposes and modes of transport. The analysis focussed on home based trips by all modes of transport and it used the data base produced during the 1977 Metropolitan Adelaide Data Base Study.*

The objective of the analysis was to determine whether a prima facie case existed for the introduction of policies which could be used to influence the temporal distribution of travel demand, particularly during the morning and evening peak periods. The paper presents the results of the analysis and the conclusions reached.

TEMPORAL DISTRIBUTION OF TRAVEL IN ADELAIDE

INTRODUCTION

The work reported on in this paper was undertaken because there is an interest in implementing policies which are designed to influence the temporal distribution of travel, particularly during the morning and evening peak periods. Since the capacity of the urban public transport system and the design standards of the urban arterial road system (and the associated traffic management and control facilities) are largely determined by the level of travel demand which occurs during the morning and/or evening peak periods, it would seem (at first glance) that introducing policies which lead to a reduction or spreading of peak travel demand would have merit because they would enable economies to be made in the provision of transport infrastructure and services while at the same time leading to a better utilisation of the transport system. Policies such as varying and staggering work, school and shopping hours and locating workplaces, schools and shops so that they are easily accessible from their catchment areas have all been considered in this context.

The objective of this analysis was therefore to determine whether a prima facie case existed for the introduction of such policies in Adelaide.

The data base produced during the 1977 Metropolitan Adelaide Data Base Study (1978) was used and, to keep the analysis within manageable bounds, it was decided to focus on home based travel by all modes of transport, viz,

Trip Purpose

Home based work
Home based education (primary and secondary)
Home based education (tertiary)
Home based shop
Home based other

Mode of Transport

Automobile	- car driver (alone)
	- car driver (with passengers)
	- car passenger
Public Transport	- school bus
	- other bus
	- train
	- tram
	- taxi passenger
Other	- walk
	- bicycle
	- motor cycle/motor scooter

To obtain the temporal distribution of travel, cross tabulations of trips by start time, mode and trip purpose were extracted from the data base file using the SPSS statistical package. The resulting distributions are shown in Figures 1 to 15. Although space limitations do not permit the actual cross tabulations to be included, they are available from the author.

Before discussing the distributions associated with each trip purpose it is worth spending a little time considering the factors which influence the temporal distribution of travel and what the distributions shown in Figures 1 to 15 actually indicate.

For work, school and shopping trips there are six main factors:-

1. The starting and ending time and the duration of the work, school and shopping period and their relationship to each other.

2. The spatial distribution of workplaces, schools and shops in relation to their catchment areas.

3. The mode of travel used by people (be it the only mode available or the one chosen from a set of alternatives).

4. The accessibility offered by the various modes of transport and the transport system to workplaces, schools and shops.

5. The degree to which trips for various purposes (by various modes) are linked or chained.

6. The activity patterns of households.

Figures 1 to 15 therefore show the temporal distributions of travel for the Adelaide metropolitan area (in aggregate) which resulted from the combination of the above six factors in 1976/77.

As regards the factors themselves, the starting and ending time of work, school and (to a lesser extent) shopping periods dictates when people must arrive at and leave their destination respectively. The actual start time of trips depends on the mode chosen, the location of the destination relative to the origin, the accessibility of the origin to the destination (provided by the transport system) and whether the traveller chooses to chain the trip (i.e. home-school-work, etc.). The spatial distribution of workplaces, schools and shops in the metropolitan area and the accessibility offered by the transport system act in combination to determine the temporal distribution of travel.

Sharp peaks in the temporal distribution which are of short duration coupled with a large number of trips undertaken by the walk and bicycle modes suggest that trip destinations for the particular trip purpose throughout an area are close to origins. That is, the spatial distribution of the destinations is such that they are easily accessible from their catchment areas. Typical examples of this in Adelaide are the distributions for primary and secondary school travel (Figures 4, 5 and 6). They reflect the policy adopted by the Education Department of locating primary and secondary schools throughout the metropolitan area so that they serve defined catchment areas.

On the matter of the policy tools available to influence the temporal distribution of travel, it would appear that they are urban development and/or economic/social policies as well as purely transport policies. It would also appear that they are more complex in their impact than is generally acknowledged. For example, a study of the effect of flexible working hours on travel patterns undertaken in Adelaide in 1975 (P.A. Management Consultants, 1975), found that while the introduction of flexible working hours led to a marked reduction in "peaking" in the morning and evening and a substantial spreading of arrival and departure times, it also led to a decrease in the use of car pools; an adverse impact on a demand minimization policy.

Using purely 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 (i.e. 100 to 150% difference). The introduction of differential peak and off-peak fares coupled with a general fare increase in Adelaide in 1983 had some interesting results. A "before and after" survey conducted by the 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.

On the roads side, one policy option which could be used to alter the temporal distribution of car travel would be simply to adopt a policy of only providing sufficient road capacity to cater for off-peak travel. The road network would be allowed to become congested during the peak thereby encouraging motorists to alter the start time of their trip so that peak period demand spreads. Unfortunately, increased traffic congestion not only has the undesirable effect of increasing the number of traffic accidents but also generates a considerable number of complaints from irate motorists and motoring organisations.

In summary, before developing policies which are designed to influence the temporal distribution of travel it is firstly necessary to determine whether a prima facie case exists for such policies. Secondly, all the impacts of such policies must be identified to guard against the solution to one problem becoming the cause of far more serious problems.

TEMPORAL DISTRIBUTION OF WORK TRAVEL

Figures 1, 2 and 3 show the temporal distribution of home based work trips for the various modes of transport.

Figure 1 indicates that, for public transport trips:-

- the morning and evening peak periods extend from 6 a.m. to 9 a.m. and from 3 p.m. to 6 p.m. respectively.
- there is a greater spread of trip start times in the morning than in the evening (especially for bus trips) which is in part a reflection of the fact that a large number of public transport trips terminate in the CBD.
- the peak demand for bus and train trips in the morning occurs between 7 and 8 a.m. while that for tram trips occurs between 8 and 9 a.m.
- In the evening, peak demand for bus, train and tram trips occurs between 5 and 6 p.m.

Figure 2, for car travel, indicates a similar distribution to public transport with the differences that:-

- the peak demand in the morning is more intense than that in the evening.
- the distribution of demand within the morning and evening peak periods is more uniform than that for public transport.
- the distribution of travel in the evening has a pronounced tail extending from 12 p.m. to 3 p.m. and from 6 p.m. to 11 p.m. which could reflect the effects of part time employment and shift work.
- in the evening the peak demand for all three modes occurs between 4 and 5 p.m.

Figure 3, for walk, bicycle and motor cycle trips indicates a similar distribution to car travel with the differences that:-

- the spread of trip start times in the morning and evening peaks is almost the same.
- the peak demand for motor cycle and bicycle trips in the morning occurs between 7 and 8 a.m. while that for walk trips occurs between 8 and 9 a.m. In the evening, the peak demand for all three modes occurs between 4 and 5 p.m. (cf car trips).

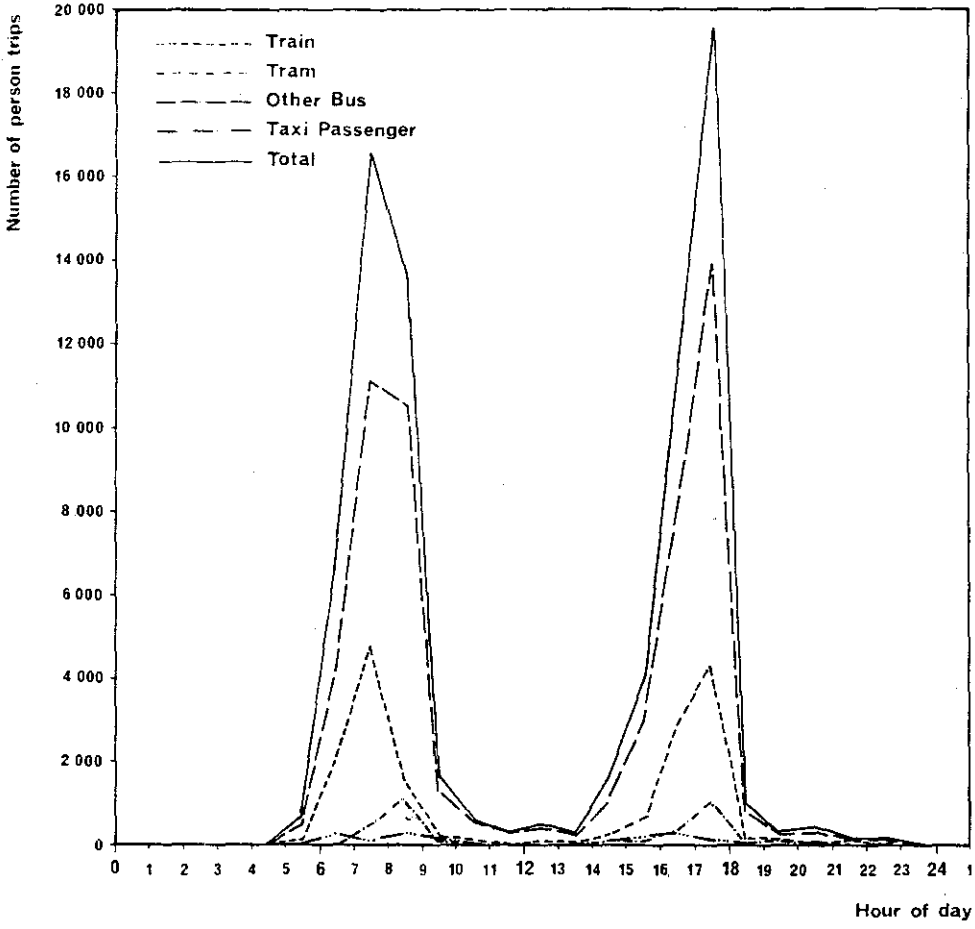

Figure 1 **Home Based Work**

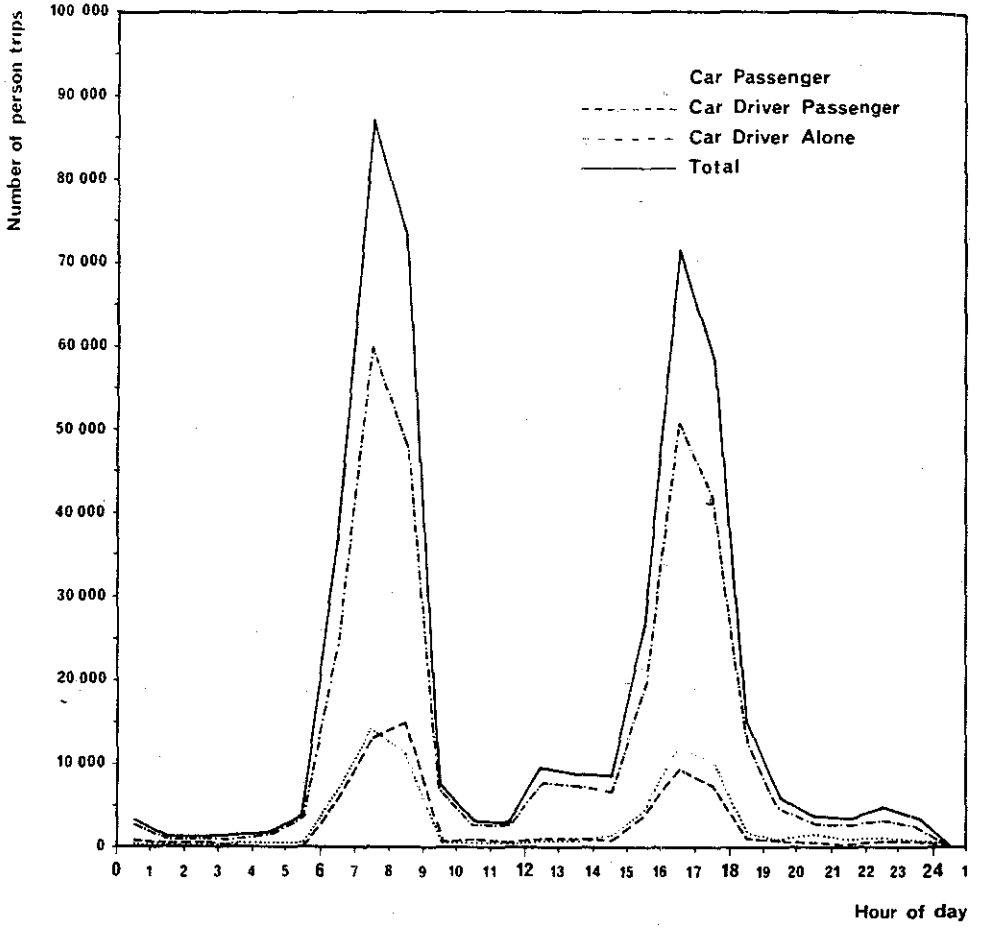

Figure 2 Home Based Work

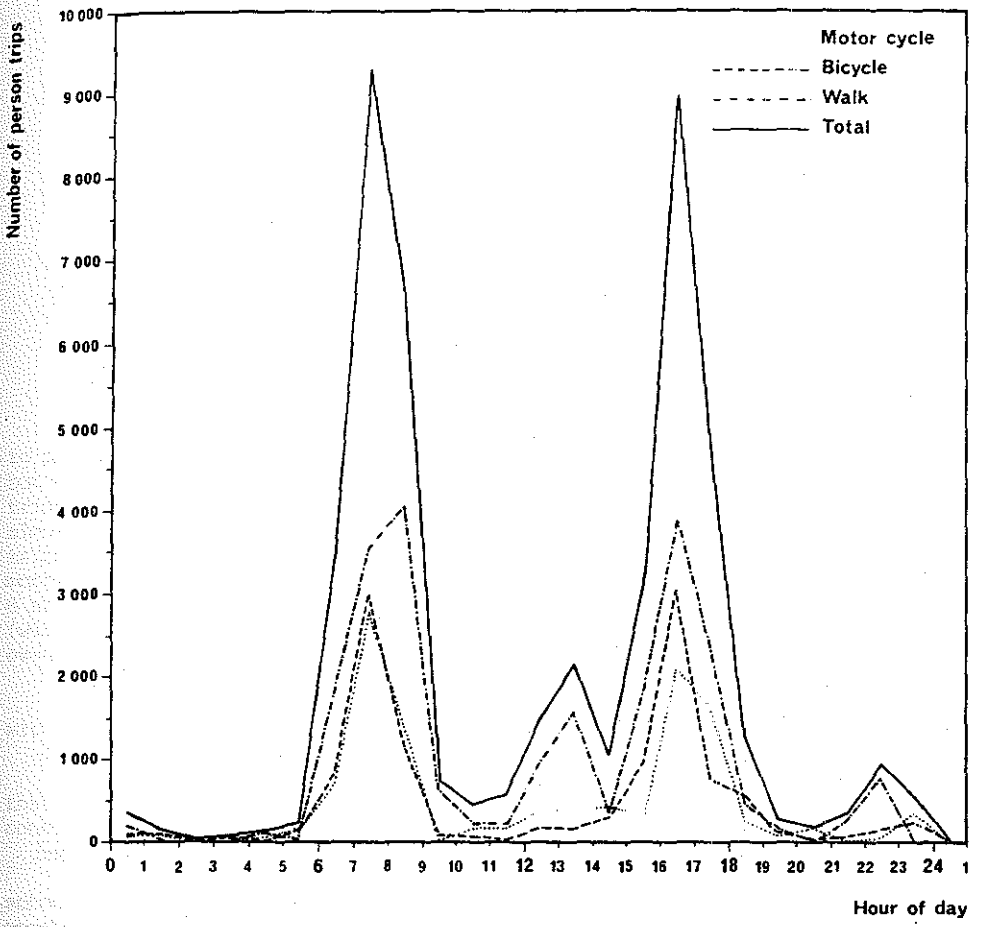

Figure 3 **Home Based Work**

The conclusions which can be drawn from Figures 1, 2 and 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 is in general satisfactory. Secondly, it suggests that the majority of people are working fixed rather than flexible hours. There is thus scope to reduce peak demand and increase the spread of trip start times by the more widespread introduction of flexible working hours.

- the similarity of the spread of start times for public transport and car trips suggests that introducing flexible working hours will have the beneficial effect of reducing peak demand on both the road and public transport systems.

- figures 1 and 2 suggest that the majority of people commence work between 8.30 and 9.00 a.m. and since their trip start times are dictated by the duration of their journey (which in turn depends on the mode chosen), a policy of decentralising work places away from the CBD is likely to lead to a reduction in and spreading of peak demand in the morning.

TEMPORAL DISTRIBUTION OF SCHOOL TRAVEL

Figures 4, 5 and 6 and Figures 7, 8 and 9 show the temporal distributions of home based education (primary and secondary) trips and (tertiary) trips respectively for the various modes of transport.

In Adelaide there is considerable variation in the starting times for primary and secondary schools. State primary schools generally commence at 8.50 a.m. while private primary schools vary their starting times from 8.30 to 8.50 a.m. Similar variations occur in the starting times for secondary schools.

Figures 4 and 7 indicate that, for public transport trips:-

- the morning and evening peak periods extend from 7 to 9 a.m. and 3 to 4 p.m. (primary and secondary) and 7 to 10 a.m. and 3 to 6 p.m. (tertiary).

- the intensity of demand for primary and secondary school trips is greater in the evening than in the morning while, for tertiary education trips, the reverse is the case.

- the sharp morning and evening peaks for primary and secondary school trips compared to the more spread out peaks for tertiary education trips reflects the fact that primary and secondary schools begin and end at particular times of the day. Because tertiary institutions have more flexible teaching hours the temporal distribution tends to be more dispersed.

for primary and secondary school trips the peak demand for bus (both school and other) and taxi trips in the morning occurs between 8 and 9 a.m. The same is true for tertiary education trips. However, the peak demand for tram and train trips occurs between 7 and 8 a.m. (primary and secondary) and 8 to 9 a.m. (tertiary). In the evening, for primary and secondary school trips, the peak demand for all modes occurs between 3 and 4 p.m. For tertiary education trips the peak demand for bus and train trips occurs between 4 and 5 p.m. while that for taxi trips occurs between 7 and 8 p.m.

Figures 5 and 8, for car travel, indicate a similar distribution to public transport in the case of primary and secondary school trips, but a considerably different distribution in the case of tertiary education trips. Not unexpectedly, primary and secondary school trips by car are almost entirely car passenger trips. Figure 8 for tertiary education trips is particularly interesting since it not only shows an intense morning peak between 8 and 10 a.m. (with maximum demand occurring between 8 and 9 a.m.) but a very dispersed evening peak between 3 and 8 p.m. (with maximum demand occurring between 6 and 7 p.m.) and a secondary evening peak between 9 and 10 p.m. (reflecting evening lectures, etc.)

Figure 8 illustrates the spread of peak demand that can be achieved with very flexible ending times.

Figures 6 and 9, for walk, motor cycle and bicycle trips, indicates that the distributions for primary and secondary school trips are considerably different to those for tertiary education trips.

Figure 6 indicates, that the distributions of primary and secondary school walk, motor cycle and bicycle trips are almost exactly the same as those for public transport and car trips.

Figure 9 on the other hand, apart from showing a pronounced morning peak between 7.30 and 9.30 a.m. and an evening peak between 3 and 5 p.m. is characterised by several minor peaks between 11 a.m. and 1 p.m. and between 9 and 11 p.m.

The conclusions which can be drawn from Figures 4 to 9 are:-

- the temporal distributions of primary and secondary school trips are characterised by sharp morning and evening peaks (regardless of the mode of travel used) between 7 and 9 a.m. and 3 and 4 p.m. respectively. Although this peak demand is most probably localised due to the spatial distribution of primary and secondary schools throughout the metropolitan area it will exacerbate the morning peak load on both the road system and the public transport system, but will not have the same adverse effect in the evening. If, however, primary and secondary school starting times were shifted forward by one or two hours (say 8.30 a.m. to 10.30 a.m.) it would reduce the morning peak load and significantly increase the evening peak load since students would be returning home at the same time as workers.

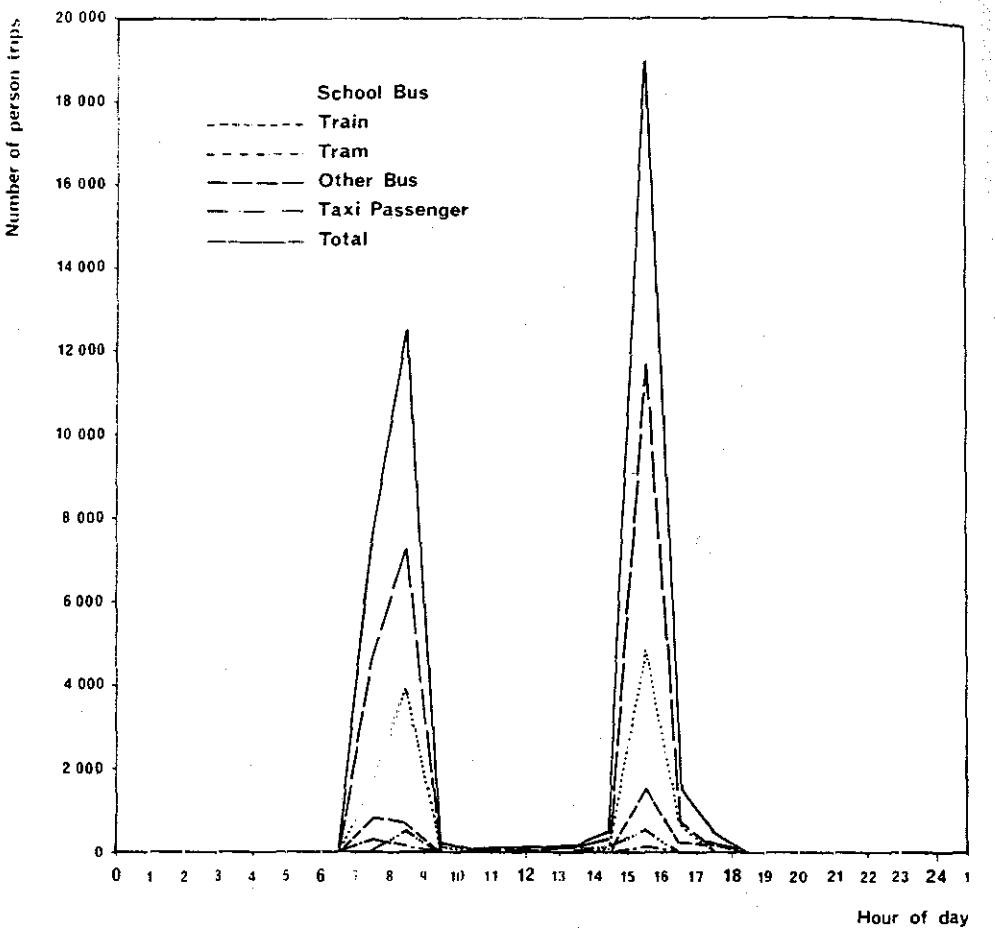

Figure 4 Home Based Education (Primary & Secondary)

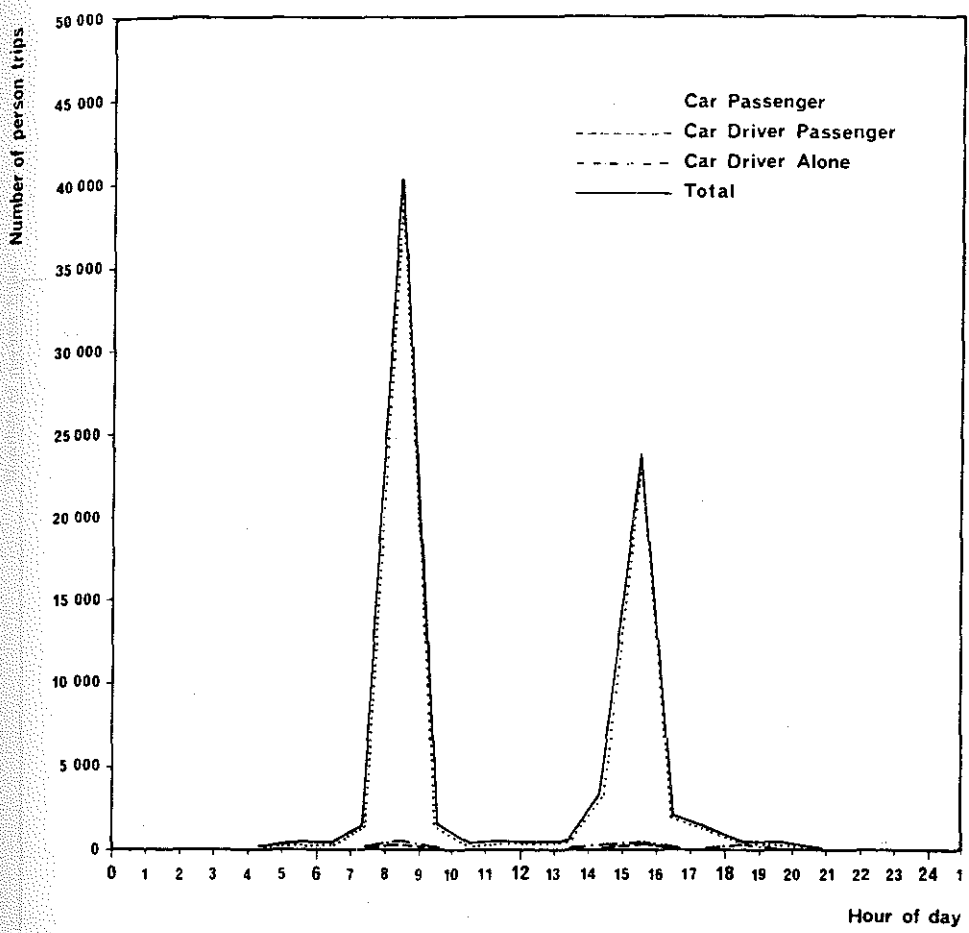

Figure 5 Home Based Education (Primary & Secondary)

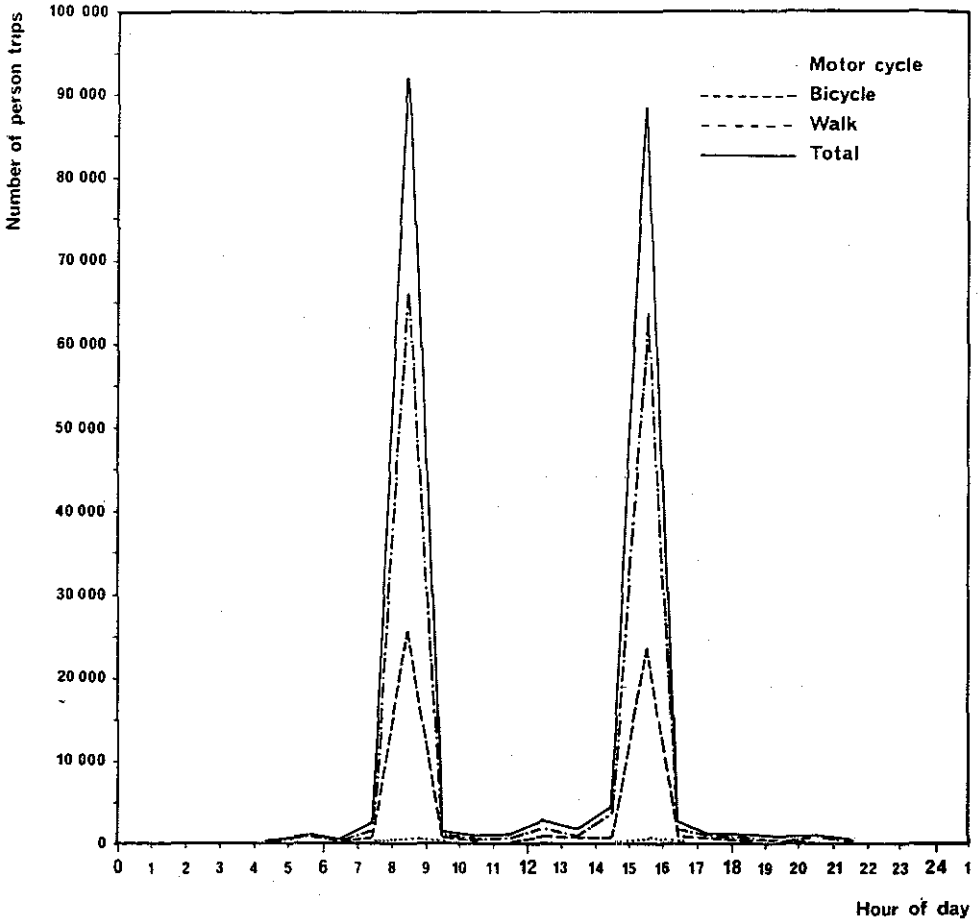

Figure 6 Home Based Education (Primary & Secondary)

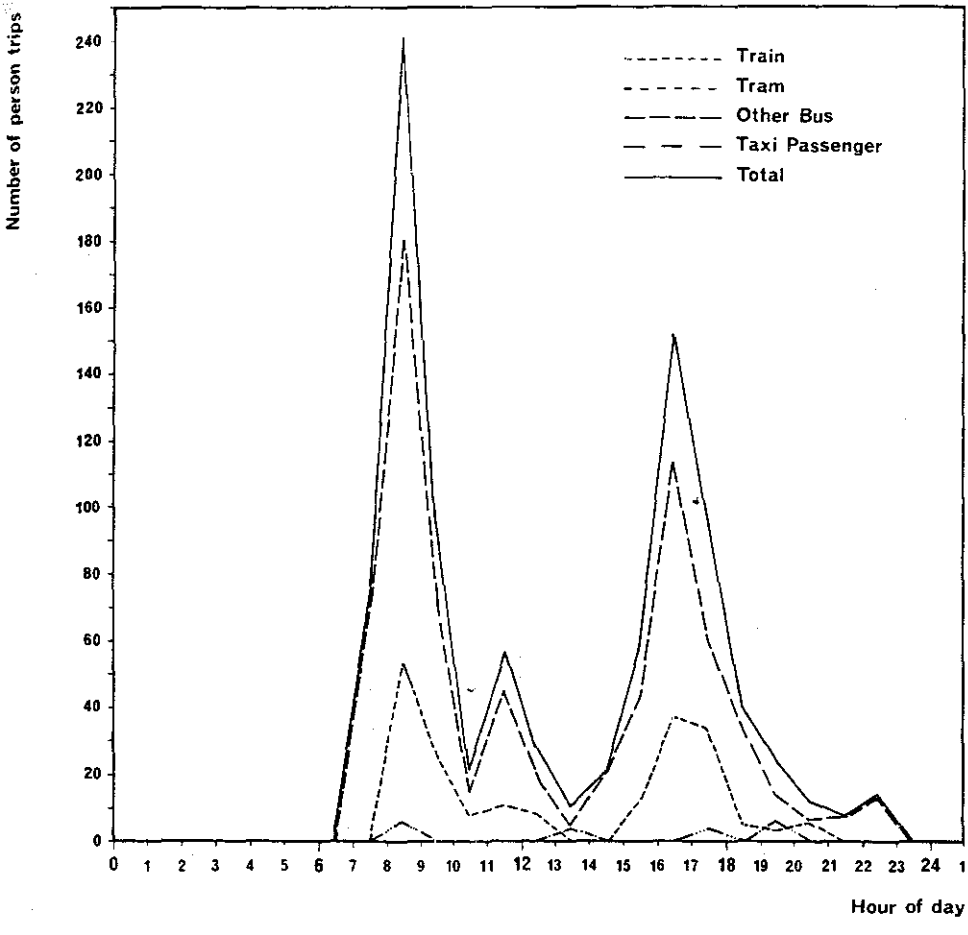

Figure 7 Home Based Education (Tertiary)

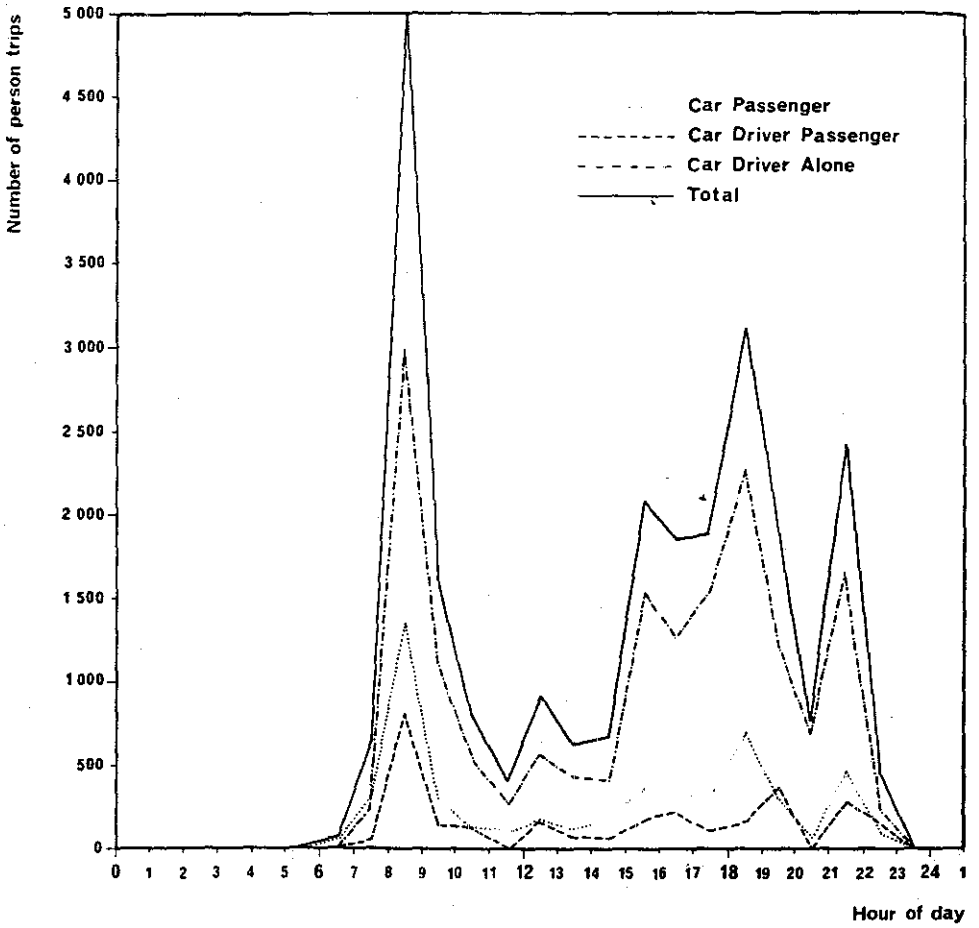

Figure 8 Home Based Education (Tertiary)

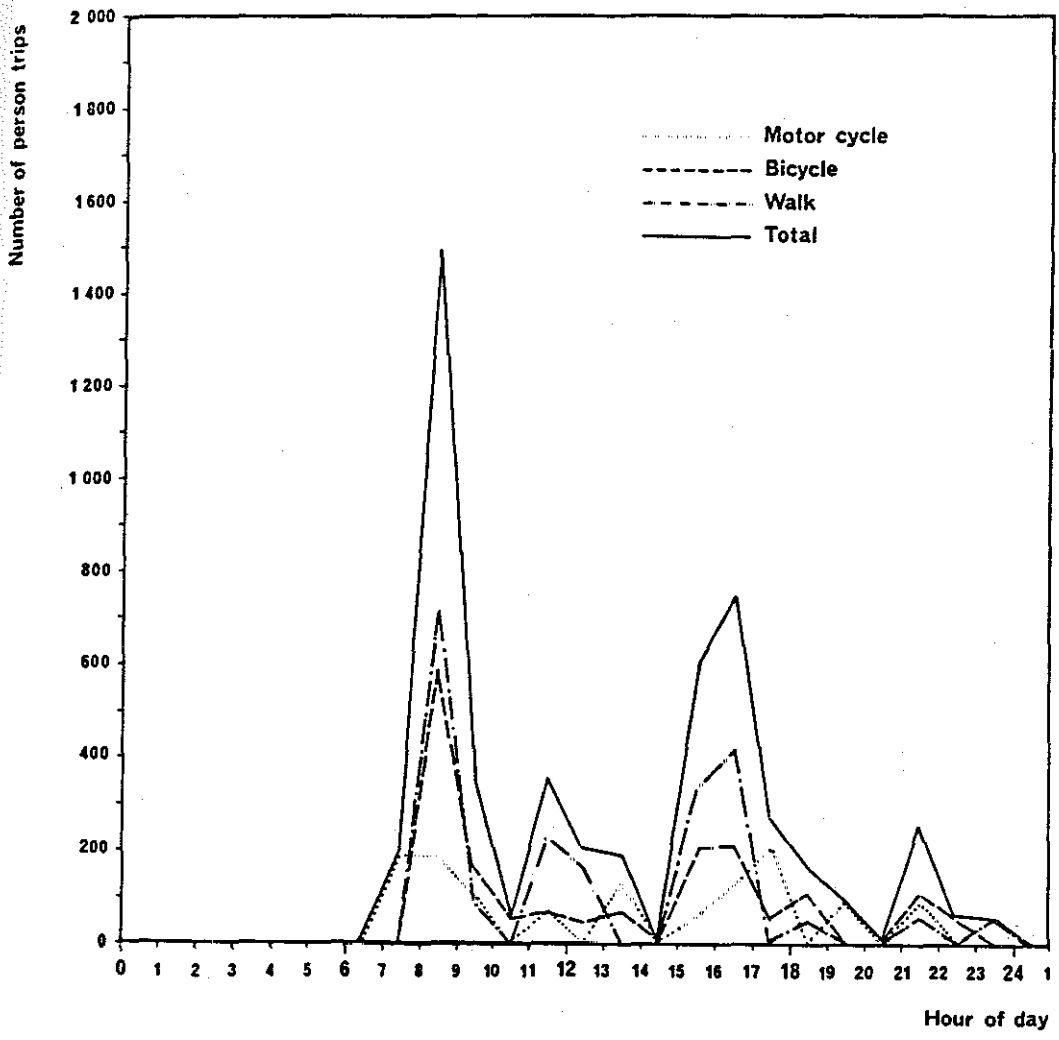

Figure 9 Home Based Education (Tertiary)

the temporal distributions of tertiary education trips are characterised by a sharp morning peak and a dispersed evening peak. There is therefore scope to reduce the impact of such trips on the morning peak by shifting the starting time of tertiary institutions forward by one or two hours. However, due to the small number of trips involved there will not be a dramatic reduction in overall peak demand.

TEMPORAL DISTRIBUTION OF SHOPPING TRAVEL

Figures 10, 11 and 12 show the temporal distribution of home based shopping trips for the various modes of transport.

Figure 10 indicates that, for public transport trips demand is almost uniform throughout the day, the exception being bus trips which have a morning peak between 8 and 11 a.m. and an evening peak between 2.30 and 4.30 p.m.

Figure 11, for car trips, indicates that demand extends from 8 a.m. to 10 p.m. with pronounced morning and evening peaks between 8 a.m. and 12 noon and between 2.30 and 7 p.m. respectively. Maximum demand on the evening peak occurs between 4 and 5 p.m., the time at which maximum demand occurs for work trips (see Figure 2). The work and shopping trips in the evening peak period combine to place a considerable load on the road network. Note also that for both work and shopping trips which occur in the evening peak the major mode is car driver (alone).

Figure 12, for walk, motor cycle and bicycle trips, shows similar distributions to those for public transport and car trips.

The conclusions which can be drawn from Figures 10, 11 and 12 are that:-

- in spite of the fact that shopping trips are not constrained to a particular starting time in the same way that work and school trips are, it is clear that they are constrained by other family activities which have the same effect.

- because the evening peak for shopping trips (by all modes) occurs at the same time as that for work trips and because the number of shopping and work trips started during the evening peak are almost the same they act in combination to maximise the load on the public transport and road system. Any policy which caused the distribution of shopping trips in the evening to spread would have a beneficial effect on the transport system. Although extending shop trading hours beyond 5.30 p.m. would seem to have merit, the evening peak for shopping trips (at least as far as families are concerned) may reflect the need for all members of the family to arrive home at a particular time. If this is in fact the case, then extending shop trading hours would have little effect on the evening peak.

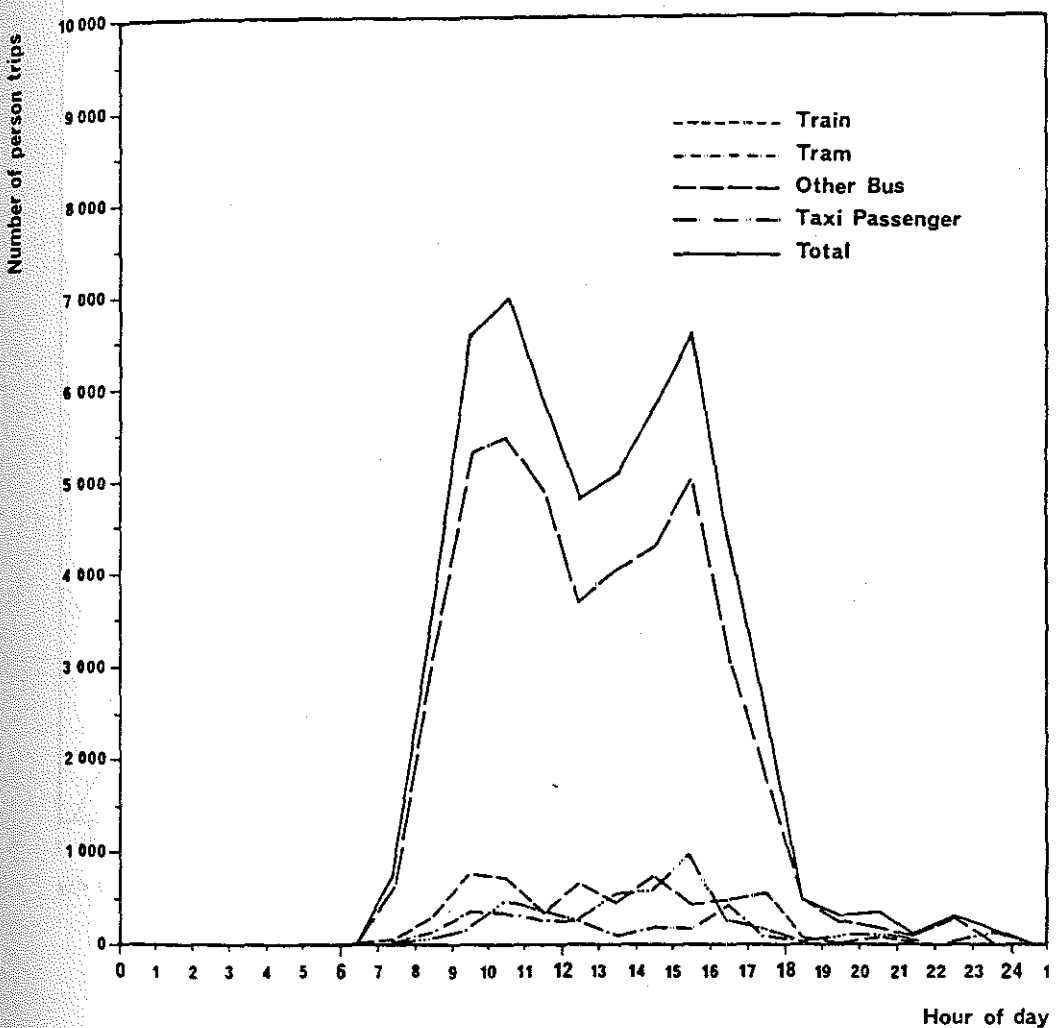

Figure 10 Home Based Shop

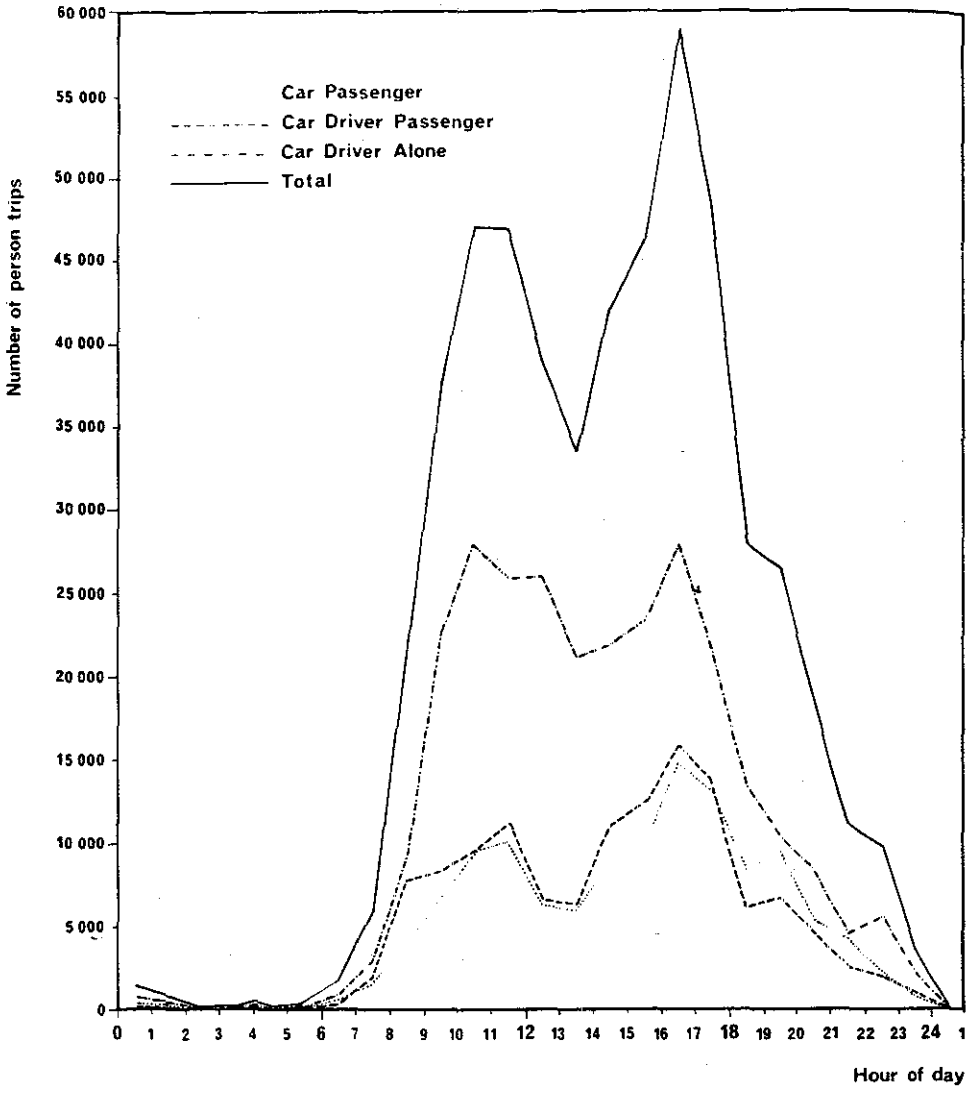

Figure 11 **Home Based Shop**

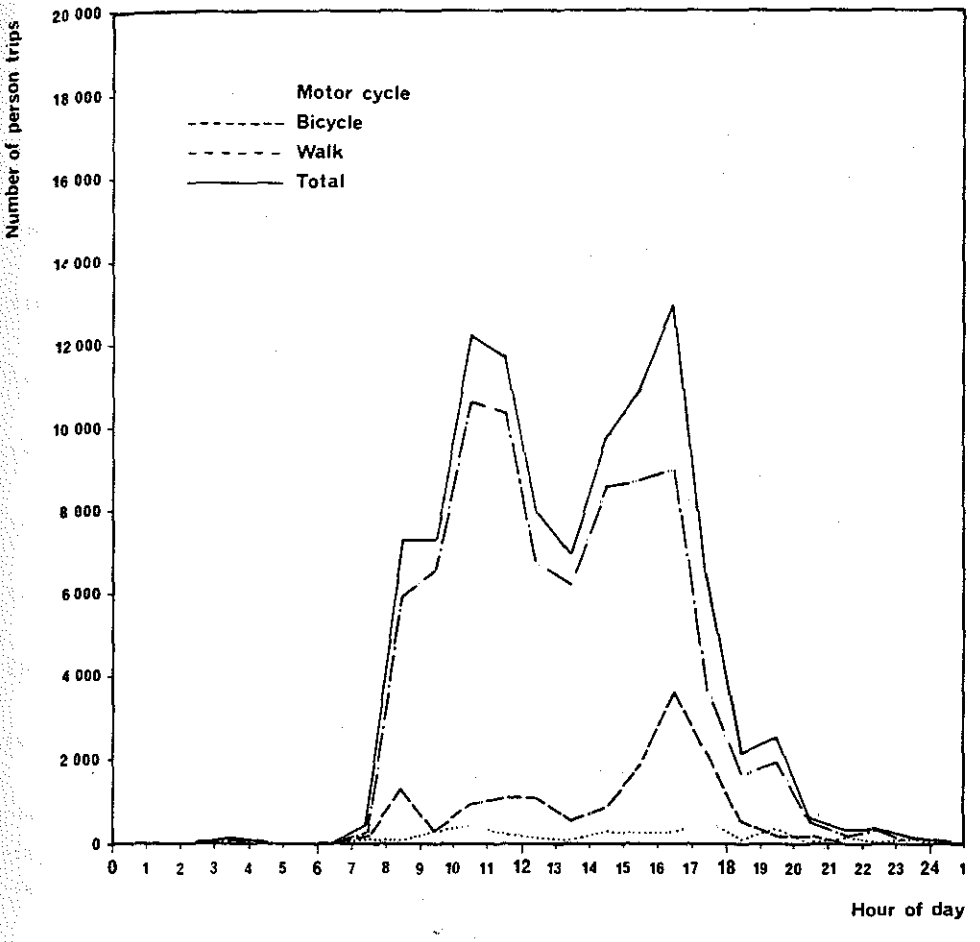

Figure 12 Home Based Shop

TEMPORAL DISTRIBUTION OF OTHER TRAVEL

Home based other trips comprise social and recreational travel and as such would be expected to occur in the afternoon and evening.

Figures 13, 14 and 15 show the temporal distribution of home based other trips for the various modes of transport.

Figure 13 indicates that, for public transport trips:-

- there are both morning and evening peak periods which extend from 8 a.m. to 12 noon and from 1 p.m. to 8 p.m. respectively.
- bus is the most important mode of travel with peak demand occurring in the evening between 4 and 5 p.m.

Figure 14 indicates that, for car trips:-

- there are both morning and evening peak periods which extend from 7 a.m. to 9 a.m. and 3 p.m. to 11 p.m. respectively. The evening peak is much greater than the morning peak with peak demand occurring between 7 and 8 p.m.
- the number of trips by car driver (alone) and car driver (with passenger) are almost equal throughout the day. Car occupancy is 1.32 persons/vehicle compared with 1.19 persons/vehicle for work trips.

Figure 15 indicates that, for walk, motor cycle and bicycle trips:-

- there is only an evening peak period which extends from 3 p.m. to 10 p.m. with maximum demand occurring between 4 and 5 p.m.
- the main modes of travel are walk and bicycle with peak bicycle demand occurring between 4 and 5 p.m.

The conclusion which can be drawn from Figures 13, 14 and 15 is that home based other trips are heaviest in the evening and that they therefore combine with work and shopping trips to place significant loads on the road and public transport system. The opportunities available for altering the temporal distribution of home based other trips are, however, very limited.

CONCLUSION

Examination of Figures 1 to 15 indicates that there is a prima facie case for altering the temporal distribution of travel to achieve a reduction and spreading of morning and evening peak demand particularly for work, primary and secondary school and shopping travel. It is also clear that policies designed to alter the temporal distribution of travel should concentrate on car travel.

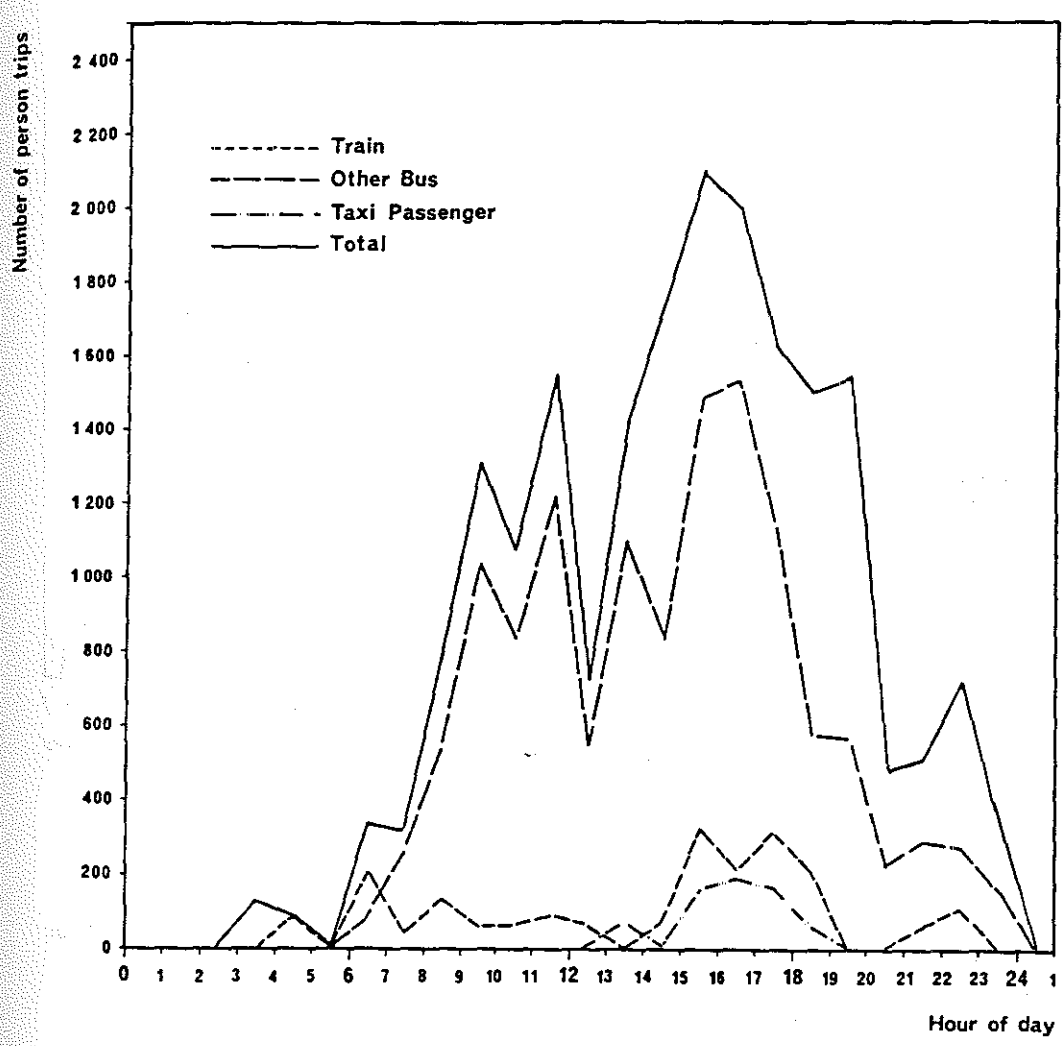

Figure 13 **Home Based Other**

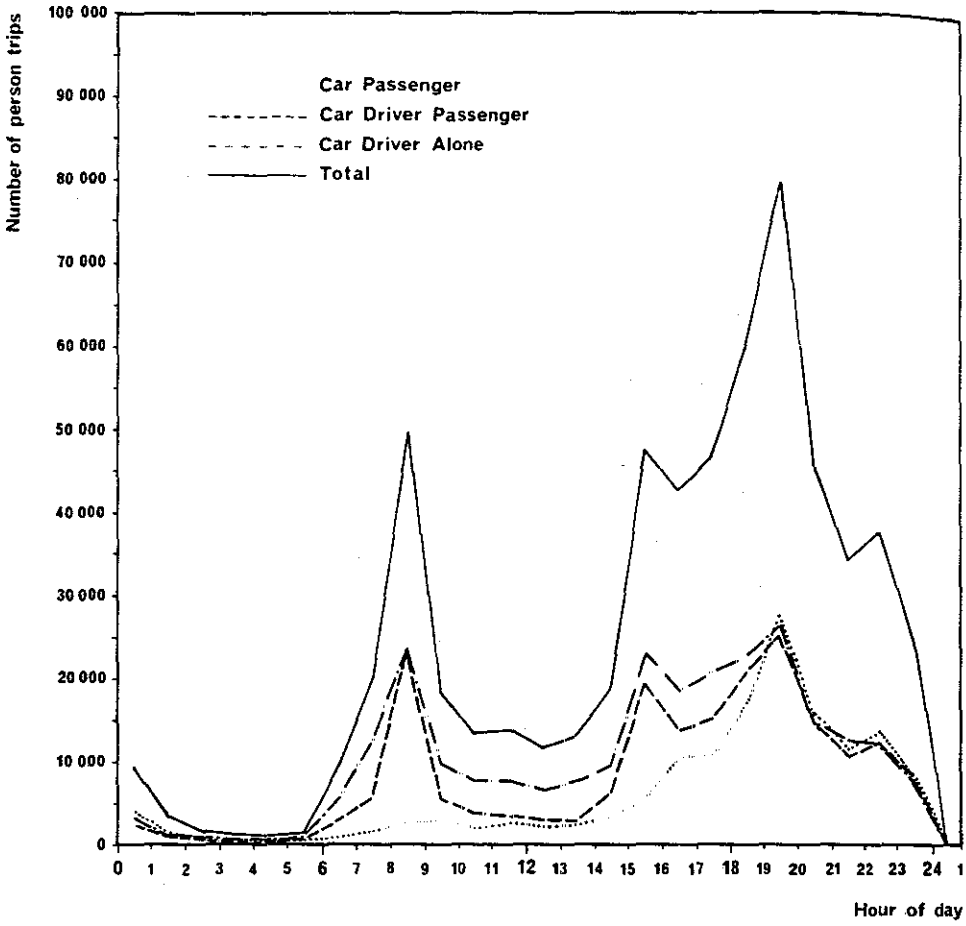

Figure 14 **Home Based Other**

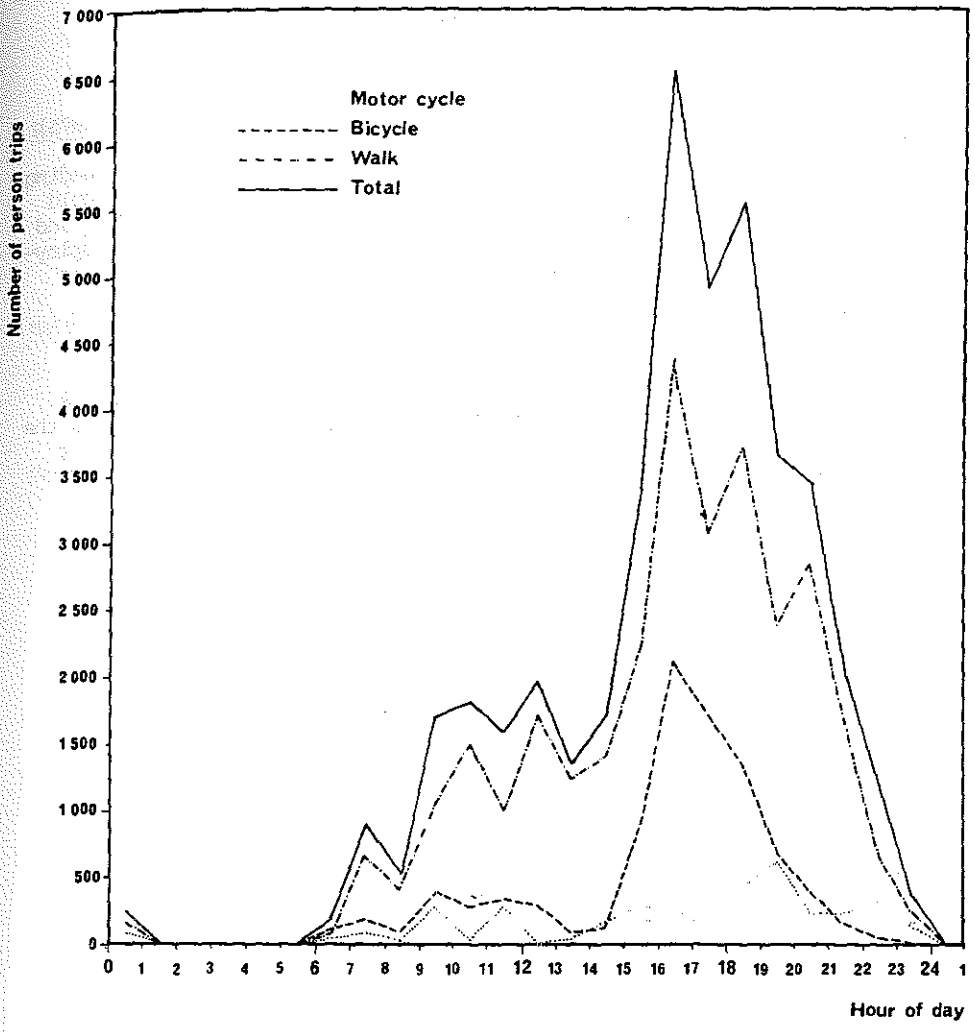

Figure 15 **Home Based Other**

The results of other studies (P.A. Management Consultants, 1975) suggest that the widespread introduction of flexible working hours (as one policy measure) will achieve a significant reduction in and spreading of peak demand for work travel. While it is acknowledged that it would not be feasible to introduce flexible working hours in manufacturing and other industries which work in shifts, the decline in blue collar employment which has occurred in Adelaide over the years and the increase in white collar employment indicates that significant benefits could be achieved through the introduction of flexible working hours.

Notwithstanding this, in order to ensure that policies are introduced which achieve their objective without causing more problems than they solve, considerably more research is needed to identify how the activities of households determine their travel patterns and therefore the temporal distribution of travel.

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