The 1991 Sydney Home Interview Survey Preliminary Results: Implications for Modelling

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Abstract:

This paper is the first attempt at analysing a comprehensive set of information taken from the 1991/92 Sydney Home Interview Survey (HIS). It gives an overview of the socio-economic characteristics off persons and households and their travel patterns. The data is analysed to address several issues in modelling such as a disaggregate and aggregate approach, peak and off-peak travel, journey-to-work and other purposes. This paper is not intended to be exhaustive; rather it is an initial step towards identifying a range of issues which can be covered in later, more detailed investigations.

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Introduction

Transport modelling in the 1990's has changed substantially since the 1960's. This is due mainly to the changing role of modelling. The emphasis has shifted from merely forecasting traffic volumes to analysing the impacts on travel demand of changes in the environment, government policies, funding approaches, human behaviour and lifestyle.

In Sydney, the 1991/92 Home Interview Survey (HIS) is currently being undertaken. Data from the HIS will be used to recalibrate and possibly respecify the current Sydney Urban Travel Model. Efforts to enhance the model by introducing disaggregate and behavioural modelling techniques are also being considered. This will eventually lead to a model that will not only forecast traffic volumes on the road and public transport networks more accurately, but will also reliably predict the market response to changes in transport, landuse and wider government policies. An important step towards this end is an analysis of the inter-relationships between socio-economic, landuse, transport characteristics, level of service variables and their effect on trip making.

Trip making is viewed as a series of actions that arise from a sequence of decisions. For example, a trip to work is a product of options such as where to work, when to travel and by what mode. When to make the trip could be a function of the workplace conditions, such as location, work hours and perhaps the perceived travel conditions.

A system of interrelated factors (socio-economic, landuse and transport) affects trip making to varying degrees. The above decisions are considered important to understanding travel demand. The analyses that follow focus on preliminary broad level 1991 HIS results discussed under the headings: mode choice; trip purpose; and the time of day of travel.

It will be noted, however, that these parameters are interrelated and it is not adequate to discuss one topic without reference to the others. The decision to order the paper into the above topics is adopted to facilitate discussion of important modelling issues and thus itemise some modelling options. This paper does not attempt to recommend desired option(s) as the choice rests on a range of operational and financial issues beyond the scope of this paper.

The main objectives of this paper are therefore:

(1) To give a preliminary overview of trip making characteristics of the population in the study area (Sydney, Wollongong, Blue Mountains, Newcastle and Central Coast);

(2) To present a preliminary profile of travel demand characteristics and the factors that are known to affect it; and

(3) To present some options for modelling based on the above.

Only socio-economic factors are considered in this paper as traffic zone coding is not yet complete.

Mode Choice Profiles

The choice of mode is deemed to be a function of several variables which can be amalgamated into the one concept - 'accessibility'. Different people have different degrees of access to different modes depending on socio-economic and geographic circumstances.

Mode choice models attempt to simulate the decision-making processes that result in mode choice and thus determine what share of total traffic will use each mode. It is important to know beforehand the distribution of observed trips over the available modes in the study area as this helps in determining priorities and sampling fractions for mode choice modelling.

Choice of Mode by Household Income

Household income greatly influences people's choice of mode and provides a measure of car accessibility. Figure 1 shows that the overwhelming majority of trips in the study area across all income groups are by car, but it also shows an increasing tendency to choose car as the household income increases. In contrast, the proportions of bus and walk trips decline as the household income increases. It is important to note that the proportion of train trips remains stable across a wide range of incomes.

Choice of Mode by Vehicle Ownership

Figure 2 shows the percentage share of modes by vehicle ownership level. Different levels of vehicle ownership affect the choice of mode and particularly the use of public transport facilities. People having access to at least one vehicle are more likely to use car than any other mode. Also, the more cars that are available to a household, the more likely that car mode will be used. Car owning households tend to use public transport more on weekdays than on weekends, probably for work-related trips.

Only 11.7% of households surveyed have access to a company car. Nevertheless, nearly a third of car trips are by persons from these households. Only 17% and 19% of train and bus trips respectively are by persons belonging to company car owning households.

About 80% of all trips made by persons belonging to households with access to a company car are made by car, compared with 69% made by persons from non company car owning households. The proportion of trips does not change dramatically if disaggregated into journey to work (80.3%) and other trips (79%). In AM peak periods, the proportion of car trips for the journey to work by persons belonging to company car owning households is observed to rise to about 86% for trips made between 7:00 and 9:00 AM (the peak period for work trips) and 89% for

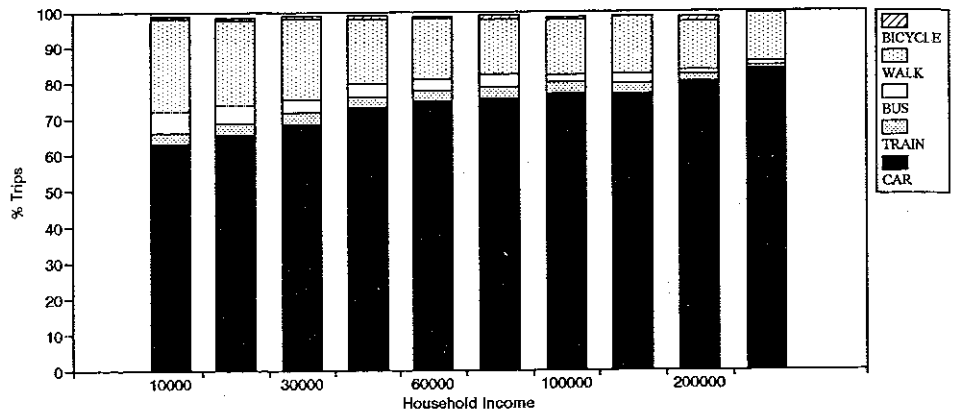

Fig 1. Percent Share of Trips by Mode and Household Income

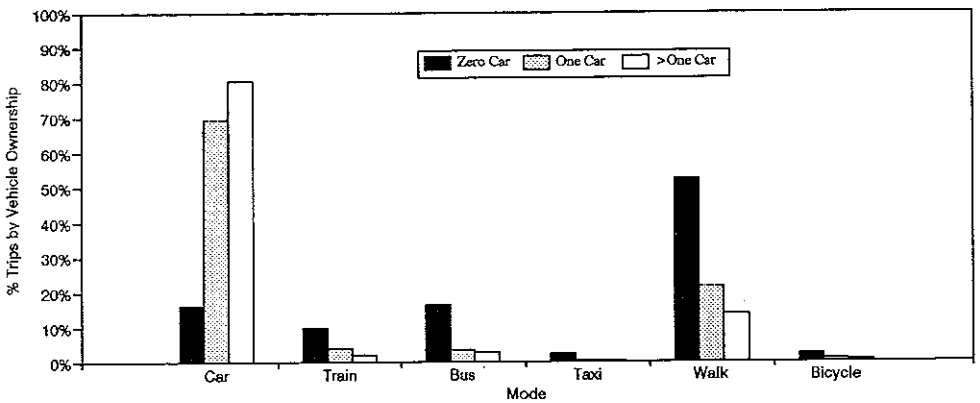

Fig 2. Percent Share of Trips by Mode and Vehicle Ownership

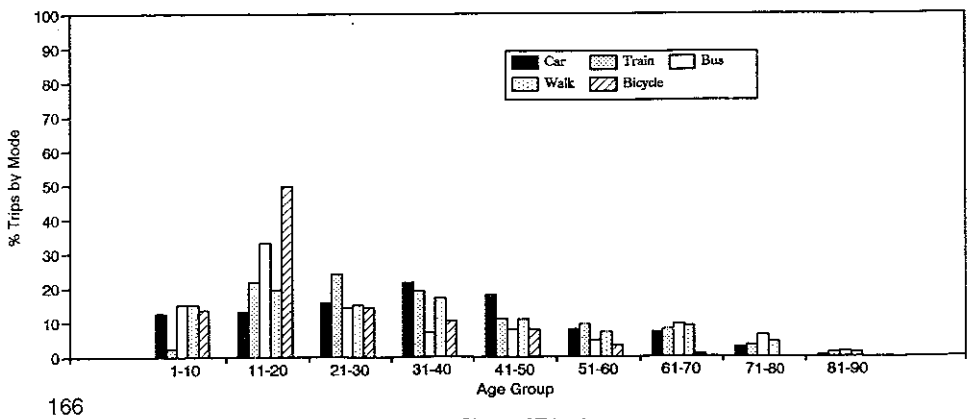

Fig 3 Percent Share of Trips by Mode and Age

trips made between 8:30 to 10:30 AM (the peak for all car trips). These results highlight the 'car captivity' concept particularly in journey-to-work modelling.

Choice of Mode by Household Size

Intuitively, the larger the household size, the lower the degree of access to a car and therefore the greater the propensity to use public transport. However, contrary to this hypothesis, the data has shown that, as the household size increases the share of car trips also increases. It is generally observed that larger households tend to acquire more cars to compensate for the potential loss of accessibility.

Compared with other households, one-person households are more dependent on public transport, with 13.8% of trips made by either bus or train, compared to the overall average of 6.9%. This may be more related to income than household size as one-person households are mostly persons aged 50 years and above (65.8%) who often have a lower income.

Choice of Mode by Age

The importance of public transport to younger people is shown in Figure 3. It can be seen that young people (aged 11 to 20) make up the majority of train and bus users. Persons aged between 11 and 20 years are more likely to make bicycle trips than older people, with almost 50% of bicycle trips made by them. Additional analysis will be undertaken on the role of bicycle trips to determine the purposes for which they are used, where they are most likely to be used, and the time they are used. This is important for the planning of mixed traffic zones and bicycle ways, particularly in Sydney's Central Business District. This will be further analysed when geocoding is completed.

Walk trips are widely spread among all age groups with majority coming from the 11-20 years old. More walk trips are made by the young (<20 years old) and old (>60 years old) as a percentage of all trips by each age group. Persons aged between 41 and 50 years are least likely to make walk trips, probably because this group has the best access to both a private or company car. Another reason could be that the majority of workers are between the ages of 30 and 50 with daily trip making pattern more or less constrained by their working time. On the other hand, the older groups usually do short trips to shops and personal business trips.

Those using cars are more likely to be between 31 and 40 years old. Car trips are predominant across all age groups, with younger people more likely to be passengers and older ones (aged 31 to 50) more likely to be drivers. The above results indicate that car usage and age are not linearly related.

Trip Purpose Profiles

The purpose of trip is an important consideration in analysing trip making behaviour because the decision-making processes tend to vary with the type of trip. For example, the decisions behind a trip to work are stable over long periods of time. This is one of the main reasons why forecasting models in the past have concentrated on journey-to-work trips. In contrast the decisions behind shopping trips may vary more with time, destination and possibly mode.

There is, however, a growing professional consensus that modelling should concentrate not only on work trips. Looking at the characteristics of all types of trips will give time of the day, mode, and by whom the majority of different trip types are made. This will give the modeller an idea of how different and how complex are the choice structures behind each trip purpose.

Trip Purpose by Time of Day

Figures 4a, 4b, and 4c show the hourly profile of trips by purpose, distinctively showing the peaking characteristics of some trips, such as education, work and serve passenger trips in the morning and trips to home, social/recreational and serve passenger in the late afternoon. Employer's business and personal business trips show less peaking characteristics as they are more evenly spread throughout the day (until about 4:00 PM). An AM Peak model would therefore capture most of the journey-to-work, education and serve passenger trips while a PM Peak model would capture to home, serve passenger, social/recreational and some shopping trips. An Off Peak model would capture majority of personal and employer's business and some shopping trips.

Trip Purpose by Household Income

Figure 5 shows the importance of serve passenger trips even for low income households. The number of social/recreational trips made by each household increases slightly as the household income increases. Work trips become more prominent as the household income increases. The number of trips each income group allots to a particular purpose does not vary substantially across all groupings. Therefore, household income is not a useful explanatory variable for trip purpose modelling but can be suitable for mode choice modelling within each trip purpose.

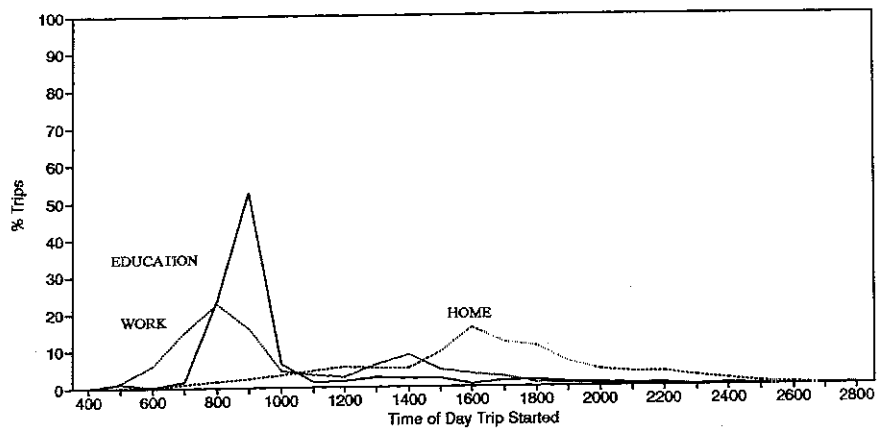

Fig 4a. Percent Share of Trips by Purpose and Time of Day

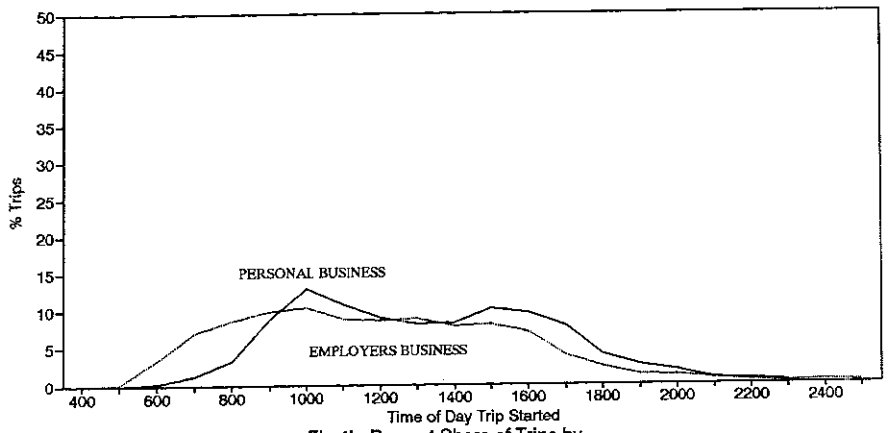

Fig 4b. Percent Share of Trips by Purpose and Time of Day

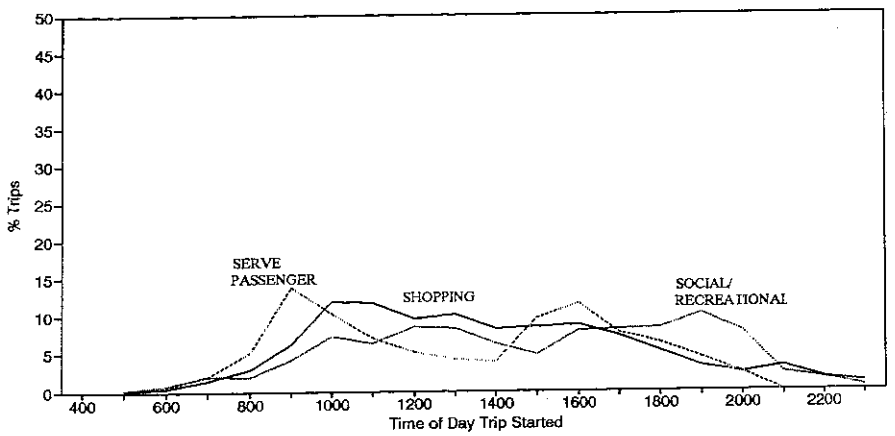

Fig 4c. Percent Share of Trips by Purpose and Time of Day

Trip Purpose by Vehicle Ownership

Figure 6 shows the proportion of particular purpose trips made by each vehicle owning group. More employer's business trips are made by persons belonging to households with access to a car and the number of employer's business trips increases even further once a company car is available to the household.

It is interesting to note that although more than half of all social/recreational trips are made by persons belonging to greater than 1 vehicle owning households, the number of social/recreational trips as a proportion of all trips made by each vehicle ownership group is similar. In other words, vehicle ownership does not seem to influence each group's propensity to make social/recreational trips.

Some of the variations in trip making by company owned and privately owned cars are: (1) company cars are used more frequently for employer's business trips than private cars, as expected; (2) private cars are used more for shopping, school and serve passenger trips; (3) no substantial difference in the use of company or private car for social and recreational trips. Trips to school is the least served purpose by car.

Overall, private car trips have a large share of all trips by car. This share however, goes down slightly for work-related trips, particularly employer's business where there is an increasing preference for the use of a company car.

It was mentioned above that car captivity for company car owning households seems to be important in journey-to-work modelling. Here it is shown that it becomes even more important in modelling employer's business trips.

Trip Purpose by Mode

Figure 7 shows that, aside from serve passenger, people tend to use their cars most to go to social or recreational activities and shopping. It also shows that a large proportion of people tend to use train for their work trip. The fact that bus doesn't show up as markedly may be due to the mode definition which includes bus-ferry and bus-train trips as ferry and train trips respectively. Shopping and social/recreational trips stand out as purposes most likely to be accessed by walking. Shopping trips are generally short trips, being made to a centre close to the place of residence. In modelling shopping trips, therefore, 'walk' is an important alternative to car. On the other hand, 'train' becomes an important alternative to car in journey-to-work modelling.

Trip Purpose by Mode and Average Travel Time

The average travel times by car were found to be lower than by public transport. Travel time (door-to-door) maybe a significant explanatory variable in the choice of mode, for the journey to work.

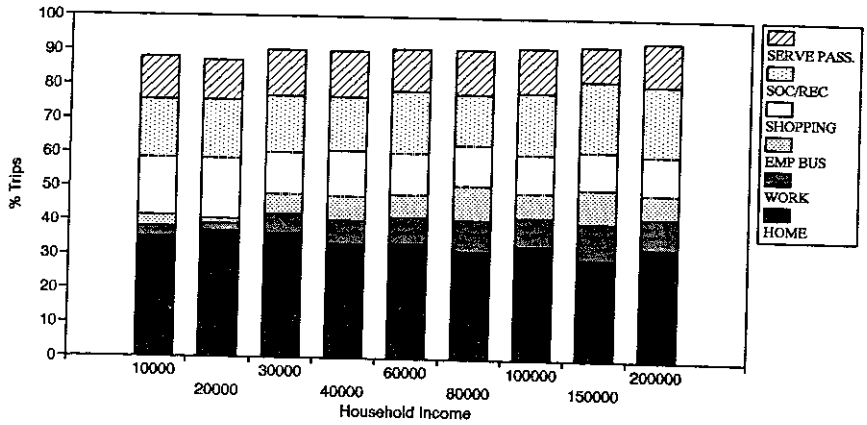

Fig 5. Percent Share of Trips by Purpose and Household Income

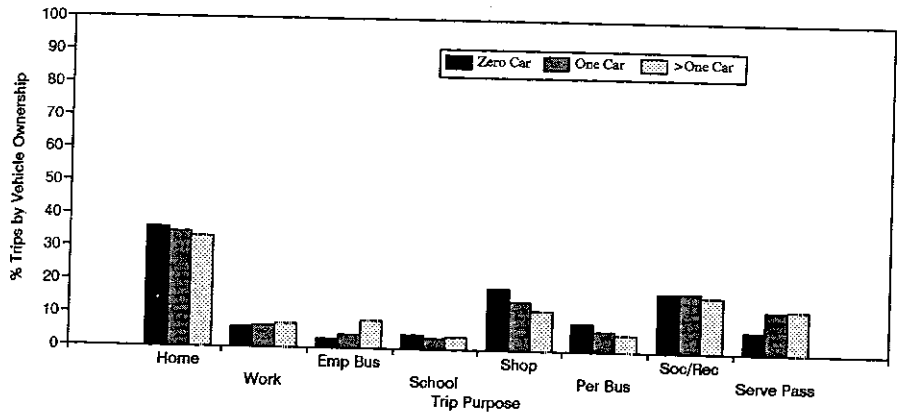

Fig 6. Percent Share of Trips by Purpose and Vehicle Ownership

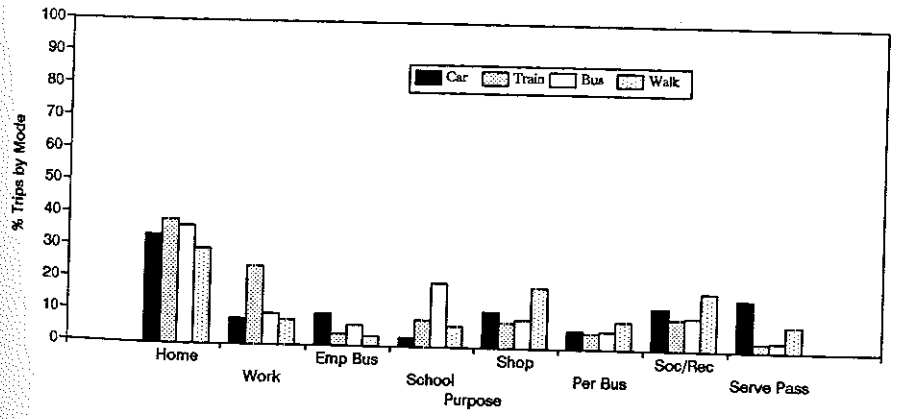

Fig 7 Percent Share of Trips by Purpose and Mode

For car journeys, the journey to work is longer than any other purpose. The least amount of time is spent shopping and serving/accompanying passengers. This may be due to shopping opportunities being closer to home than are work opportunities. This may imply that travellers are willing to expend more time and money for a trip that produces a direct monetary benefit.

For all trip purposes, travel times by public transport are longer than by private transport. A significant component of public transport time is access and egress, and waiting times. Walk and taxi trips also have low travel times, largely because these modes are used for shorter distance trips.

Time of Day Profiles

Another nagging issue in modelling is whether to model AM peak only as traditional practice suggests. As Figure 4 shows, the majority of to-home trips will not be captured if only AM peak is modelled while personal business and shopping trips will only be captured if an off-peak model is calibrated. The variability of trip characteristics by time of day and also by day of week needs to be considered because policies that are intended for the working population, may pose unforeseen equity issues for the non-working population.

Time of Day by Mode

From Figures 8a and 8b, it is clear that public transport facilities (bus, train, ferry) are used more in the morning and afternoon peaks, which roughly coincide with start and finish times of work and school. Trips by car also show peaks at around 9:00 AM and 3:30 PM, with a trough around 12:30 to 1:00 PM. However, the frequency of car trips between the morning peak and mid-day is relatively flat compared to public transport.

Modelling Implications

What Modes to Consider?

One of the first considerations in modelling is which modes to include. The Sydney Urban Travel Model (SUTM) 1971 and 1981 used only private transport vs. public transport. However, it becomes essential to look at modes more specific than just public and private transport because it is necessary to look at specific alternatives to car, such as bus, train, carpool, etc.

The size of the share of each mode could be a consideration in determining the modes to include. Only those modes with a major share need to be included.

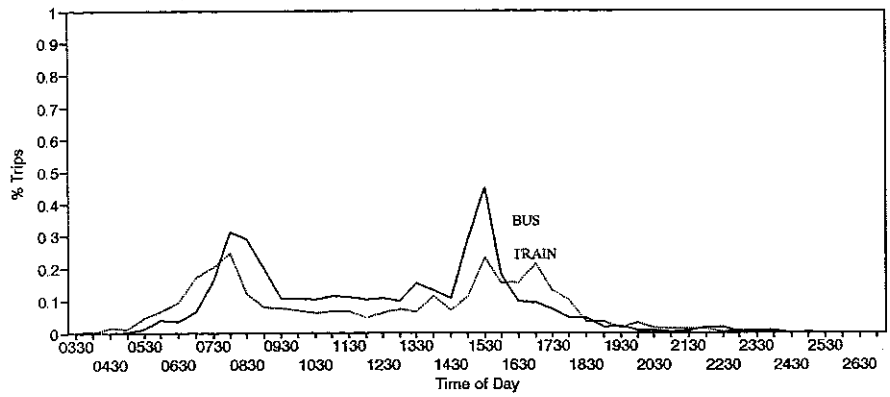

Fig 8a. Percent Share of Trips by
Time of Day and Mode

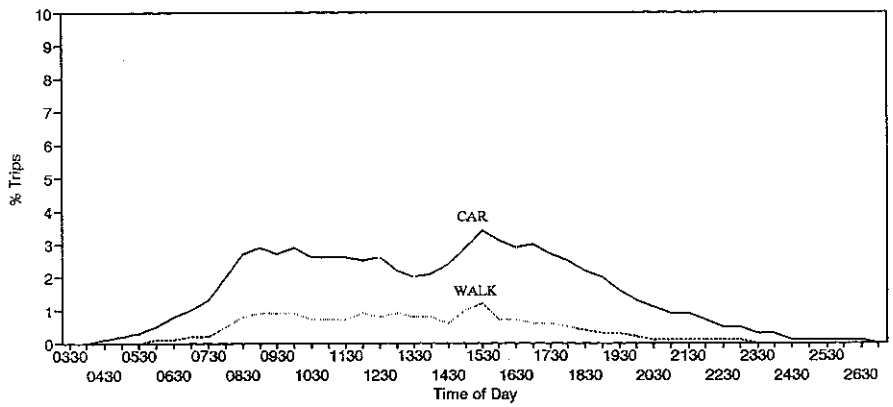

Fig 8b. Percent Share of Trips by
Time of Day and Mode

In modelling on an interzonal basis, it is safe to assume that 'walk' trips are not a viable alternative to faster modes. Alternatively, the proportion of walk trips made for a range of distances could be removed before modal split or choice analysis. The 1981 SUTM adopted a relationship between the proportion of 'slow' trips (bicycle, walk, taxi and other as coded in the 1981 HIS) and the highway distance between the production and attraction zone. This was used to remove 'slow' trips from all trips before modal choice/split analysis. This method creates a restriction in forecasting future demand since it assumes that the existing relationship between the share of walk trips and highway distance remains true in the future.

The issue of combining bus and train into one public transport mode also needs to be addressed. One needs to consider whether the difference in the level of service characteristics of bus and train as well as the different uses or purposes that travellers have in using them is enough justification to treat both as competing modes. It may be that one mode augments the other, and in such a case, they may reasonably be treated as one mode.

Another issue is the traveller's framework of choice. How does a traveller decide which mode to take? Will the traveller first decide between public or private transportation, and then between bus or train when public transport is chosen, or are the three options weighted together? These are the choice scenarios that should be tested during the modelling process. It is also necessary to use choice-based models that reduce sample size bias because of the overwhelming majority of car trips.

What are the possible explanatory variables for mode choice?

The results of the 1991 HIS indicate that among the socio-economic variables, household income, vehicle ownership and household size are potentially significant factors that explain traveller's choice of mode. This is strongly shown by the regression results in Table 1 where the t-values and R^2s are high. Household income has a directly proportional relationship to the share of car trips as does vehicle ownership and household size. Conversely, an inverse relationship exists between the share of public transport and household income, vehicle ownership and household size.

As discussed previously, it is counterintuitive that car usage should increase with household size because a bigger household should entail more people sharing the household car(s). This relationship exists because household size is directly proportional to vehicle ownership. Vehicle ownership is also directly proportional to household income.

Age, although not having a linear relationship with car usage, was also observed to be a potentially significant variable because of the substantial variation in mode preference shown by different groups. 'Lifecycle' may prove to be a significant explanatory variable.

Company car availability is another variable which explains mode choice. Intuitively greater confidence is achieved if persons with access to a company car are considered captive to car mode. Company car availability, however, may prove

difficult to forecast as it is known to be sensitive to government policies such as taxation. If regulations were to change significantly such that the number of company cars were to drop, it may be very difficult to predict the impact say 10 years into the future. Thus, the inclusion of company cars in a model that is aimed at strategic modelling is questionable but extremely useful for short to medium term tactical modelling.

The other issue which is equally important is the policy relevance of the variable. For example, what government policy instrument affects household size or age? What are the current strategies of the government and which policies are likely to be important in the future? Is vehicle ownership likely to be curbed or is it possible that owning a licence could be more strictly regulated? In considering the right explanatory variables, it is therefore not only the statistical significance of the variables that is used as a yardstick but also policy relevance of the variables.

Modelling decisions have to be made on which variable should be retained and which should be dropped. As the above analyses show, there is a positive relationship between household income and car usage, vehicle ownership and car usage, and household size and car usage. If household size, household income, and vehicle ownership are significantly positively correlated, using all three variables together in a model may create problems of multi-collinearity, as their impacts tend to cancel each other. It also implies that one of the variables in a pair of correlated variables may be dropped from the equation. This may prove beneficial if one is difficult to forecast and/or is not policy relevant.

Table 1. Linear Regression Analysis

Variable		Parameter Estimate	T-Value	Constant	R^2
Independent (X)	Dependent (Y)				
Household Income ('0000$)	Car Trips Share (%)	0 0090	6 10	0 680	0 823
	Bus Trips Share (%)	−0 0021	−5 58	0 047	0 795
Vehicle Ownership	Car Trips Share (%)	0.3220	2.62	0 231	0 873
	Bus Trips Share (%)	−0 0660	−1 96	0 144	0 793
	Train Trips Share (%)	−0 0390	−3 34	0 091	0 917
	Public Transport	−0 1090	−2 30	0.235	0 841
Household Size	Car Trips Share (%)	0 0430	3 15	0.574	0.768
	Bus Trips Share (%)	−0.0090	−1 70	0 072	0 490
	Train Trips Share (%)	−0.0080	−4.24	0.060	0 857
	Public Transport	−0.0180	−2 38	0 131	0 655
	Walk (%)	−0.0220	−3.77	0.266	0.826
Vehicle Ownership	Average Household Size	0 7420	16 14	1 867	0 992
Vehicle Ownership	Average Household Income	1.709	44 56	1 635	0 999

Socio-economic variables are only part of the travel demand dimension. Levels of service (LOS) variables such as travel time are regarded as direct explanatory variables of mode choice and play an important role in predicting changes in ridership share. For example, changes brought about by increases in bus fares or the introduction of tolls will affect bus patronage and car usage. LOS variables such as in-vehicle time, waiting time, access time, number of transfers, are known to have highly significant explanatory power in mode choice modelling (as in 1981 SUTM). Thus, the fewer the number of socio-economic variables, the simpler the model and the more policy relevant since the LOS variables are direct policy variables.

Socio-economic variables are more useful in identifying target groups, e.g. who will be affected by the introduction of a toll road, who uses which mode, etc. The importance of grouping individuals into homogeneous groups cannot be over-emphasised. Cross-tabulation or cross-categorisation is a simple yet effective way of identifying, for example, who are the public transport users and who are captive to car mode.

Peak, Off-Peak and 24-Hour Modelling

Peak modelling measures the period of maximum congestion on the network while off-peak and 24-hour modelling measures the total costs of travel. Several issues need to be evaluated in order to decide between AM peak, peak (AM and PM), off peak, and 24-Hour modelling. AM Peak modelling will capture the majority of trips to work, education and serve passenger. It will also capture most public transport trips. The advantage of modelling in the AM peak is that there is a more defined mode split and a singular trip purpose, to work, that can be more easily isolated than for a 24-hour period.

The technique adopted in the past was to model AM peak home-based work trips only since the focus was on capacity planning. The total number of home-based work trips disaggregated by highway driver and passenger, public transport, and slow trips were then expanded to total morning peak trips using expansion factors. This avoided the more complex multi-purpose modelling of all possible purposes. The 1981 SUTM, for example, developed modal expansion factors for two home-based work purposes (manufacturing and other) rather than model each trip purpose separately. The two home-based work trips by each mode were expanded according to a transit or highway disutility relationship and employment density at the attraction zone. These are pragmatic shortcuts but their reliability in forecasting future behaviour is suspect.

The afternoon peak actually consists of several peaks, one for children leaving school, the second and wider peak for people departing from work, and the last for social and recreational trips beginning in the late afternoon. The peak is therefore more diverse and widespread.

Modelling off-peak travel may be useful in understanding the needs of special groups of users. Evidence suggests that the purpose of trips and socio-economic characteristics of trip makers in the off-peak period are different to trip makers at other times of the day.

A 24-hour model would capture a variety of trip purposes, various types of trip makers (i.e., workers, school children, the aged), and multi-leg journeys. There may be a need, in this case, to model a 'tour' which involves several purposes and destinations.

Depending on the period being modelled, it has been shown that certain types of trip purposes will be captured. In the AM peak for example, both home-based work trips and school trips should be included in modelling. If PM peak, to-home trips, business trips and social/recreational trips should be included in the model. This may mean redefining 'linked trips' so as to include other purpose trips. Short trips to shop and picking up children from school while on the way home may be grouped into one journey-to-home. With the 1991 HIS database, this sort of redefinition is easily achieved.

Importance of aggregate and disaggregate models

Disaggregate analysis is important for understanding the behavioural mechanism behind when and how to travel. Aggregation on the other hand, is useful to forecast how many will travel, when and by what mode. It should not be construed that analysis and modelling can only be done at an individual level. If the traffic zone is homogeneous in socio-economic and transport level of service characteristics, then there is no reason why analysis cannot be done at traffic zone level.

The aim of modelling is to identify which factors make individuals behave differently and to quantify the degree of importance of those factors. It has been identified that the greater the variability of a factor that defines a distinct choice, the better it explains the particular choice. Thus, models estimated at a more disaggregate level tend to pick up more factors (and a greater variability within these factors) and therefore perform better for policy analysis.

Strategic planning has always been associated with aggregate models as a result of its focus in long-term scenarios and forecasts. Often, however, we are interested in short to medium range scenarios, e.g.: how would the introduction of a toll affect the traffic volume on a road; how would running more trains during peak periods or a more reliable timetable affect train patronage; how would improving bus access affect patronage? Disaggregate models are particularly useful in addressing these short to medium term policy issues.

When to aggregate?

Because trip making is essentially the product of the decision-making processes of an individual or group of individuals, travel demand has to be analysed from a disaggregated viewpoint. However, the analysis has to be translated into a macro model of the study area. Aggregation problems arise when the within-zone variance of the explanatory variables are significantly higher than the between-zone

Table 2 Standard Deviation of Zonal Data, HIS 1981

Standard Deviation	*Variable* *No. of Cars Owned*	*Maindrv of HH Car*	*Personal Income*
Mean w/in zone	.9119	.50293	7237.7
Between zone	.3375	.07602	852.8

variance. From 1981 HIS, it has been observed that the within-zone standard deviation is significantly higher than the between-zone standard deviation as shown in Table 2. The 1991 HIS data is still to be analysed.

Aggregation is not only possible via geographic grouping. Individuals can also be grouped using socio-economic variables, otherwise known as market segmentation. Table 3 indicates a segmentation via vehicle ownership, age group and mode choice. This type of segmentation is useful in identifying car, bus and train users. It is shown that while car usage tends to increase with vehicle ownership, within a particular vehicle ownership category, the propensity to use bus or train as opposed to car is very much determined by the age of the trip maker. It is shown that public transport patronage peaks between the ages of 11 and 20 for all vehicle ownership categories. The effect of age is even more pronounced in the

Table 3. Percentage Share of Car, Bus, and Train Trips

Vehicle Ownership	Age Group	Modes Used		
		Car	Train	Bus
Zero Car	1–10	55.6%	4.4%	40.0%
	11–20	43.5%	15.7%	40.9%
	21–30	35.5%	25.9%	38.6%
	31–40	30.2%	35.7%	34.1%
	41–50	43.5%	29.0%	27.4%
	51–60	34.0%	39.6%	26.4%
	>60	37.4%	16.5%	46.1%
One Car	1–10	94.7%	0.8%	4.5%
	11–20	76.4%	9.1%	14.6%
	21–30	89.5%	7.1%	3.4%
	31–40	93.2%	5.3%	1.5%
	41–50	90.7%	4.7%	4.7%
	51–60	89.8%	6.1%	4.1%
	>60	92.6%	3.7%	3.7%
>One Car	1–10	93.4%	0.5%	6.1%
	11–20	87.0%	4.6%	8.5%
	21–30	94.2%	3.7%	2.1%
	31–40	98.4%	1.3%	0.3%
	41–50	98.0%	1.2%	0.7%
	51–60	96.5%	2.3%	1.2%
	>60	93.3%	2.4%	4.3%

zero vehicle ownership category, where the young (20 and below) and the aged (60 and above) tend to use bus more whereas the middle aged (40-60) tends to use train. Segmentation by lifecycle, vehicle ownership and household income did not show meaningful results.

Table 3 shows a 'synthetic' but analytically valid grouping of individuals which could probably be more valid in modelling than zonal grouping which reduces within group variance due to the grouping of individuals with similar characteristics. This type of grouping can be used to expand the sample.

Summary and Conclusions

This paper presents a preliminary review of the 1991 HIS based on currently available data. It focuses on several items believed to be most relevant in modelling and presents an overview of the various factors involved in trip making, in particular mode choice. Several variables have been identified and assessed as possible factors affecting individual choice: vehicle ownership, household size, income, and age. It is important to remember, however, that an individual's travel behaviour is very complex and intrinsically difficult to model.

The decision on what attributes to include in the modelling process is also addressed. Several factors were identified as important, including policy relevance, forecastability, statistical consistency and efficiency and whether multi-collinearity exists. Another important aspect is the type of model being developed. Tactical models require the inclusion of more policy sensitive variables. They need to reliably predict changes in trip making due to changes in socio-economic and levels of service circumstances. These variables need to be consistent and efficient estimators of choice. Long-range or strategic models require less variables since the aim is to forecast travel demand well into the future. As more factors are included in the model, it becomes more difficult to forecast. In addition, the more disaggregated the model, the more procedural problems are encountered in aggregating from individual to zone data. One technique for avoiding the zonal aggregation problem is to utilise market segmentation.

Other issues raised include the decision between binary or multi-modal modelling, the importance of disaggregate and aggregate models, when to aggregate, and peak vs off-peak modelling. It is relevant in the current economic and environmentally sensitive climate to include attributes that can evaluate changes in travel demand and behaviour due to the introduction of policies promoting demand management, traffic management, traffic calming schemes, and further public transport development. This would result in more complex models which are perceived to be more reliable and accurate but would require more time and money to develop. Hence, tradeoffs eventually have to be made between accuracy, reliability, temporal and spatial stability and budget constraints.

References

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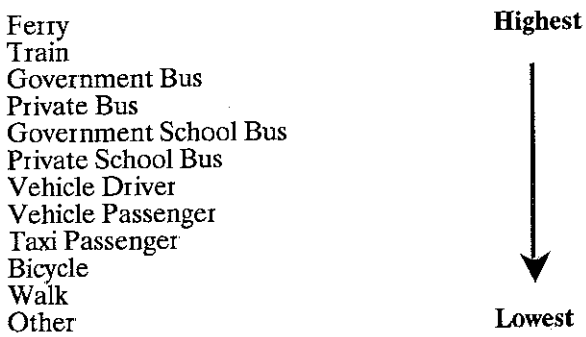
Appendix 1. Some Data Definitions

1. Trip - A trip is any movement on a public street with a distance greater than 100 metres. Movements of less than 100 metres are also called trips if the purpose of travel changes.

2. 'Linked Trip' - Some trips may involve the use of several modes. For example, a person who travelled first by car to a station, then by train, and then walked the remainder of the way to the workplace, is traditionally considered to have made only one 'linked' trip. While the purpose of each stop was to change mode, the 'linked' trip had only one purpose - to go to work. The data used in this paper is based on trips using this concept.

3. 'Priority and Hierarchy Mode' - The case of linked trips presented problems in assigning a particular mode to the entire trip. In order to easily present such trips, the 1981 Travel Survey adopted the concept of 'hierarchy' mode. All the modes were arranged according to the measure of 'importance' set out below:



Another classification adopted in the 1991 Travel Survey involved the selection of the mode which had the longest trip duration (in minutes). In cases where two or more modes had similar travel times, the hierarchy set out above was then used to select the 'priority' mode.