THE TRAVEL AND ACTIVITY STRUCTURE OF AUSTRALIAN CITIES: TRANSPORT PLANNING SURVEYS

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ABSTRACT: *Transport planning has for many years been perhaps the most numerate of all the inputs to planning, and transportation survey data has had a major influence on many areas outside the direct issues of planning for road traffic.*

Much of this valuable household data has been applied in Australia to date only to such traffic movement applications, and as a result effective perspectives on urban travel and activity patterns buried in the magnetic tapes containing the raw data have not been realised.

This paper illustrates some of the results obtained from a systematic analysis of these valuable household data sources. Some results from vehicle access, ownership and value are given: For instance - trip rates, time usages and participation frequencies by age and by lifecycle. Exposure patterns for on-road travel by time on mode are illustrated for the 'travel' activity for Adelaide from the point of view of individuals and of households.

These results illustrate each stage of a systematic treatment. Travel is treated as one of many activities, and the analysis starts with access to vehicles, moves to the participation in various forms of travel with the complementary analysis of levels of usage of each mode - for those who actually use it, and then to examining the patterns of time commitment on each mode (ie system utilisation and exposure to risks on travel). The patterns of time commitment for other activities are then presented as a new way of assessing the demand for the activities (which travel serves as a derived demand).

Travel is a derived demand, and 'travel' is only one of the fifteen more different types of activities usually recorded in a typical transportation survey. Results are given for these other activities - such as time at work, in home or at entertainment - in a separate paper. These results are simply examples drawn from the development of a transport and activity Atlas of urban Australia. This will be one of the end products of this program of work to obtain, rehabilitate, and make effective the legacy of transporation planning data sets from the 1970s.

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INTRODUCTION

Transport planning has for many years been perhaps the most numerate of all the inputs to planning, and transportation survey data has had a major influence on many areas outside the direct issues of planning for road traffic.

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This paper illustrates some of the results obtained from a systematic analysis of these valuable household data sources. Some results from vehicle access, ownership and value are given: For instance - trip rates, time usages and participation frequencies by age and by lifecycle. Exposure patterns for on-road travel by time on mode are illustrated for the 'travel' activity for Adelaide and Canberra.

These results illustrate each stage of a systematic treatment of the raw data from the point of view of individuals and of households. Travel is treated as one of many activities, and the analysis starts with access to vehicles, moves to the participation in various forms of travel with the complementary analysis of levels of usage of each mode - for those who actually use it, and then to examining the patterns of time commitment on each mode (i.e.system utilisation and exposure to risks on travel). The patterns of time commitment for other activities is then presented as a new way of assessing the demand for the activities (which travel serves as a derived demand).

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In many cases of practical planning, appropriate data giving a context and perspective on the numerate information on location, behaviour, and people involved can be an adequate basis for action - and make it considerably easier to determine when and if detailed specific further surveys and/or analyses are required.

This paper starts by reporting the results of analyses of <u>access</u> to vehicles by age of person. The access of households and individuals to vehicles by their lifecycle categorisation is then introduced, and illustrated by the stock value distribution of the cars owned by elderly households and the access to bicycles in households of different types.

Travel generation is normally expressed in traffic and transportation planning in terms of trips/household/weekday, which confuses the <u>travel activity levels</u> of the households which contained people who travelled on a given day with the <u>percentage</u> of households containing at least one person who travelled on the given day. The terminology used here

will be:

> 'Participation rate' for the percentage (or fraction) of households which report travel (of the relevant type) on a given day.
>
> 'Activity rate' is used to describe the number of trips/day made by the households (or the people) who report at least one trip.

The importance of these distinctions has been discussed elsewhere (Wigan, 1982b) but should be reiterated here: 'Trip Rates' are normally calculated (and used) on the basis of the number of trips made by a household in a day. This means that there are very large variations in these trip rates, as households differ substantially in the numbers of people involved, and their trip making characteristics. In many households people travel little, and are absent from their home a large amount of the time. This is particularly the case for elderly households. To obtain more useful variables to describe the levels of trip generation of a household the trip generation figure is broken down into two parts. The first is the participation rate, which simply picks out the fraction of the households who generate trips in a given day. This varies greatly, and is actually a specification of the market penetration for the type of travel concerned. This becomes much clearer when participation rates by age of person are examined. The second - referred to as the Activity rate - is the number of trips made by those who actually travel. This turns out to be comparatively stable, and evidence is beginning to build up that these values may be transferable between Australian cities.

Travel time analyses can also be presented in a similar manner, and illustrations are given on the basis of both age and the lifecycle grouping of household. The key result from both trip and travel time analysis is that the activity rate (i.e. number of trips or number of minutes/day by people reporting at least one trip a day) remains comparatively stable - it is the participation rate which shows most of the fluctuation.

This finding moves the emphasis of market analysis and forecasting towards activities other than travel itself, and makes the concept of lifecycle categorisation of households and people the more compelling. However, the detailed analysis of travel time across the day provides an opportunity to deduce the exposure (measured in minutes of travel in a city in each quarter of an hour interval) of the population to travel risks. This can be done by age, by mode, by purpose, or by any combination of these factors. Such exposure patterns can be of direct value to public transport capacity planners and to road safety interests, both of whom have realised the potential of this source of numerate information as a result of the first diagrams produced (for Melbourne for 1978) of the type presented here.

The analysis of the activities which give rise to travel has become of increasing importance in understanding travel behaviour, in predicting changes, and in assessing the distributional impact of planning or regulatory measures both within and outside the control of transport bodies.

These activity rate/participation rate concepts have also been applied to activities other than travel, and the results for two Australian cities will be published elsewhere (Wigan, 1983).

Just as the pattern of time spent across the day has a direct application in several areas- 'on road exposure' in the terms of traffic

safety interests for example, the total amounts of time spent in various activities across the day are valuable in a number of ways. A family of such results is given for Melbourne, to show how an overall activity portrait of a city can be given in a small space.

The results shown are selective and are designed to give at least a partial view of the manner in which a systematic and innovative treatment of household data can be made accessible. For this reason the paper has been kept very brief - and the weight applied to the diagrams to tell the story. The time taken to find ways of expressing these findings has to date proved to have been well spent, and the response from users of transport and planning data has been both positive and creative.

The response to the different types of information, and the presentation styles exemplified by the diagrams given here, has been instructive. Few people agree which of the results are the clearest or the most relevant. This is not unexpected, in view of the range of interests that are served. The sense of perspective engendered by this type of treatment may be hoped to make some transport problems less pressing, but on the evidence to date, will probably help many to identify problems that they had not previously identified.

DATA SOURCES

The primary sources employed to date are listed in Table 1. Many of the household interview surveys so far set up for analysis are listed with the population of the surveyed area at the time of the survey, and the household sample size.

The Bureau of Transport Economics National Travel Survey (1979) covered nearly 40,000 households across Australia, and thus provides a reference basis for Australia as a whole. The area codes for districts roughly equivalent to the household survey regions are quoted, and the population and household samples in the areas are also given. In many cases these are comparable in number to the relevant transportation surveys. Consequently the NTS is a valuable resource for cross checking household characteristics.

Full and detailed analyses have been carried out to date on only a restricted number of the surveys, and work is steadily proceeding.

The major innovations in this work have been:

(1) The use of individual data for vehicle access and activity analysis.

(2) The development of household lifecycle categories based on composition of the household rather than the relationships beteen the household members.

(3) The analysis of travel (and other activity) time usage and participation on an individual and a household lifecycle categorisation.

(4) The production of travel time exposure results for road safety and other uses, and by age group and household category.

(5) The production of comparable results for more than a single city.

HOUSEHOLD CATEGORISATION

The use of lifecycle categorisations for households has been heavily used by the Oxford Transport Studies Unit , and was the subject of several papers at the 1981 International Conference on Activity and Other New Approaches to Travel Analysis. The Oxford work was reported there by Clarke and Dix (in Press), but still retained the assumption that lifecycle categories should contain such unobservable factors as the fact of a marriage between two of the adults, or that particular members of the household were retired. This confuses two essential issues. The age structure of a household can be observed without detailed investigations of the interrelationships between the household members, and can easily be related to Census and other surveys.

The Characteristics of household members in a particular age group (retired, married, unemployed, part time worker etc) are crucial explanatory factors which can then be used on the household categories based on age structure alone. The papers by Wigan (1982c) and Saloman (in Press) and Knapp (in Press) all dealt with categorisations applied to large household interview data sets. Knapp and Wigan were specifically concerned with developing useful categories, while Saloman was more concerned with delineating lifestyle descriptors from this standpoint.

The series of household lifecycle categories set up by Wigan(1982a), were derived from houshold age structure, vehicle ownership and other observable characteristic variables, using Varimax factor analysis to determine efficient groupings of households by employment, vehicle ownership and age structure. The results for Adelaide, Brisbane, Canberra and Gold Coast were found to be closely similar, and subsequent work (Wigan, 1982b) has confirmed that the Melbourne results are also comparable.

Very recently the results of the large NCHRP program of New Approaches to Understanding Travel behaviour (Allaman,Tardiff and Dunbar, 1982) have become available. This work is restricted to the same city used for the earlier discussion of activity levels, participation rates and lifecycle effects of Wigan (1980)(i.e.Baltimore), but confirms many of the points made in the present paper for Australian cities. Similar points are made by Allaman et al on the classification deficiencies of previous lifecycle categorisations.

The three groupings identified for Australian cities were:

1) A 'mobility' factor (car ownership, employment, licence holding, young and middle aged people present - the usual attributes of car ownership), explaining about 45% of the variance .

2) A 'school age, older family' group, identified with school age children, mature adults and bicycle ownership - with no weightings for income, car ownership or employment - explaining about 25% of the variance.

3) A 'preschool, younger family' group, identified with preschool children, 26-34 year old adults - and the lack of mature adults - explaining about 18% of the variance.

These three factors consistently explain over 85% of the variance, and comprise a remarkably stable factor framework, within which even the individual factor weightings are reasonably comparable.

The 1978 NTS omits a number of household characteristics used in the standard variable list used for the transportation survey analyses, but the results shown in Tables 2 to 4 demonstrate that the same factors arise when the two independent samples of Adelaide households are compared. As the Tables show, even the individual variable weightings in the factors are comparable between the NTS and the full household survey results.

The use of the NTS to extend, generalise, and support the individual city surveys would appear to be a reasonably sound step to take.

VEHICLE ACCESS

The basic unit for traffic flow analysis is the vehicle, while the basic unit for transport analysis is the person. Planning tradition has placed a strong emphasis on the household as the basic unit, while some workers have added the 'economic unit' concept to ameliorate some of the problems inherent in the use of a physical 'household' unit. Comparatively little analysis has been done at the person level, and although extensive individual choice models have been built to analyse personal choice, aggregations of the results have not always provided quite the understanding hoped for.

The first stage of the program tackled this by examining access to vehicles within a household as a function of the age of the person concerned. This required going back to the basic data on magnetic tape in most cases, but the results were well worthwhile. Vehicle ownership has generally been examined at a household basis, but is less well identified at the individual level, where the concept of accessibility to a vehicle, of mobility of a person, and the constraints which operate within a household with more licences than motor vehicles have all proved to be difficut to handle.

The approach adopted for this first stage of the work was simply to define all people in a household containing a given number of vehicles as having access to this number of vehicles, and to aggregate over all individuals in a given age group in all households to produce a percentage of people in each age group with access to 0, 1 or 2+ vehicles.

This definition is appropriate for many purposes, as the people below licence age own, or if without vehicles of their own may well take trips as passengers in the household vehicles, and certainly have the potential opportunity to do so.

Figure 1 shows how the NTS can be used to obtain this accessibility to vehicles, aggregated for individuals in households over the whole of Australia. The vertical scale shows what percentage of individuals of a given age live in households with 0, 1 or 2 plus cars or station wagons. These results were presented at an International Conference in Oxford in 1981 (Wigan, 1982c) but this is their first publication.

The marked increase in access to cars which almost exactly covers the 'young driver' group (licence age - 25), shows a marked and significant increase in the year before licence age is reached, reflecting the anticipating action often taken by individuals or families as licence age is approached. The dilution of these results by individuals living in households without a car can be corrected by examining the ratio:

$$P[2+/1+] = \frac{\text{Probability of access to two or more cars}}{\text{Probability of access to one or more cars}}$$

which reduces to the probability of having access to more than one car in households which have at least one car. Figure 2 shows that this ratio nearly doubles over the 'younger driver' age group, and displays identical patterns for both cars and for motorcycles. Motorcycles tend to be owned almost exclusively by young drivers, and by comparatively few people in the population taken as a whole (Figure 3).

The work done to determine how best to characterise households in terms of the presence or absence of individuals in particular age groups (Wigan, 1982a) found that exactly the same groups of factors applied to all of the Australian cities analysed. These factors were based on the age structure of households, and the different possible age structures were therefore retained for analysis and presentation purposes, until more refined classifications could be developed. This work is still in progress, and a series of multiple analyses of variance have been run to ensure that the age structure groupings used are effective for transport behaviour discrimination. This work has not yet been completed.

Figures 4 and 5 illustrate the use of two of the categories developed based on the age structure of the household, and display the distribution of vehicle stock values for the first, second and third vehicles in two types of households:

(1)Households composed solely of young adults

(2) Households composed solely of elderly people (65 plus).

The distributions are markedly different, and reflect the different expenditure priorities of the two types of household (See Wigan, 1982a). The same reference shows that the car ownership levels of elderly households are very much higher for 1 or 2 car ownership at low income levels than for other types of households. When three or more cars are owned by the household, the car ownership/income distributions converge for all the types of households considered (Wigan, 1982a).

The use of Family Expenditure data can make this influence apparent. Figures 6 and 7 show 1974-5 family expenditures on vehicle ownership and use as a function of the age of the head of household. These expenditures plummet

in dollar terms for elderly households - but the percentage shares of household expenditure vary far less . However, the ratio of fixed to variable costs of vehicle ownership are remarkably stable over time, income level, and household type (See Morris & Wigan, 1979, Wigan, 1980).

These results show that elderly households not only use their cars less (while still apportioning their expenditure on fixed and variable costs about equally), but also keep them longer. The markedly greater importance of household fuels and household expenditures in their overall budget and the high levels of absence from home (both established in parallel work), point towards a larger amount of time spent away from home, in longer periods, possibly as a balancing factor for their greater freedom from time constraints.

These deductions can be checked by examining the fraction of the population reporting any time at home during the survey day. This is currently being completed as one of the applications of the analyses of activities other than moving travel time (Wigan, 1983).

Access to vehicles is not simply access to motorised vehicles . Access to bicycles is fairly high over the whole population, and recent comprehensive analysis of Melbourne analyses this in detail (Wigan, 1982b).

Figure 8 shows how bicycle access by age varies in much the same manner in Adelaide and in Brisbane, but the value of drawing distinctions by lifecycle categorisation is well illustrated by the Brisbane results in Figure 9, where households containing only adults contrast strongly with 'family' households.

Bicycle ownership is the most distinctive characteristic of a 'school age' household, and lifecycle effects are consequently the most marked of all modes. Bicycle usage has often been considered to be negligible in terms of overall transport flows. However, approaching half of all of the households in Melbourne contain bicycles, used or not, and it would appear that greater attention to bicycle ownership and use would be justified in any future household interview surveys undertaken.

TRAVEL PARTICIPATION AND ACTIVITY RATES

Taking a person-based approach to travel can provide effective 'market share' results. Figure 10 shows the participation rates in car passenger, motorcycle and bicycle trips by people in every age group in Canberra in 1975. These results take on a rapidly increasing value when the values from different cities are marshalled together : this is now in progress, and the results shown here for Adelaide and Canberra may now be added to those for Melbourne.

The use of the term 'participation' in this context is to pick out the fraction of households (or people, if the analysis is to carried out in terms of people), who are non-travellers and the complementary fraction which makes all of the journeys reported for the city. The characteristics of non-travellers are becoming of increasing importance to planners in the recreational, government and transport areas. The complementary population, that of active people and households, is the travel market for which transport provision is currently effective.

The high levels of participation in car passenger travel by the very young (and the old) lend support to the measures taken for child restraints in cars, while the clear cut shift in the peak age of participation in the use of bicycles and motorcycls (and the concomitant smaller drop in car passenger travel) suggests ways of assessing the suppressed transport demand of the 16 to 25 year olds, the 'Young Driver' age group.

Once again, the comparative results from other cities and States, where the licence ages are different will be a valuable contribution to the difficult task of balancing mobility and safety costs to individuals and the community.

Comparisons between cities are now possible, and Figures 11 and 12 show the participation rates and trip activity levels for train usage in Adelaide and Melbourne. These two cities have very different levels of provision and extent of passenger railway services, and the higher overall participation rates in Melbourne reflect the extensive network in that city.

The break between schoolage children and young adults is set at licence age, as this is the major mobility barrier for young people. Motor vehicle licence age in Adelaide (South Australia) is 16 years, while in Melbourne (Victoria) it is 17 and three quarter years. The shift in the peak participation in train use from just above the licence age in Adelaide to just below the licence age in Melbourne is thus a function of the travel mode usage characteristics of 16 to 18 year olds in the two States.

Trip activity rate is the number of trips/day made by people who travel at all. This is not diluted by the fraction of people or households of the type being examined who do not travel. If the complementary participation rate could be increased, then the numbers of extra trips would be estimated from the activity rates of those currently travelling.

The trip activity rates barely differ between different ages and across the two cities. This places the spotlight on participation rates as a measure of transport markets, rather than 'trip rates' or 'patronage'. It also makes it clear that longitudinal information (i.e. for any individual, how frequently does he/she use the train at all, from once a year to once a day or more) is now becoming of substantial importance in public transport planning.

TRAVEL TIME PARTICIPATION AND ACTIVITY RATES

Travel time can be treated in exactly the same way as the numbers of trips (treated in the last section). The amount of time that people of different types spend in travel is one direct measure of their exposure to risk, and of the priority given to travel as one of the activities carried out during the day. It also provides a direct measure of the performance of the travel system, as the total travel time by mode, summed over the whole city can then be calculated from a household basis with all of the details of the household characteristics if required.

Time on travel is only one of many different types of activities on which time is spent in a given day. The analysis framework adopted includes travel (and other) activity time results. Figure 13 illustrates how travel time by bicycle varies with age of the person involved. The maximum total exposure is for 12-licence age riders, who do indeed receive much of the

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However, once someone has been identified as a cyclist, the average amount of time exposed on the road on any given day that he (or she) cycles is roughly consistent over all age groups at about 45 minutes - a lengthy exposure time, and one which lends force to the provision of carefully selected routings for cyclists over the road network.

The link to household categories is made in Figure 14, where the bicycle participation rates of households of each category on a given weekday, and the participation rate of individuals within each such household type are presented. The lifecycle categories on the figure are:

(1) YA: young adults only in the household (licence age to 25)

(2) MA: mature adults only in the household (26 - 59).

(3) ELD: elderly adults only in the household (60+).

(4) YA+OC: young adults + schoolage children only

(5) MA+OC: mature adults + schoolage children only

(6) E+A: elderly + at least one adult (licence age - 59) only

(7) E+C: elderly + at least one child (up to licence age) (8) E+C: elderly + at least one child + at least one adult (licence age - 59)

(9) ALL: average over all households.

These forms of analysis provide a straightforward method of estimating on road exposure from a person or a household basis, and similar results are available for all of the thirteen modes of transport covered in this particular survey. Analysis of road accident statistics by age and major city in conjuction with these travel time exposure rates can provide a new source of accident risk , corrected for exposure: a commodity in short supply in Australia.

The relationships between travel time and travel timing, which bring in the constraints on travel behaviour, has been the subject of a detailed review (Wigan and Morris, 1981), covering the work of Carlstein, Jones, Lenntorp, Szalai, Thrift and Westelius (amongst others). This will not be repeated here, as the primary purpose of these analyses is to bring trip generation and activity participation into a common framework of participation rates and levels of activity of those participating. The detailed links between the mutual constraints on household travel which may be deduced from transport planning and activity surveys are being pursued separately, as a continuation of the Morris and Wigan work (1983), and also as part of the analyses of the Adelaide Activity survey (Barnard, 1981).

ON ROAD EXPOSURE VALUES

The use made of the transport system at different times across the day is of great importance to traffic and transport planners. This accumulation of vehicles, travel time, and transport capacity must be matched as well as possible to reduce the costs of infrastructure provision and to give timely services. The accumulation of parked vehicles in an area is one of the examples well known to traffic and land use planners, and corresponds to the patterns of arrivals and departures over the day with lags due to the lengths of time each vehicle spends parked. This distribution of parked vehicles will correspond closely to the accummulated numbers of people in the area who have arrived to go shopping, work or undertake some other purpose.

If the total time spent by these people in each unit of time is added up, then this will give a profile of people activity time across the day, which might be segmented by age of person, length of trip or type of mode. These distributions, of people active in a given activity and of the total time that they are spending on that activity, are for the activity of 'travel time' the total population on the move at a given time, and the total in-vehicle (or on-road) travel time demands across the day by that population.

The total amount of time spent in each quarter of an hour interval over the day can be calculated. The results for all age groups combined, for several transport modes, are given for Adelaide and Canberra in Figures 15-19.

These figures provide a substantial amount of information in a readily usable form. The peak utilisation factors for each public transport mode can be deduced by combining the seat-hours run in each quarter hour interval, and the person travel time totals presented. Precisely similar figures can be produced for the number of people on each mode in each quarter hour, unweighted by the duration of their stay on the mode concerned in that quarter hour interval. Similarly, the analogous patterns for trips starting or finishing in each quarter hour can be presented in the same manner.

An initial detailed analysis on these lines, differentiating between mode of transport, purposes of travel, and age of rider has been given by Wigan (1982b). Wigan (1982b) was restricted in the main to bicycle usage, although the analyses were carried through for all modes and all activities - a 13 x 15 grid for Melbourne in 1978 - and only the bicycle (mode + travel) cell was analysed for that report. It provides a considerably more extensive coverage of the age, activity and purpose interactions reviewed here.

The relative importance (in terms of people hours of travel time) of the different modes was made quite clear: taxi and motorcycle usage being of marginal importance, yet bicycle travel time showed up as substantial in the Melbourne figures.

The figures provided here show the structure of travel over the day, and provide a quantitative assessment of the relative weight (in terms of travel time) of each mode over the day, in a visual manner which can be grasped easily.

The order of importance of school buses and bicycles for the morning (school) peak is reversed between Adelaide and Canberra. Walking shows a similar predominance over both in both cities - and the small overlap between non-school bus and school bus travel (in the evening in particular) is quite marked.

Figure 17 shows the importance of bicycle travel compared to train and tram in Adelaide , where the rail system is comparatively restricted, and the tram limited to a single line. This is in direct contrast to Melbourne (see

Wigan 1982a), and is consistent with the uniformly higher bicycle participation rates at every age in Adelaide when compared to those for Melbourne.

Figure 25 shows that taxi travel is but a small and almost vanishing contribution to travel time, even in Canberra - a finding very similar to that for Melbourne (Wigan 1982a).

Although not illustrated here, motorcycles also take a very minor place on a travel time or time exposure criterion. Accident incidence relationships by age may be used to obtain exposure corrected involvement rates by age, and this would be well worth undertaking with special attention being paid to young drivers (and riders).

ACTIVITY INVOLVEMENT IN MELBOURNE: PORTRAIT OF A CITY

The travel time exposure results exemplified by the selected figures (15-19) represent only one of about twelve different major time usage categories. The same technique can be applied to the other activities, given suitable processing of the raw data into a suitable format. Figure 19 is such a result. For Figure 19 the total amount of time spent in the peak quarter hour interval was used as a scaling factor, so that the patterns of time commitment over the day for each activity type are not on comparable scales. This has been done to highlight the profiles of time commitments over the day for the population of the city as a whole.

Each row is a different activity. The last is 'Time at home', and is precisely the type of exposure profile required for noise and other nuisance exposure estimation. The same type of diagram can be produced for any locality, or for any age group: only the aggregated results are given here.

'Time engaged in work' is a fairly regular profile, with starting and finishing times spread over several hours, in direct contrast to 'Education' (which is in the overall case dominated by schoolchildren), with its inflexible starting and finishing timings. 'Health and medical activities' show several peaks, and a long tail into the evening, but 'Personal' business shows a peak commitment well into the evening, with a solid commitment over the whole day. 'On employers business' shows a less precise profile than 'Work'.

'Shopping time' displays a peak (and this is a weekday survey) at 11 am. It would be useful to obtain shop turnover and patronage figures by hour of day, as these would then provide a basis for productivity, profitability, and catchment estimation by retailers, and the possible basis for considerably improved models of shopping demand and parking requirements. The segmentation of the shoppers into age groups, employment status, and household income would show up the patterns of shopping timings and time durations, and would form an effective market study for retail interests in turnover and shopping hours.

'Recreation and entertainment' (weekday) shows the dominance of the 7-9.30 evening period, while 'Pick up or drop off passenger' - the 'Serve passenger' mode - shows a uniform time commitment over almost the entire day, with a peak at about 5 pm. 'Change travel mode' shows peak at 6 am and 5 pm, reflecting the special demands for this type of journey.

One can but speculate on the explanation for the late evening peak in

the time devoted to 'Religious services' !

The detailed analyses of activity, time, and participation rates in time spent at home, shopping, personal business, etc. are treated elsewhere (Wigan, 1983), but follow the general principles described for trip rates and travel times in this paper.

In the more detailed results for Melbourne, it was found that the profile and timing of different activities varied substantially when analysed by the mode of transport used to reach them. The application of these findings to parking accumulation analysis should now be followed up.

SUMMARY

A systematic analysis of Australian household interview data on the basis of both personal and household characteristics has shown that substantial contributions to travel demand, trip rate estimation, market penetration of travel modes, exposure, utilisation and safety factors can all be obtained from a more effective treatment of existing household interview data than is already available.

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AUSTRALIAN HOUSEHOLD INTERVIEW FILES

City	Survey Year	Population (10^3)	Persons in Household Sample	Held at ARRB	Set up at ARRB	1976 National Travel Survey NTS Area Code	Population (10^3)	Persons in Household Sample
Sydney	1971	2773		√	x	214	2901	10 541
	1981			x	x			
Melbourne	1964	1952		√	x	311	2649	15 543
	1972				x			
	1978		11 540	(Temporary holding)				
Adelaide	1966			√	x	501	903	5770
	1977	869	12 115	√	√			
Perth	1976		4646	√	√	608	819	2847
Brisbane	1977	995	6699	√	√	401	697	6742
Newcastle	1974	334	6524	√	√	211	420	2541
Gold Coast	1978		6295	√	√	402	310	3146
Wollongong	1971	206	4455	√	√	213	270	2386
Canberra	1975	205	6368	√	√	101	197	2221
Hobart	1971			(No copy exists)		701	191	1381
Geelong	1970		12 907	√	√	301	181	3101
Gosford-Wyong	1971		1614	√	√	212	121	2799
Launceston	1967			√	x	703	110	1230
	1976	59	5348	√	√			
Ballarat	1970	56	4344	√	√	303	103	2739
Darwin	1975			√	x	801	72	916

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	1976 National Travel Survey		
) B	NTS Area Code	Population (10^3)	Persons in Household Sample
	214	2901	10 541
	311	2649	15 543
g)			
	501	903	5770
	608	819	2847
	401	697	6742
	211	420	2541
	402	310	3146
	213	270	2386
	101	197	2221
	701	191	1381
	301	181	3101
	212	121	2799
	703	110	1230
	303	103	2739
	801	72	916

	NCARS	65+	35-59	LIC-25	NEMP	HINC	NLIC
1976	0.64	–0.37	0.31	0.62	0.87	0.73	0.78
1978	0.62	–0.51	0.47	0.31	0.72	0.65	*
	.6	.4	.5	.1	.6	.5	1

$\rho_{NLIC,(\ )}$

'MOBILITY'

FACTOR LOADINGS FOR ADELAIDE
1976 – M.A.D.S. sample
1978 – N.T.S. sample

TABLE 2

	LFCYC	65+	35-59	12-LIC	5-11	NBIC
1976	0.76	–0.13	0.48	0.58	0.46	0.51
1978	–0.03	–0.41	0.62	0.38	0.41	*
	1	.0	.2	.4	.4	.2

$\rho_{LFCYC,(\ )}$

'SCHOOLAGE, OLDER FAMILY'

FACTOR LOADINGS FOR ADELAIDE
1976 – M.A.D.S. sample
1978 – N.T.S. sample

TABLE 3

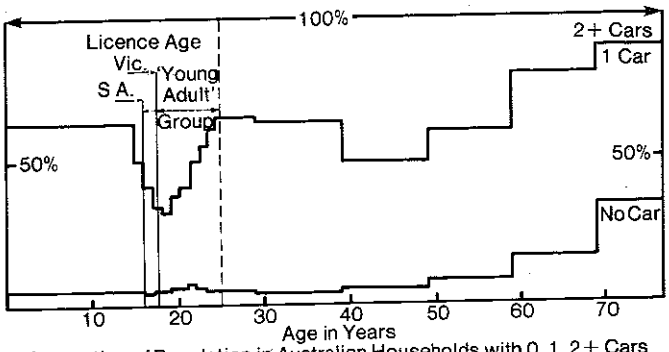
	LFCYC	35-59	26-34	12-LIC	5-11	0-4
1976	0.26	–0.52	0.93	–0.18	0.24	0.54
1978	–0.02	–0.57	0.98	–0.23	0.20	0.52
	1	.0	.2	.4	.4	.2

$\rho_{LFCYC,(\ )}$

'PRESCHOOL, YOUNG FAMILY'

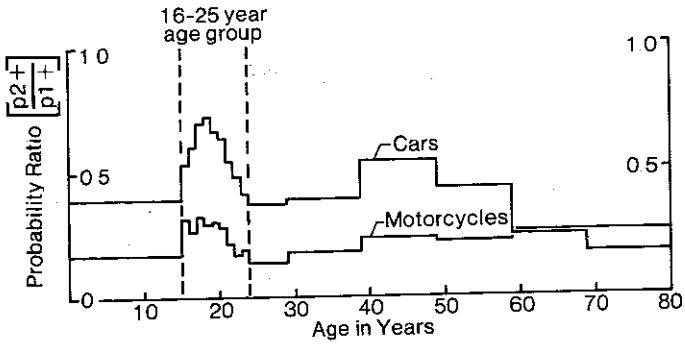
FACTOR LOADINGS FOR ADELAIDE
1976 – M.A.D.S. sample
1978 – N.T.S. sample

TABLE 4



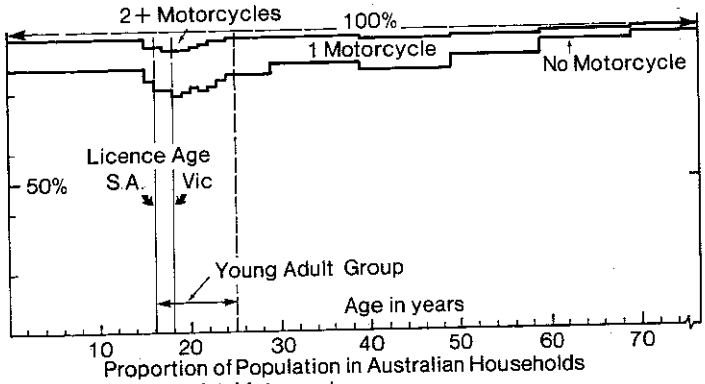
Proportion of Population in Australian Households with 0, 1 2+ Cars
(Derived from 1977-8 N T S)

FIGURE 1



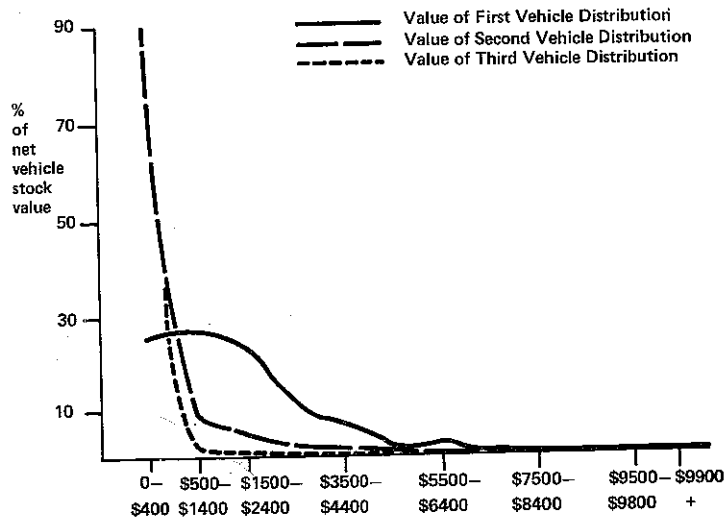
Probabilities of having access to multiple vehicles of a given type, given that it is a household which owns at least one of the relevant type
Source: Derived from Australian 1977-8 N T S

FIGURE 2



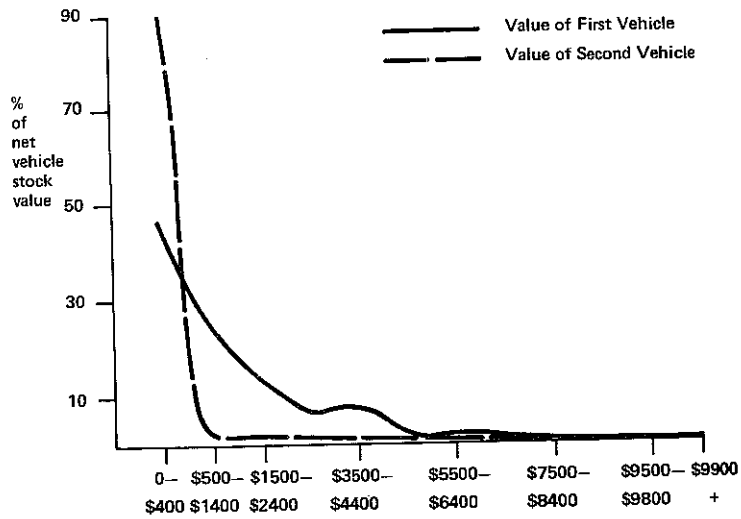
Proportion of Population in Australian Households with 0, 1 2+ Motorcycles
(Derived from 1977-78 N T S)

FIGURE 3



Distribution of Vehicle Stock Values of Young Adult Households (Adelaide 1977)

FIGURE 4



Distribution of Vehicle Stock Values for Elderly Households (Adelaide 1977)

FIGURE 5

WIGAN

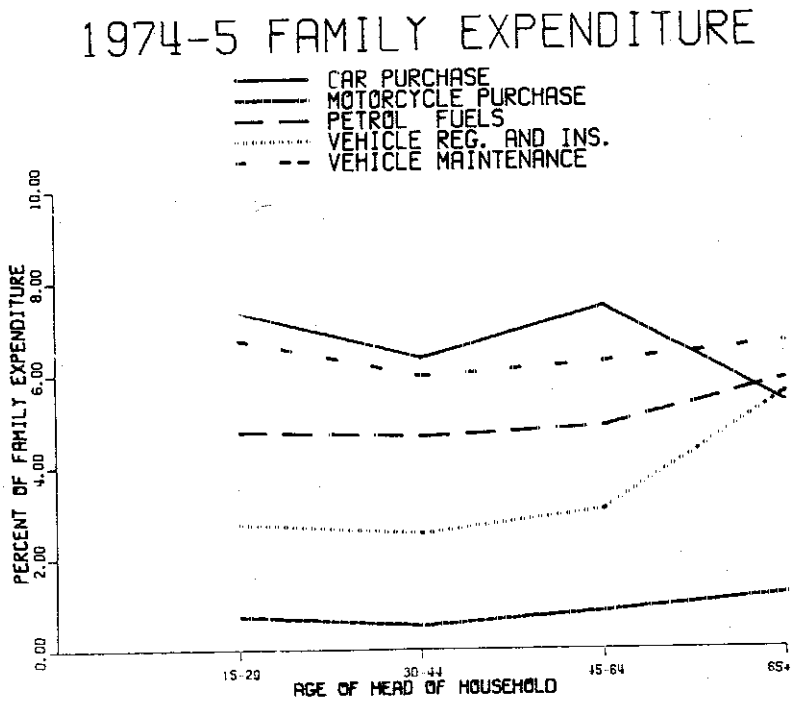


FIGURE 6

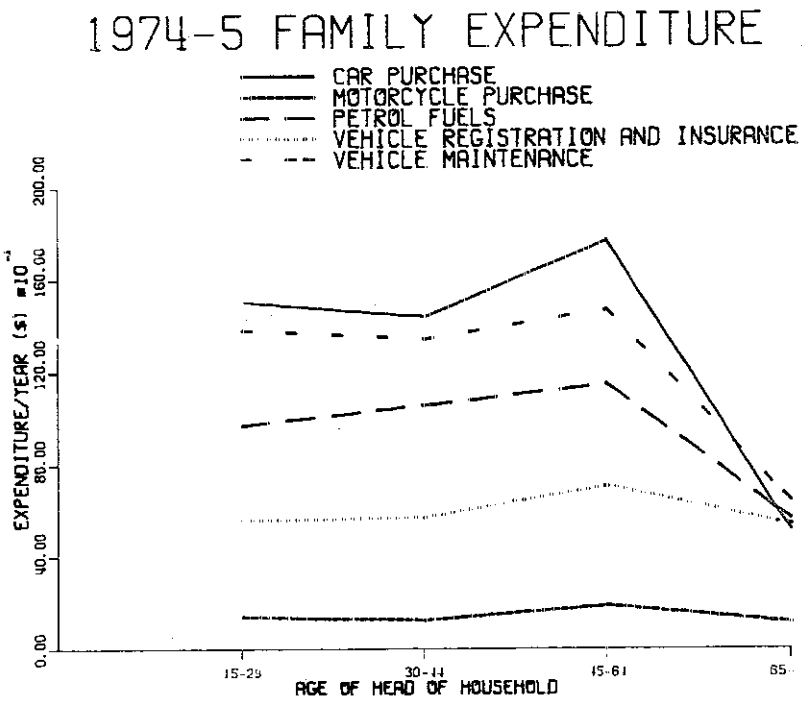
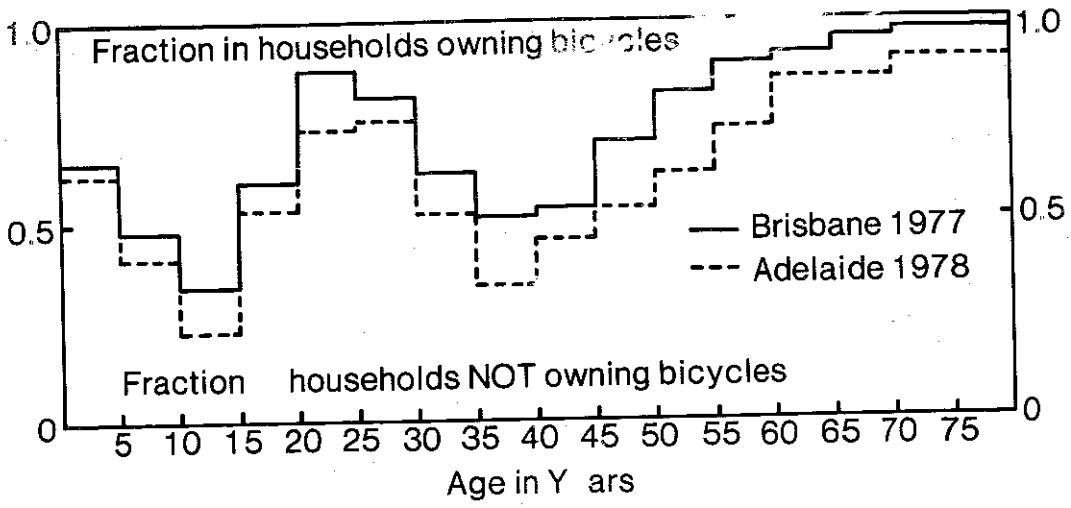
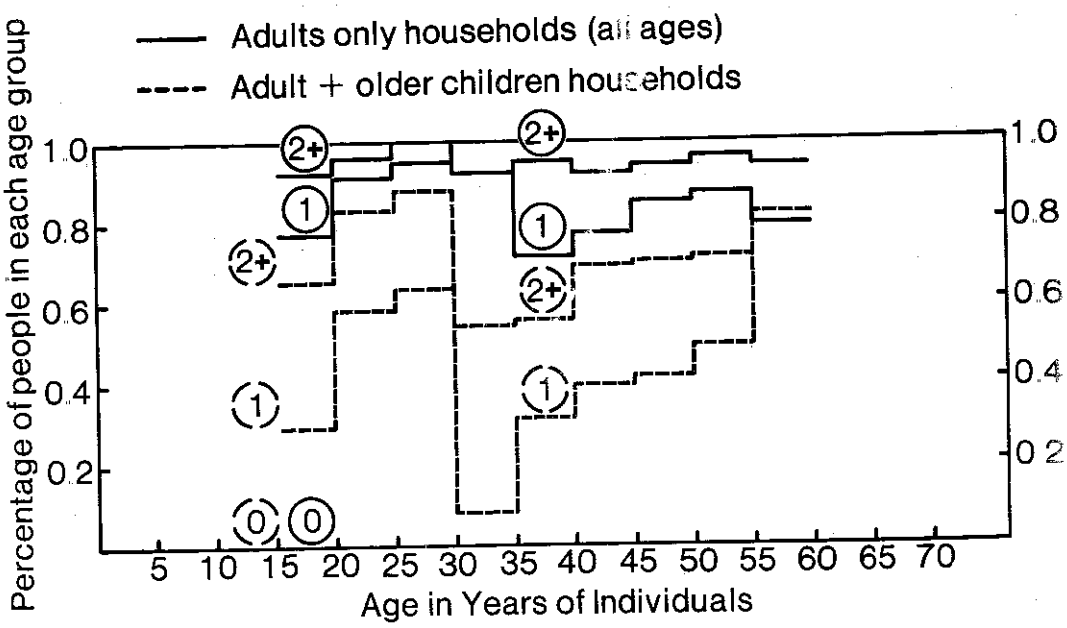


FIGURE 7



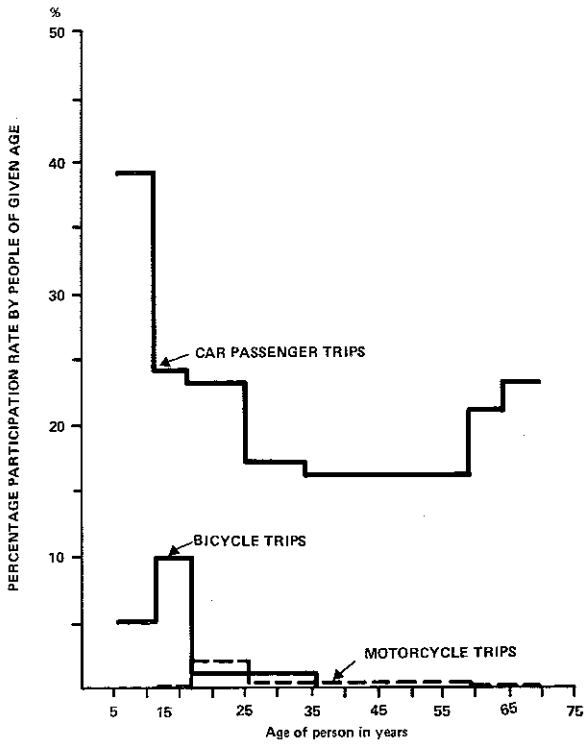
Fraction of population with access to bicycles in Brisbane (1977) and Adelaide (1978) households.

FIGURE 8



Bicycle Ownership by Lifecycle Group in Brisbane (1977) Households

FIGURE 9



PATICIPATION IN TRAVEL BY AGE:
CANBERRA (1975)

FIGURE 10

LEVEL ØF TRAIN USE

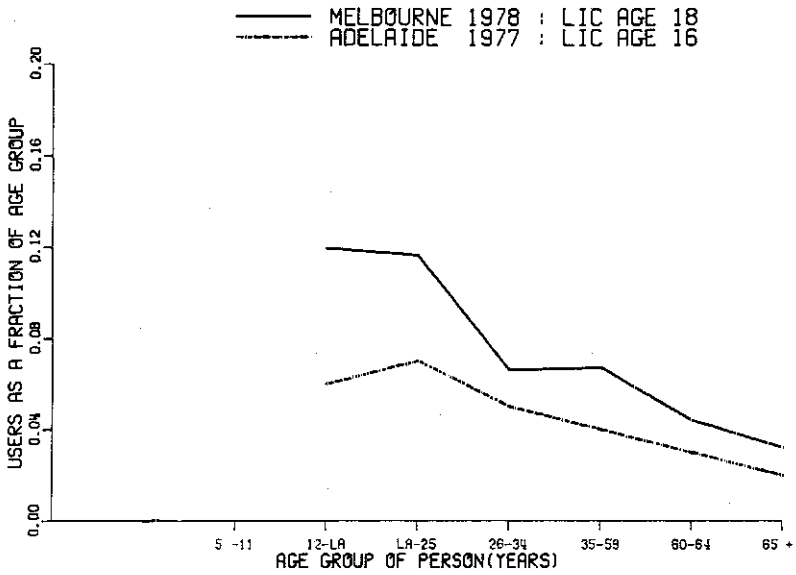


FIGURE 11

LEVEL ØF TRAIN USE

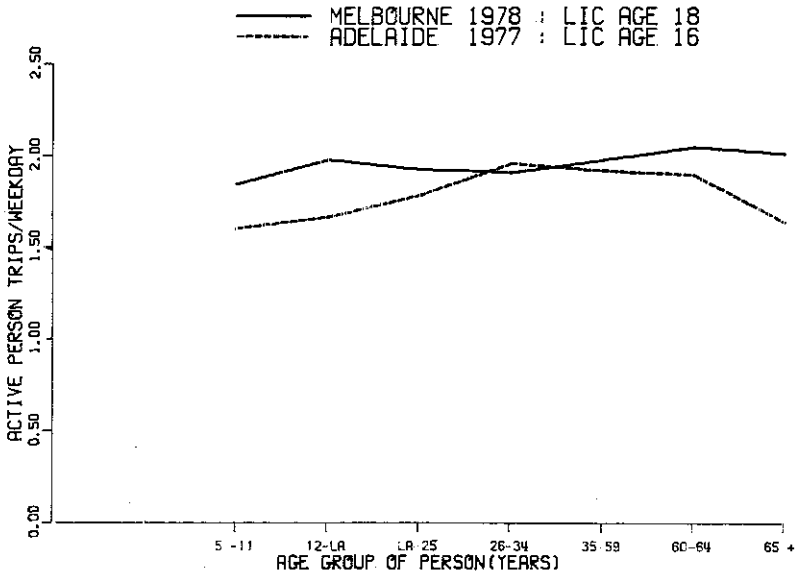


FIGURE 12

BICYCLE EXPOSURE/DAY

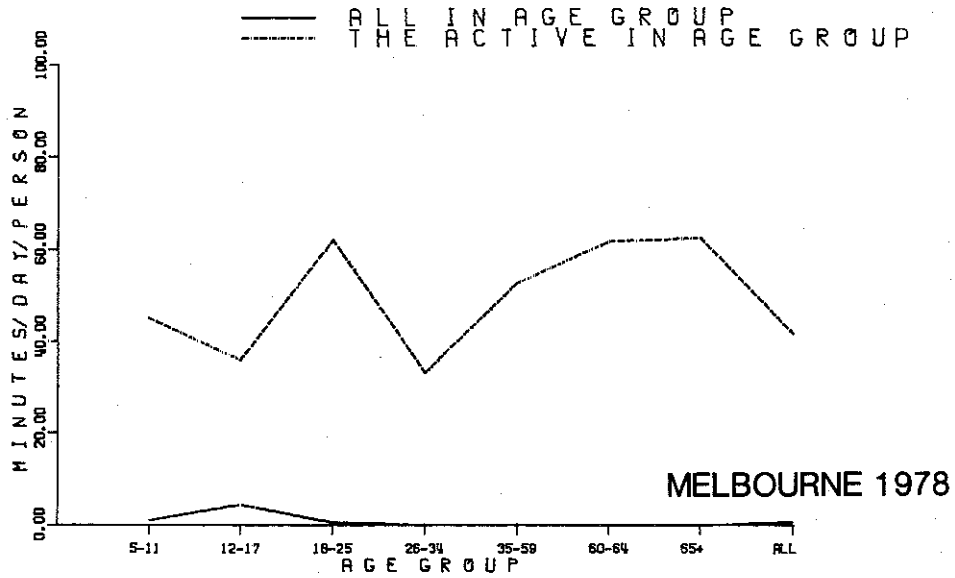


FIGURE 13

CYCLING FRACTIONS OF LIFECYCLE GROUPS

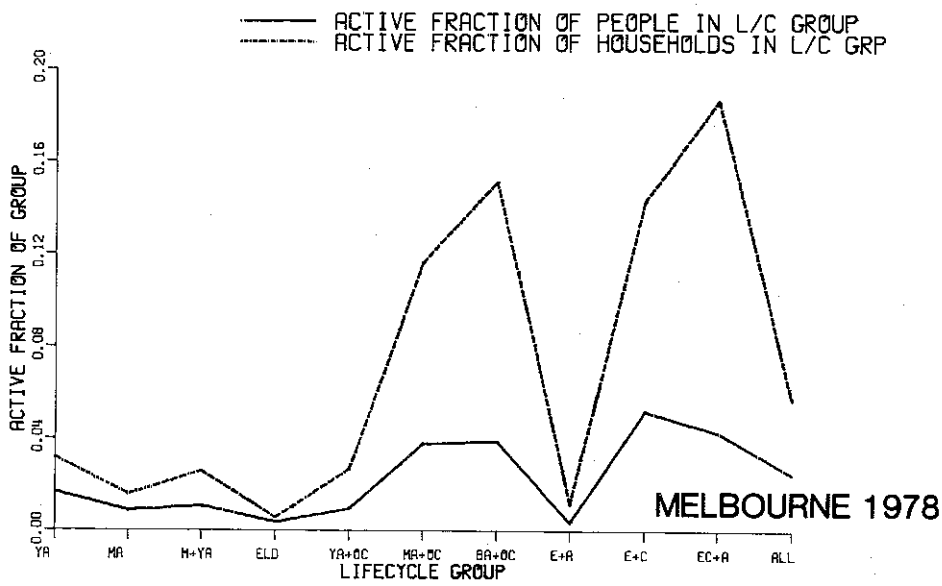
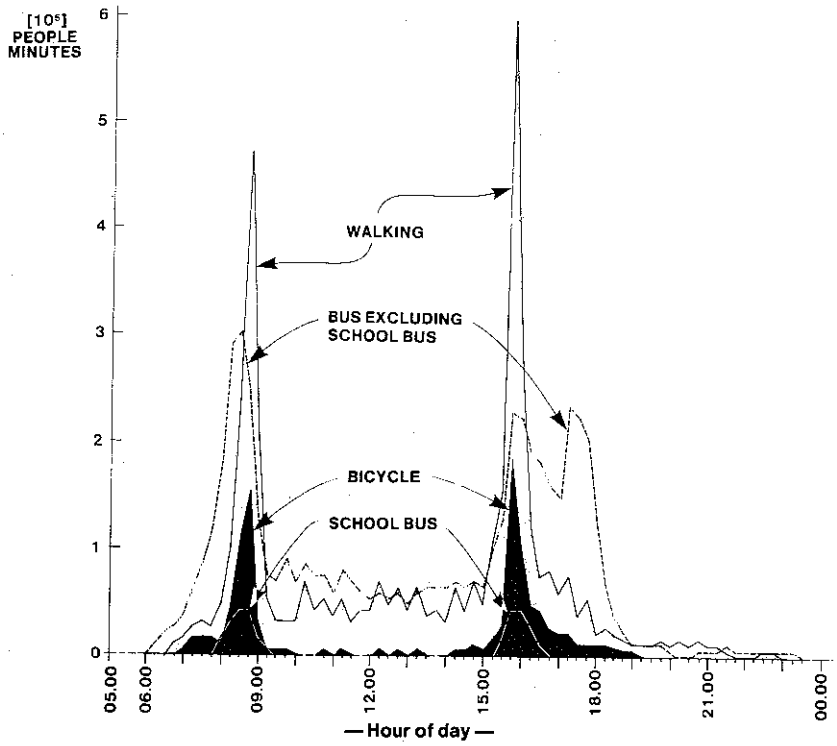
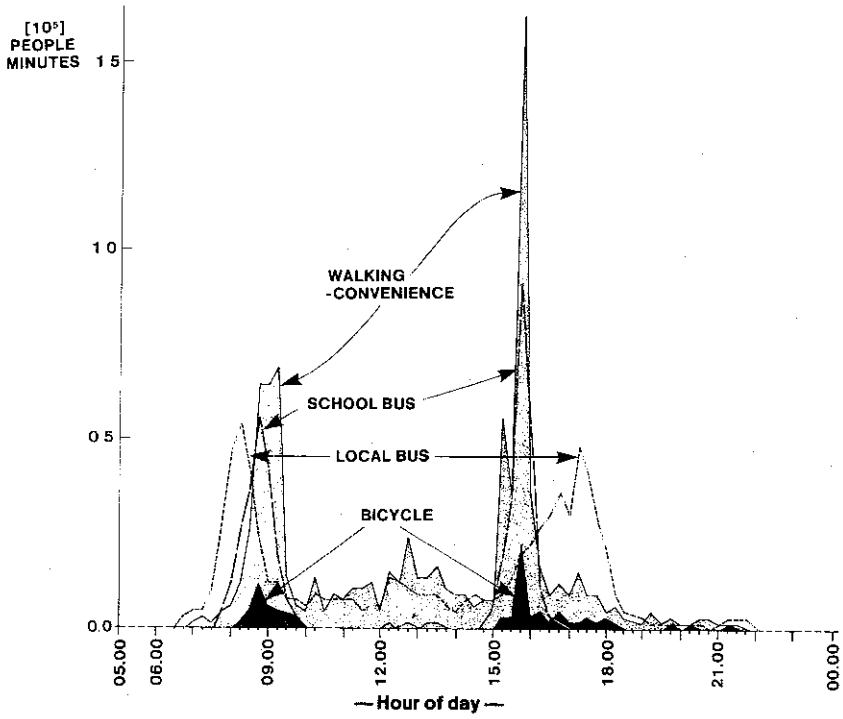


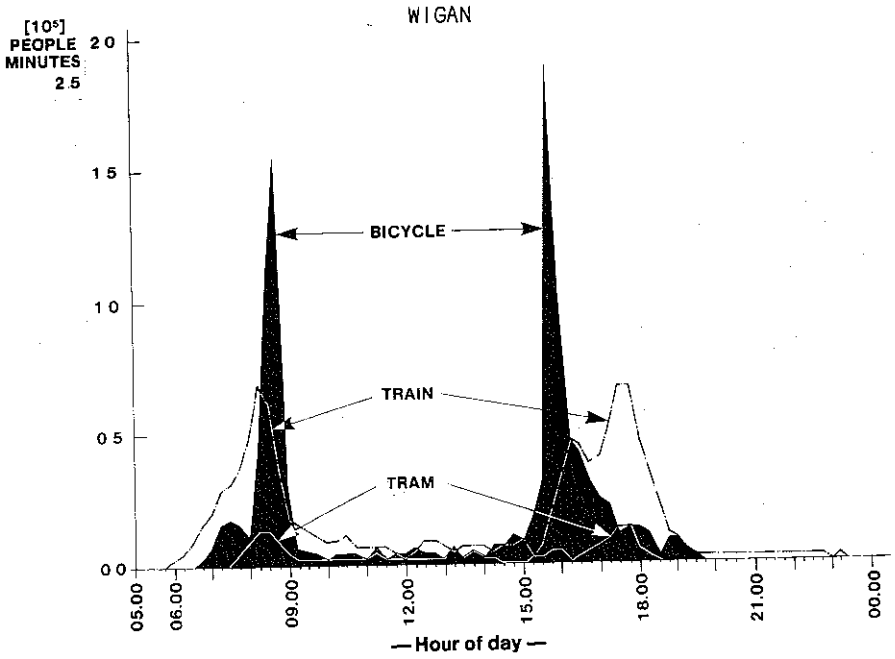
FIGURE 14



ADELAIDE 1977

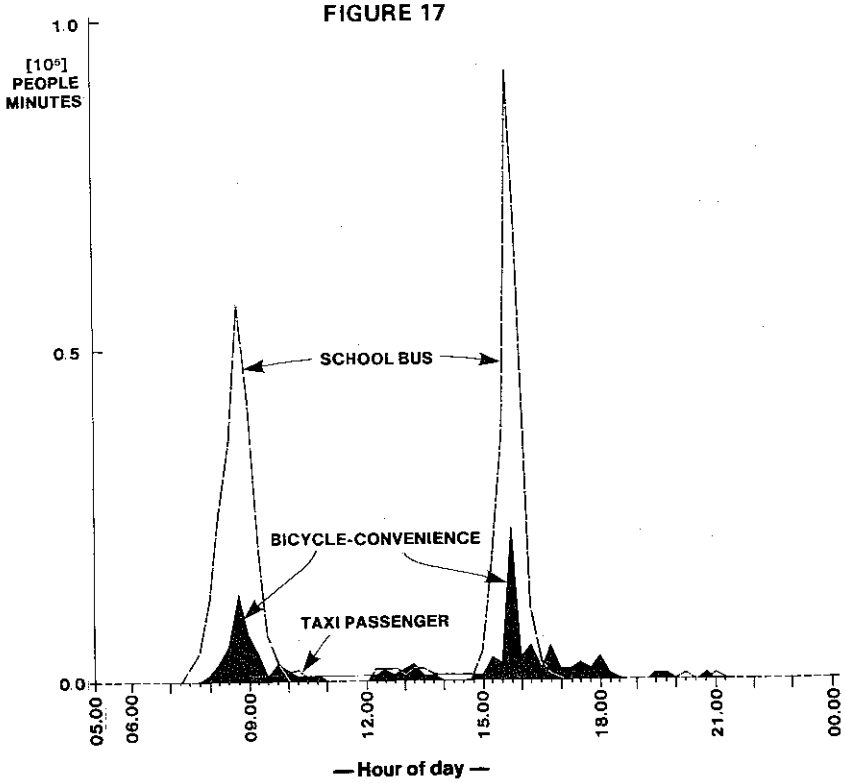


CANBERRA 1975



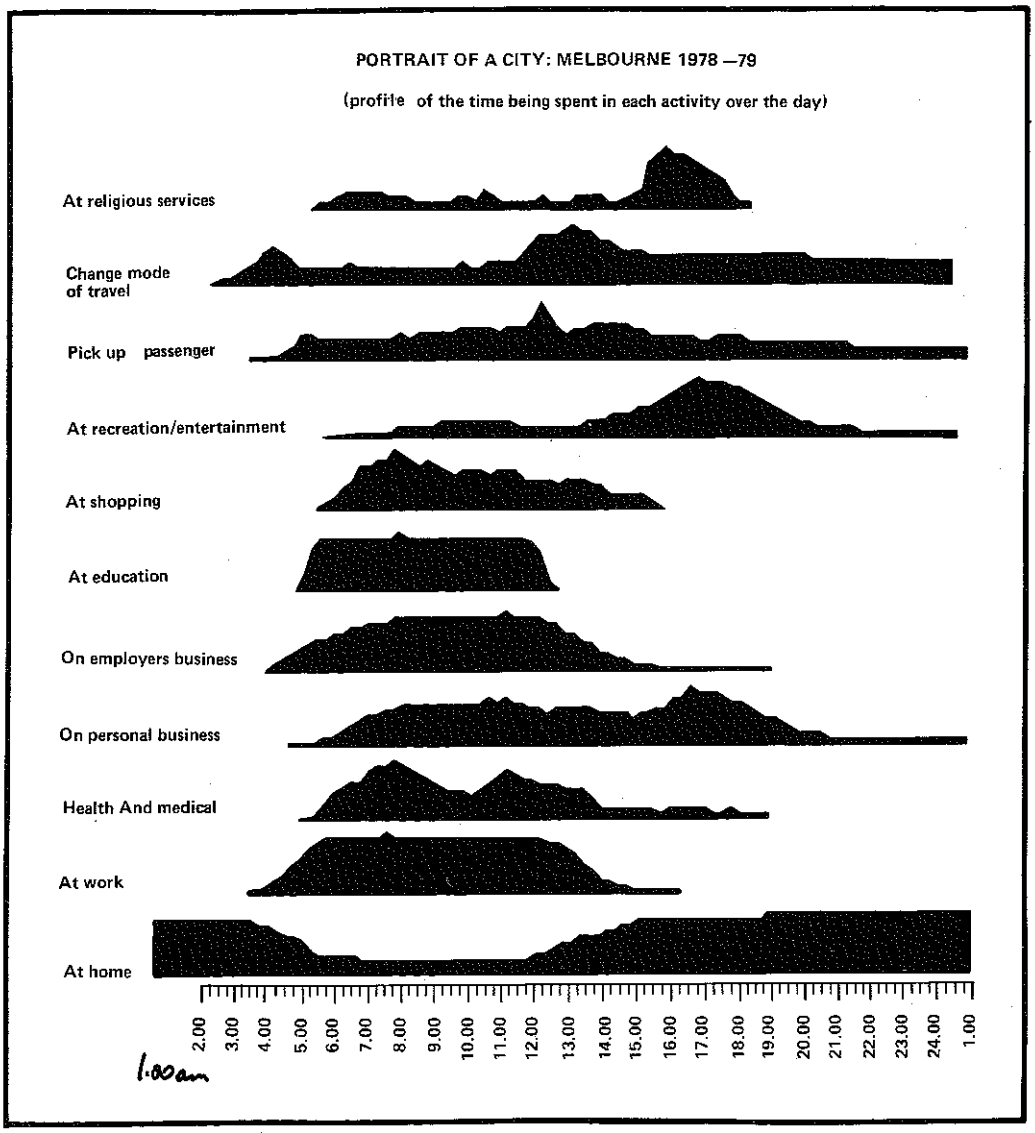
ADELAIDE 1977

FIGURE 17



CANBERRA 1975

FIGURE 18



Vertical scales differ between purposes