Public Transport or Private Vehicle: Factors That Impact on Mode Choice

Grace Corpuz
Transport Data Centre, New South Wales Ministry of Transport, Sydney, NSW, Australia

1 Introduction

In New South Wales, the state government formalised its commitment to sustainability in transport by stipulating as one of its key priorities in the 2006 State Plan its aim of "increasing share of peak hour journeys on a safe and reliable public transport system". This objective identified the following two targets pertaining to the use of public transport (Premiers Department, 2006):

- Increase the share of trips made by public transport to and from the Sydney CBD during peak hours to 75% by 2016 (currently 72%).
- Increase the proportion of total journeys to work by public transport in the Sydney metropolitan region to 25% by 2016 (currently 20-22%).

Considering the sustained and pervasive popularity of the private vehicle not only in Sydney but in most major cities, this objective presents a challenge. In 2004, public transport accounted for 10.2% of all trips made by Sydney residents on an average weekday, down from 1991 when the level was 11.9%. The private vehicle has been encroaching on this share capturing most of the decline in the usage of other modes to exhibit a gain in its share from 66.9% to 70.5% in the same period. In the morning peak, the story is the same with public transport share decreasing from 17.3% to 15.6% compared to private vehicle share which increased from 65.3% to 69.9% between 1991 and 2004 (TPDC, 2006).

What makes people use or prefer the car more than public transport? What will facilitate the use of public transport? An understanding of the factors that affect mode choice is essential to the promotion of more sustainable behaviour and the achievement of the state's transport targets.

In this paper, we analyse the Transport Data Centre's (TDC) Sydney Household Travel Survey (HTS) data to assess the factors affecting mode choice. We also identify areas where public transport use may have the most potential for expansion subject to focused intervention.

2 Scope and aim of this paper

Techniques to study and quantify the mode choice process have been in use and development for decades. The methodologies are involved and reflect the complexity of the travel behaviour, the range of factors that impact on the choice process, the interaction between variables during decision-making and the variability due to the diversity of travellers making these decisions themselves. These approaches mathematically model the choice process in what Hensher et al (2005) refer to as a 'multi-attribute environment' taking into consideration the effects of influencing variables not singularly but conjointly.

In contrast to these multi-variate techniques which are normally applied to measure and predict car and public transport demand, this paper primarily uses simpler univariate and qualitative approaches by analysing the effects of the influencing variables individually in turn. As a further support, related results from multi-variate approaches are also provided where available. The purpose is to clarify and describe the relationship and/or impacts of each factor to mode choice in order to facilitate understanding for policy-oriented

applications. This paper analyses empirical data from the Household Travel Survey to (a) identify factors that affect mode choice, (b) describe the impacts and, (c) determine which variables analysed exhibit high potential for policy intervention.

Ortuzar and Willumsen (2001) provide a useful list of factors known to influence the choice of mode in three main groups: attributes of the traveller, attributes of the journey and characteristics of the transport facility. The analyses in this paper will examine characteristics falling under these three groups focusing largely on those that may be tested using data available from TDC's Household Travel Survey.

Mode choice and usage will be discussed in relation to the following aspects:

- Socio-demographic characteristics of traveller
- Trip purpose
- Time of day
- Access and frequency of public transport
- Parking, travel time, convenience and cost

2 The Sydney Household Travel Survey

The Sydney Household Travel Survey (HTS) is the largest and most comprehensive source of personal travel data for the Sydney Greater Metropolitan Area. This area includes the Sydney and Illawarra Statistical Divisions and the Newcastle Sub-Statistical Division (Figure 1). The investigation in this paper will be confined to travel by residents of the Sydney Statistical Division (SD) only.

The HTS is the longest running household travel survey in Australia. It began in 1997 and has been operating continuously since then. The survey collects detailed trip information for each day of the year by face-to-face interview. Socio-demographic information about the residents of the selected household are also collected.

For further details about the HTS, its scope, coverage and methodology, please see TPDC (2006).

Figure 1 Sydney Greater Metropolitan Area

3 Socio demographic characteristics

Figure 2 shows the differences in mode usage in relation to a number of socio-demographic characteristics. Many of the variables are clearly correlated with mode usage with some groups using the car or public transport more than others.

The groups who use the car more and public transport less than others are:
- The under 11s, the working age group (31 to 60 year olds), even the 61 to 70 year olds
- The workers as well as the unemployed or keeping house
- Those with vehicles especially those in multi-vehicle households
- Those in couple with children households
- Those households with higher incomes

The groups who use public transport more than others are:

- The 11 to 20 year olds
- The students
- Those with no licences
- Those with no vehicles in the household

Among the different socio-demographic characteristics, the analyses suggest that access to a vehicle appears to have the greatest impact of enhancing vehicle use. Conversely, the lack of access to the vehicle is associated with lower vehicle use and higher public transport use. This is evident in the stark contrast in the mode split between those who hold licences and those who do not, and can also be observed in the difference between those in households with none and those with vehicles.

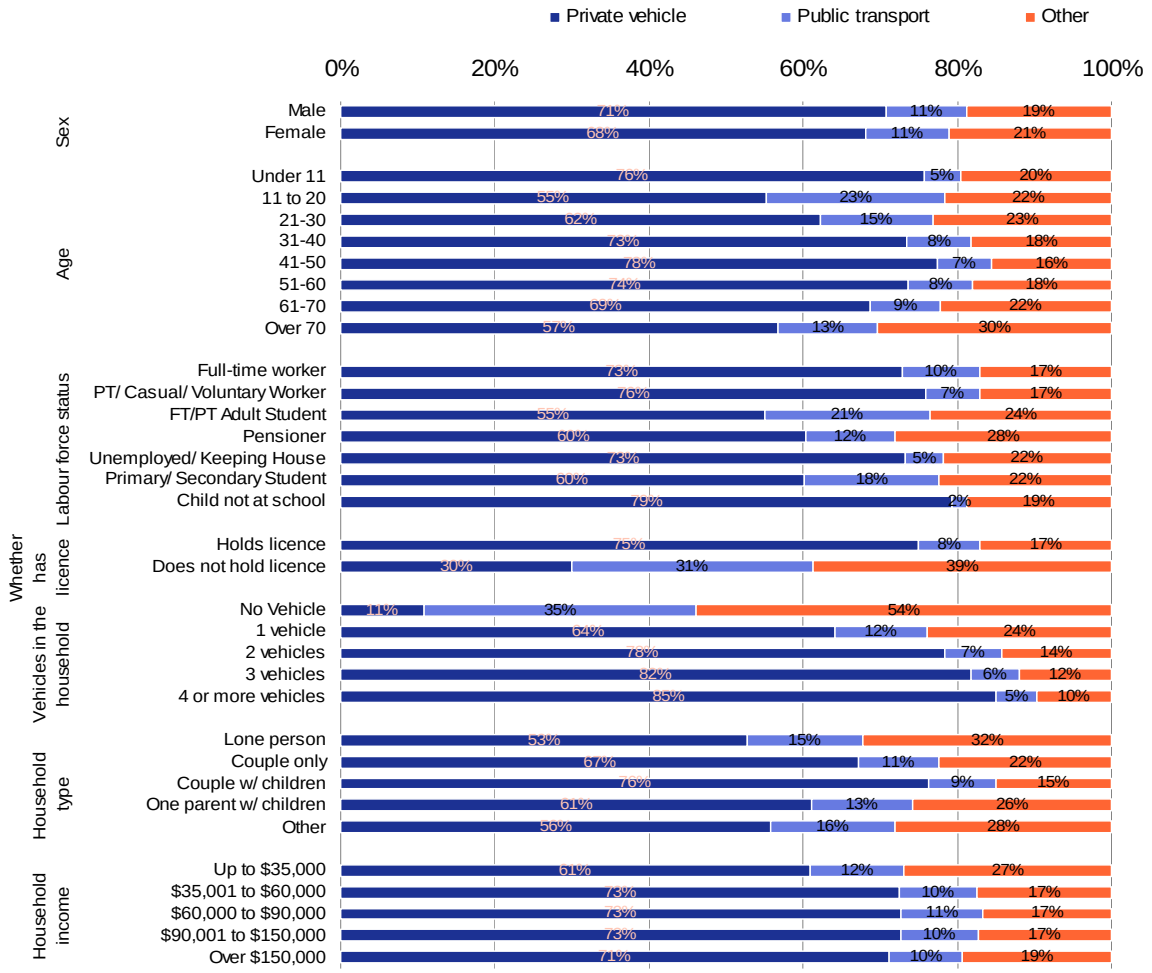

Figure 2 Mode[1] usage by socio-demographic characteristics
Average weekday, 2004

Those with no vehicles in the household had only 11% of their trips by car. This share is multiplied almost six times to 64% for those with just one vehicle indicating that the impact is largest at this point. Car share rises by a smaller but still considerable magnitude of fourteen percentage points with the second vehicle, a further four points for the third vehicle and another three points for those with four or more vehicles. The shares of public transport as well as other modes (predominantly walking) exhibit the same diminishing effect except that these are contracting as a result of the expansion in car share. Clearly, the effect on mode

[1] 'Private vehicle' includes driver and passenger trips. 'Public transport' includes train, bus and ferry. 'Other' is mainly walking with other modes.

choice is most significant up to the second vehicle and the impact appears to decline rapidly beyond this number.

Results from TDC's VKT (Vehicles Kilometres Travelled) Regression Model confirm these findings. The model identified the number of vehicles in the household to be positively correlated as well as being the strongest influencing factor on VKT, accounting for over half of the explained variability in the VKT generated by the household [1]. However, there was no clear evidence of diminishing impact in the multi-variate analysis. (Corpuz, McCabe and Ryszawa, 2006).

These results suggest that policies and/or urban planning scenarios that impinge on the access to the vehicle, and in particular access to more than one vehicle could potentially have a significant impact in reducing car use and promoting more sustainable modes.

4 Trip purpose

The private vehicle is the most frequently used mode for every trip purpose but its share varies in relation to public transport depending on the reason for travel. Figure 3 shows that car use is highest for work-related (89%) and serve passenger trips (88%) which by their very nature are probably most captive to this mode. Public transport use, on the other hand, is highest for educational (27%) and commute (20%) trips.

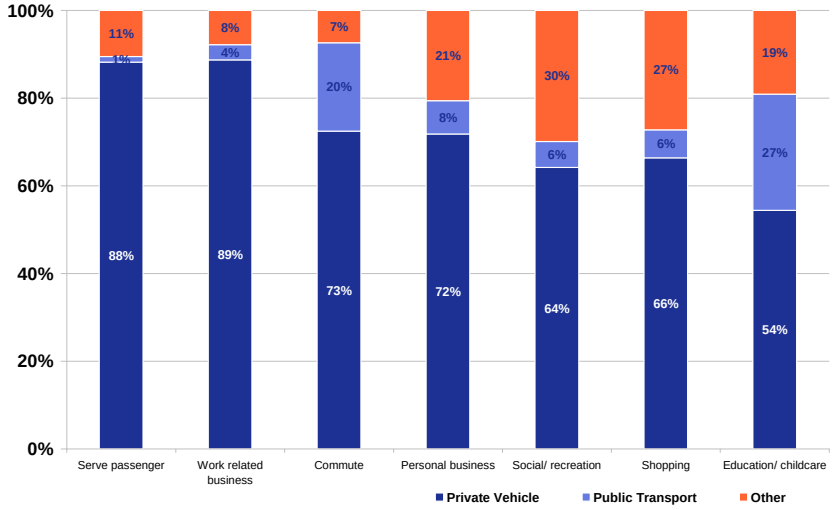

Figure 3 Proportion of trips by purpose and mode[2] on an average weekday, 2004
Source: TPDC 2006, p10

These analyses clearly indicate that mode choice varies by trip purpose. However, is it the purpose of travel that defines the choice of mode per se? A closer look will reveal that it is most likely the *characteristics of* rather than just the trip purpose itself together with other variables that exert an effect on mode choice. For example, the comparatively higher public transport use for educational trips in Sydney can be attributed to lower travel costs afforded by the free school pass to qualified students. In addition, the demographics of the group that undertake these trips are predominantly young with limited access to a private vehicle.

For commute trips, public transport also has a relatively higher share. This is especially the case for work trips into the Sydney CBD where the parking arrangements along with high public transport serviceability promote its use while deterring car travel.

[1] More precisely, the number of vehicles in the household explains over half of the explained variability in the *square root* of VKT
[2] 'Private vehicle' includes driver and passenger trips. 'Public transport' includes train, bus and ferry. 'Other' is mainly walking with other modes.

This pattern suggests that trip purpose is probably not the single most important determinant of mode choice and may not be the critical aspect for policy intervention. Focus should be directed to understanding the characteristics of the trip purpose that drive the choice to identify the issue that may be better targeted. However, the analysis indicates that the potential for public transport use is greatest for commute and educational trips.

4 Time of day

The distribution of travellers by time of day shows that the private vehicle is the most used mode consistently throughout the day (Figure 4). Train and bus use picks up during the morning and late afternoon peaks when congestion puts the greatest pressure on travel time and costs making the car comparatively less attractive during these periods. In comparison during the midday period when there are less traffic pressures and public transport services are not as frequent, car use almost completely dominates among the motorised modes.

This implies that public transport improves its viability relative to the car during the peak periods when the former maximises its speed, cost and service frequency advantages. However as Figure 5 would show, the magnitude to which public transport usage increases relative to the car during the peak periods is not substantial. To the extent that the speed and cost differential between the two modes during the peak periods can be enhanced will probably exert a stronger impact on mode shifting. This can be ascertained from the higher public transport usage during the more congested AM peak period in comparison to the PM peak.

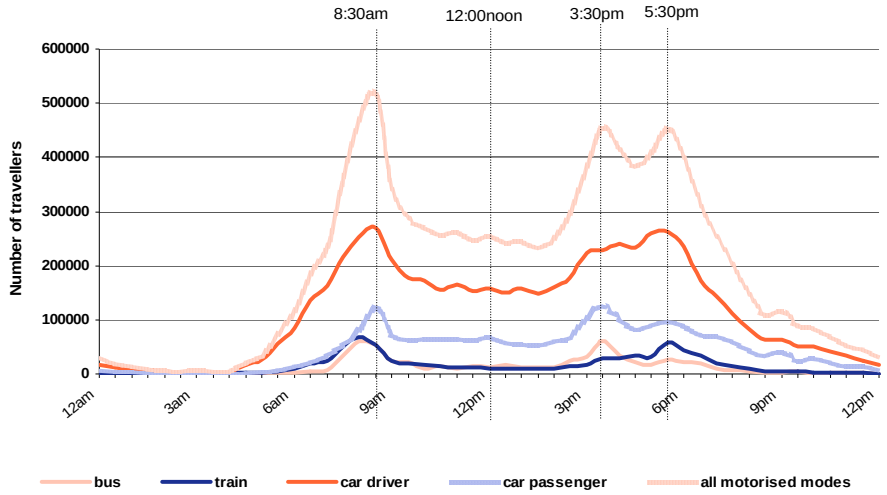

Figure 4 Number of travellers on motorised modes by mode and time of day Average weekday, 2004

Source: Corpuz 2006, p2

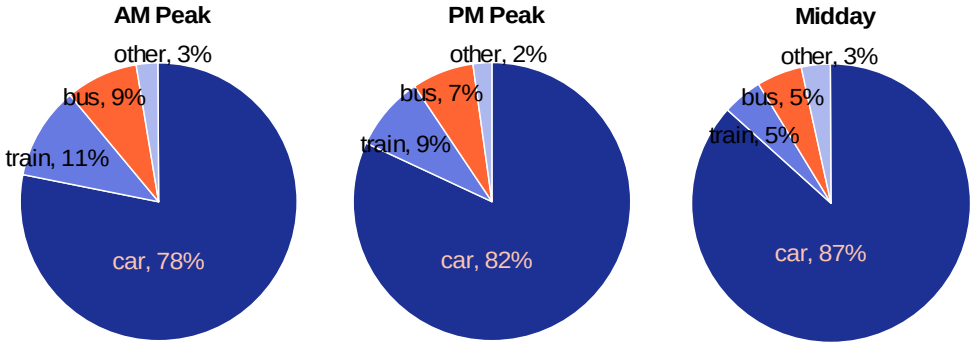

Figure 5 Distribution of travellers by mode by time period , Average weekday, 2004

5 Access and frequency of public transport

Evidence from the HTS shows that about a third who use the private vehicle for their trip to work do so because public transport is inaccessible or unavailable (Figure 8 on page 9). However, accessibility once available does not seem to necessarily translate to public transport use. This can also be seen from the HTS data which show that only about 16% of commuters using public transport do so because of access either at the place of residence or work (Figure 7 on page 8). This percentage is not particularly remarkable especially when compared with the proportions which cited parking problems or lack of vehicle access. This suggests that accessibility though positively correlated to public transport use may not be exerting as strong an impact as may be expected.

Related results from a multiple regression model developed by TDC using HTS data show similar findings. The model indicates that accessibility to public transport from the place of residence is associated with lower levels of VKT (vehicle kilometres travelled) by the household. Specifically, the study found that the better the access[1] is from the household's dwelling to a high frequency train, bus or ferry, the less VKT is generated by that household (Corpuz, McCabe and Ryszawa, 2006). This pattern can be seen in Figure 6 which shows lower levels of VKT around key transport nodes, particularly along train lines compared to other areas. Based on the model however, public transport access accounts for only about 17% of the explained variability in VKT[2] and is only secondary to that of the number of vehicles in the household which accounts for over half of the variability.[3]

In Australia, Luk et al (1998) similarly found in a review of four cities that enhancements in public transport, particularly in rail resulted in a reduction in car travel but that the impact was insubstantial and localised. It has also been suggested that significant investments into public transport improvements will have to be made to achieve marked increases in public transport share (Hensher, 1998). In a related study of UK companies, results indicated that not all car commuters will change to public transport even if improvements were made. The results differed by company but between 38% to 57% 'would consider' or 'would possibly' shift. Only 17% of car commuters in one company actually would (Kingham, Dickinson and Copsey, 2001).

Since massive investments into infrastructure are becoming scarce in a climate of prudent fiscal management, it will be necessary to maximise the effectivity of smaller-scale improvements. Policy should probably address accessibility and other improvements in public transport not in isolation but along with interventions that consider other factors that may amplify the benefits and which are less costly to implement.

[1] Access as defined in the model is a composite of the distance to the transport facility and the frequency of the service. Specifically, it is defined as the sum of the walk time in minutes from the dwelling to the nearest high frequency (at least one service every 15 minutes) transport facility and wait time (half of the frequency in minutes).

[2] More precisely, public transport access accounts for 17% of the explained variability in the *square root* of VKT

[3] The TDC study did not examine the relationship of accessibility to PKT (passenger kilometres travelled) so it was not established whether the former was associated with higher public transport use. Another study using empirical evidence for Toronto showed that variables representing the level of transit service are positively correlated with transit passenger kilometres travelled (PKT). The study also found the relationship to be among the strongest but only in comparison to the other variables in a model with an R^2 of only 0.329. (IBI Group 2000, pp 27-35).

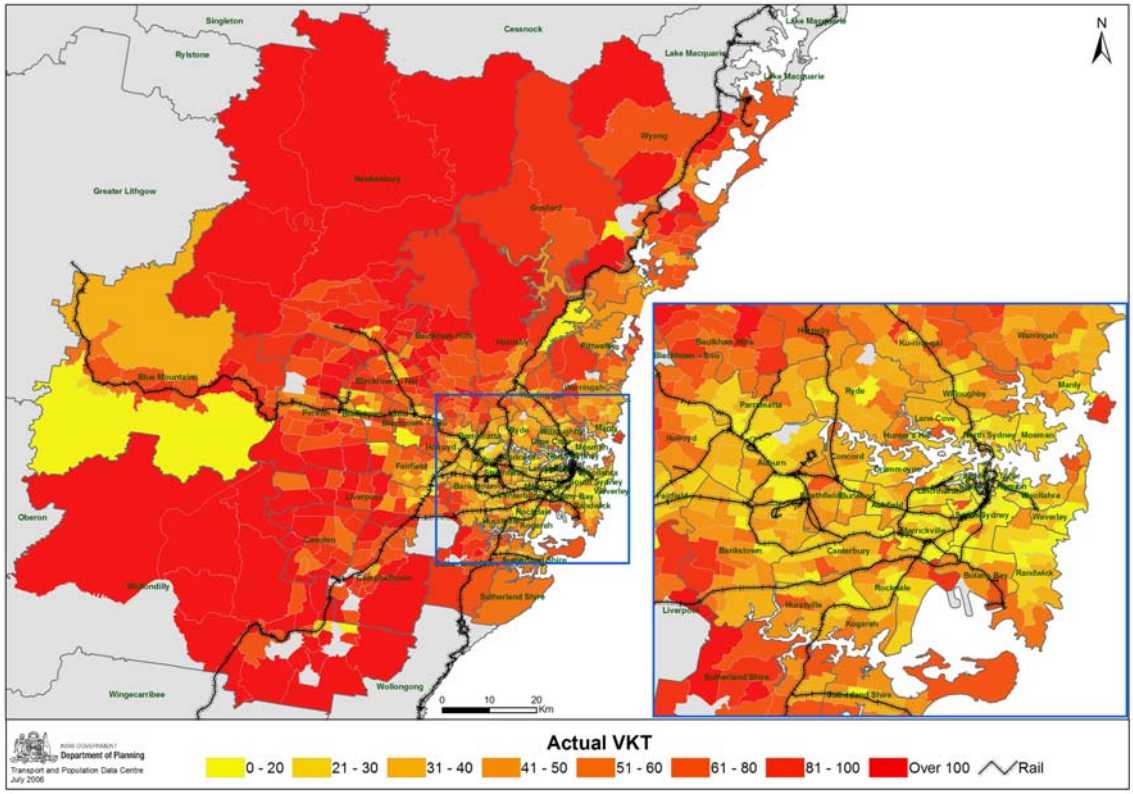

Figure 6 Average VKT generated by the household by travel zone
Source: Corpuz, McCabe and Ryszawa, 2006

6 Parking, travel time, convenience and cost

In the HTS, respondents are asked for their reasons for using public transport or the private vehicle for their journey to work. This data is one of the most informative about the factors impacting on the mode choice process.

In 2005, 22% of Sydney residents commuting to work used public transport while 73% used the car. Of those who used public transport, the highest proportion (48%) did so in order to avoid parking problems. This is ten percentage points higher than the level in 1999 (Figure 7). The second most prevalent reason was the lack of access to a vehicle ("do not have a car", 25% or "car used by someone else", 10%) which reinforces previous findings that show a low car and high public transport usage for those without access to a vehicle. Other aspects of public transport that encouraged its use were price ("cheaper", 24%); comfort and convenience ("less stressful", 20% and "enjoy time to relax", 14%). Travel time ("faster", 18%) was also important, although less people in 2005 compared to 1999 were being satisfied in this respect, as well as accessibility ("live or work close to public transport", 16%).

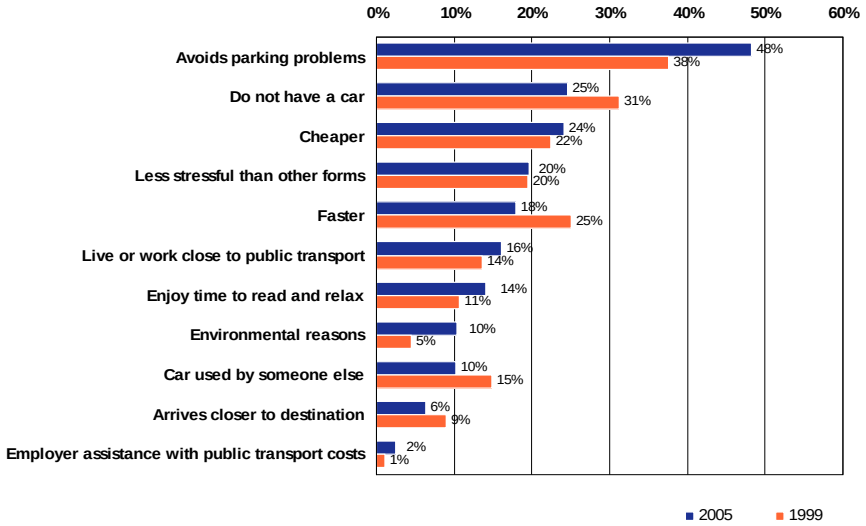

Figure 7 Reasons for using public transport to travel to work, 1999 and 2005
Note: Percentages do not add to 100% because respondents can provide more than one reason.
Source: TDC (2007 unpublished)

Also interesting was the doubling of the proportion of public transport users to 10% in 2005 that cited environmental reasons. This suggests that growing awareness in this area appears to be influencing mode choice and that it may be now timely to fully exploit the issue for marketing sustainable modes.

Based on the prevalence of the reasons, aspects that encourage public transport use may be ranked approximately in order of importance as follows: parking problems; lack of access to vehicle; cost; comfort and convenience; travel time; and accessibility. Interestingly, the first two most important act as sticks and apply to those who are evidently not captive to public transport. Once these deterring factors are removed, these public commuters are the most susceptible to a shift back to the private vehicle.

Also relatively high up in importance is cost. This is particularly relevant in recent times when car running costs are rising due to high petrol prices and increasing congestion. Clearly, travel cost influences choice, however, lower public transport cost will not in itself cause a shift without the accompanying acceptable level of service and accessibility which as will be shown are also important to car users. [1]

In the choice of the car for the journey to work, speed was the most frequently cited reason (48% of respondents in 2005). Problems with public transport appeared to be next most significant. Inaccessibility of public transport was cited by a third and 26% indicated problems with public transport. The next group of reasons given in 2005 were related to convenience ('more comfortable' 20%, 'no waiting' 20%, 'can make trip whenever' 20%, 'arrives closer to destination' 18%) (TDC, 2007). Thus, travel time and comfort were clearly important to car users and if offered competitively by public transport may result in a shift. However, these are not independent from ensuring an acceptable level of public transport accessibility and service which are also important. A further challenge is that even if all these factors favour public transport, the shift from the car is not assured. [2]

[1] Kingham, Dickinson and Copsey (2001) reports from the results of their study of UK companies that 'increasing the cost of car driving through fuel pricing is unlikely to reduce car use, at least if not accompanied by improved and relatively cheaper alternatives.'
[2] As previously cited, results from a study of UK companies indicated that not all car commuters will change to public transport even if public transport improvements were made. (Kingham, et al, 2001).

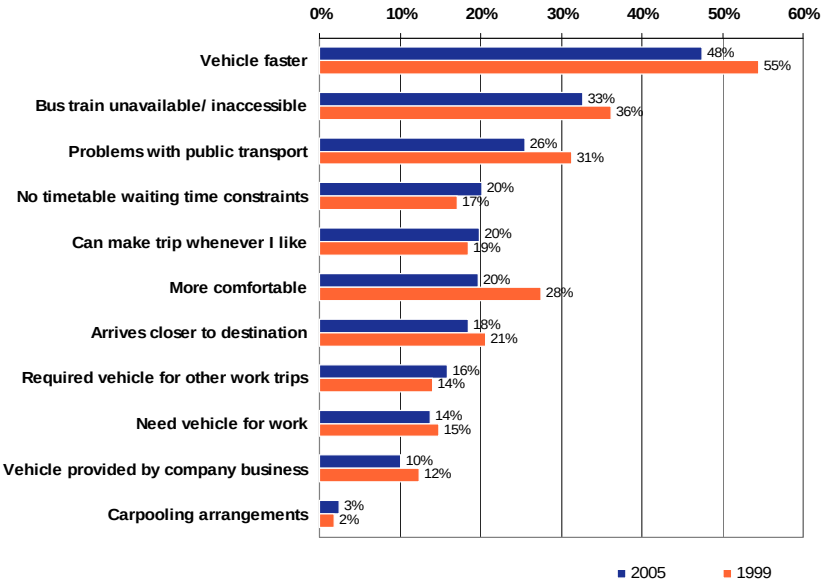

Figure 8 Reasons for using car to travel to work, 1999 and 2005
Note: Percentages do not add to 100% because respondents can provide more than one reason.
Source: TDC, 2007 unpublished

There are commuters, for example, who are simply captive to the car and unlikely to shift to public transport. In the HTS, these were the car users who indicated that the vehicle was provided by the employer (10%) or that they needed the vehicle for work (16%).

7 Summary and conclusions

Empirical data from the HTS indicate that public transport use is most viable in the following situations (a) where parking capacity or arrangements are problematic for car use, (b) where the vehicle is not available or accessible, (c) where it is cheaper. Other aspects such as travel time, convenience and accessibility are important but appear to be less significant compared to the first three factors. Environmental reasons are not as significant as other factors in the choice of public transport but it is an emerging area that presents timely opportunities.

Car users are primarily concerned with speed as well as with the comfort and convenience associated with shorter travel time and the flexibility of the trip-making. When these factors no longer apply or are diminished, for example during peak periods, is when public transport gains a foothold. However, the shift is not strong even in these situations. There may need to be a significant change in speed and comfort to achieve a considerable *shift away from* the car. But even then, there remain the issues about public transport accessibility, service and frequency which together are important to car users. These aspects need to be addressed to complete the *shift to* public transport.

Public transport accessibility is particularly interesting. It is widely considered as promoting sustainable travel behaviour and therefore continues to be an area of focus in urban and transport planning. The data do show that accessibility is associated with greater use of sustainable modes, however, its impacts do not appear to be the strongest. Only 16% of public transport commuters cite accessibility as their reason for their mode choice while significantly more indicated parking and vehicle access issues. This is further confirmed in what appears to be a relatively weaker effect of public transport accessibility (compared to say, the number of vehicles in the household) in lowering VKT based on the results of the TDC VKT Regression Model. What this suggests is that public transport accessibility is

certainly important but its impact may be limited especially when the other aspects that appear to be exerting a stronger influence on the mode choice are not addressed. This is worth noting considering that strategies to improve accessibility require infrastructure investments and are among the most expensive to implement. These approaches may be best applied along with policies that address the other determinants of mode choice in order to maximise the effectivity of even small-scale improvements.

It is informative to note that despite the simpler univariate approach applied in most of the analyses in this paper, the conclusions are consistent with the results from TDC's Scenario Modelling Project which used more complex multi-modal modelling techniques. The key findings from Stage 2 of this project indicated that price-related travel demand management interventions, in particular fuel pricing and parking policy were most effective in reducing car and increasing public transport use compared to landuse change or infrastructure investment (Kilsby et al, 2003). Simpler exploratory analyses such as those undertaken in this paper can therefore be quite useful in making indicative assessments and identifying scenarios or policies which can be tested and compared using more precise modelling techniques.

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