

An Overview of Trip Generation

Purpose of the Working Paper

Two different approaches to the collection of trip generation data form the basis of micro (site impact) and macro (regional, state, or national) analysis and projection of future travel and traffic. This discussion attempts to clearly describe these differences, assess the strengths and weaknesses of the data collection techniques, and to bridge the gap in the application and interpretation of results.

Acknowledgements

Much of this discussion is taken from a document called “A Treatise on Trip Generation” written by John Hamburg and Nancy McGuckin (1987) as training material for traffic engineers and transportation planners in the consulting firm of Barton-Aschman Associates. This document re-visits and updates that original piece primarily for the ITE Trip Generation update conducted in 2013. Any errors are the responsibility of Nancy McGuckin.

Introduction

Trip generation is a concept or way of viewing travel behavior. It is based on the notion that people and/or goods regularly travel to and from a particular location, and that the type of activity at the location—warehouse or retail, office or residential—determines the amount and type of travel. The calculation of the number of trips generated by different kinds of activity or land-uses forms the fundamental building block in the estimation of travel.

For example, people leave their houses everyday to go to work, to shop, to school, etc. The departures and returns are designated as trips¹. If a cordon were placed around the residence to keep track of the comings and goings over a 24-hour period the number of trips the dwelling unit generated per day could be counted. If four trips left the home—for instance, one to work, one to school, one to shop and one to the dentist--and these same four trips returned to the home, the dwelling unit would have a trip generation rate of eight trips per day. Of course, additional trips to that dwelling unit made by non-residents such as a gardener, a furnace repairman, or a furniture delivery truck would be counted as well.

In a similar fashion trips to and from any kind of location are counted to determine the trip generation rate. Each specific type of establishment--a factory, a store, an office building or an entire shopping center—is called a trip generator. The trip generation concept of travel behavior is that the number of trips by people (or goods) to a location is a function of the type of activity at the location. The amount of trips generated is also related to the type of urban location (downtown or suburban) and sometimes the characteristics of the traveler (auto ownership or income). This concept provides the essential connection between land use and the amount of travel, measured in trips.

The linkage provided by trip generation allows the traffic engineer to estimate the amount of vehicle traffic associated with a proposed land-use development. This same linkage allows the transportation planner to start with land-use projections and create a model or chain of estimates (the four-step model includes trip generation, distribution, mode choice, and assignment) to obtain forecasts of vehicular and passenger volumes in a zone or region. In both cases the results are generally used to assess the impacts on, and capacities of, the local or regional roadway and transit systems.

The Use of Trip Generation Rates

Trip generation rates are used to estimate travel in terms of actual person or vehicle flows on the streets. These estimates may be made for a single street or group of

¹ The trip is an intuitively attractive idea—in theory it is a ‘slice’ of travel with a beginning and an end. But satisfactory definitions are elusive. Does travel between stores in a strip mall or between buildings in a complex constitute separate trips? Does a postal delivery truck make many tiny trips as it moves from house to house? How about trips with no distinct destination such as exercise or joy-riding?

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streets in a relatively small area, say the streets bordering a proposed shopping center site, or for all the streets within a specific corridor or within an entire metropolitan area.

The projects for which trip generation rates can be used range in time from evaluating the traffic impacts of a proposed development in the near term to evaluating alternative transportation plans for an entire metropolitan region 25 years in the future.

Trip generation rates are not only used for local site impact analysis or long-range forecasting, but instead are used across a continuum that includes large scale developments, community level planning, and corridor studies. Nevertheless, two fairly distinct approaches to collecting and using trip generation have grown up around the evaluation of site-level land-use development versus the use of trip generation for regional planning. These two different approaches can broadly be described as micro (site impact studies) and macro (regional planning studies).

In terms of data collection, one approach relies on direct observation and counts of traffic entering and leaving specific land uses while the other relies primarily on person-trip information obtained in regional origin-destination surveys.

Intuitively, it would seem that the trip generation rates obtained from these two approaches would be compatible. However, the rates derived from site cordon counts, such as those traditional used in the ITE Trip Generation Manual, and the rates obtained from regional household travel surveys are different. This discussion is an attempt to explain some of the differences in the collection and application of trip generation rates.

Differences in Data Collection

The two approaches to trip generation begin with two basic collection strategies: reports by or measurement of travelers and direct observation or counts of traffic entering and leaving specific sites or areas.

Reports from travelers, and more recently measurement of traveler movements via locational technology, is the technique most frequently used in a regional travel survey. This type of survey is also called the origin-destination, or O-D survey, because it locates both ends of the trip.

Vehicle or person counts obtained from specific locations are the basis for trip generation rates used in site planning and site impact evaluation studies. This data collection method uses the imaginary cordon to count all trips to or from an establishment.

A comparison of the differences between direct observation of traffic at the site and the imputation of that traffic based on survey results is shown in Table 1, and may be useful to illustrate the factors that need to be considered when comparing methods and trip generation rates.

Moving from Person Trips Rates to Vehicle Trip Rates

A major difference in the specification of trip generation rates is measuring person trip rates or vehicle trip rates. If the goal of the analysis is to assess traffic (vehicle) impacts then ultimately the goal is to specify vehicle trips. Much of the regional planning process uses person trip generation as a starting point and distributes people into different modes (drive alone, drive with others, transit, walk, etc.), which ultimately produces vehicles on the highway network.

Vehicle-trip generation rates for both site impacts and regional highway travel depend on the average auto occupancy at a site or zone, and the availability and level of use of non-auto means of travel, such as transit and walking. If one employer is actively sponsoring a ride-sharing program and subsidizing transit passes while another is not, the former will likely have a lower vehicle trip generation rate even though the person trip rates to each site might be identical. However the rate table is ultimately structured, a means of moving between vehicle rates and person rates will be critical, and of course will depend on the auto occupancy for different sites.

Auto Occupancy

People travel together for a lot of reasons. For example, traveling together on a road trip is part of the fun, and people often drive together for shopping, errands, or to go out to eat. Area type, density, and metro area size also have an influence.

Auto occupancy can be measured many ways. The data in this section are from two types of sources: 1) a national household survey (NHTS) that tracks the household vehicle and how many people are in it throughout the sample day, and 2) samples of businesses in different metro areas where each location—like a store or an office building—is cordoned off and all the people and cars entering are counted. The two measures have inherent differences, but can show some of the same data relationships and direction.

Looking at the NHTS data, the purpose of the type—for instance a shopping trip or to go to a restaurant—is related to auto occupancy. Figure 1 shows the average vehicle occupancy for a few common types of trip purposes. Of these selected purposes, travel to work has the lowest vehicle occupancy while trips for shopping, errands, and to restaurants and coffee shops have higher average occupancies.

Figure 1 – Average Vehicle Occupancy by Purpose of Travel, NHTS 2009

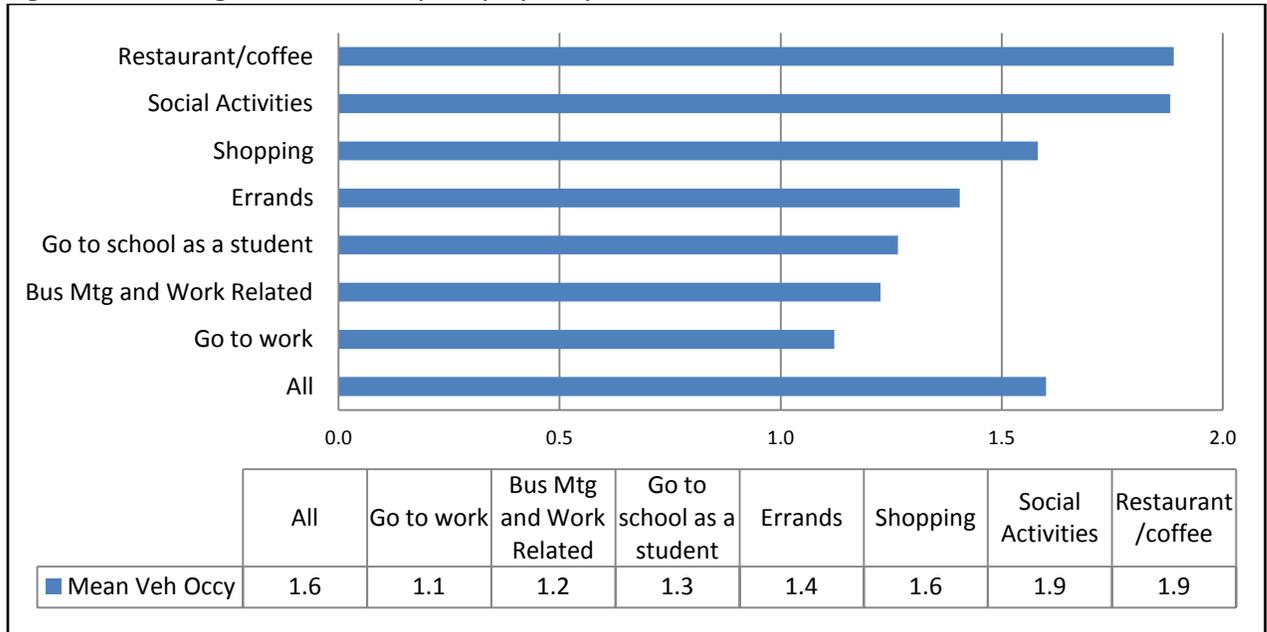
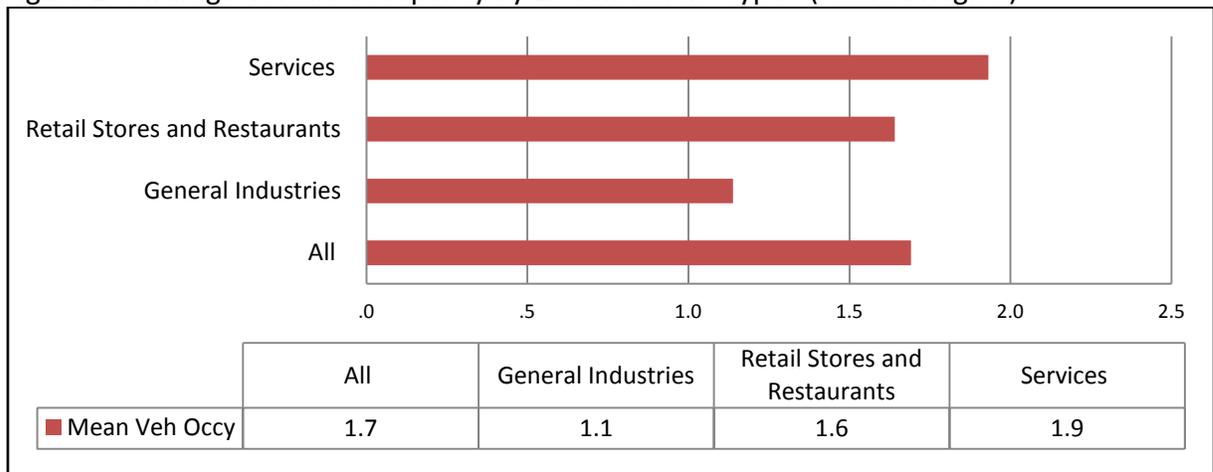


Figure 2 shows the auto occupancy data from a large survey of sites located in the Atlanta region² with the locations divided into general businesses, retail and service. General industries include offices, retail includes both large and small stores, and the service sector includes banks, auto repair, theaters, doctor’s offices and the like. Even though these rates are only in one metro region and measured in a different way than those shown in Figure 1, the range of estimates (1.7-1.9 in Atlanta and 1.6-1.9 for the nation as a whole) are not so different.

Figure 2 –Average Vehicle Occupancy by Establishment Type* (Atlanta Region)



*Visitor Trips only

² The data shown in this brief are from a number of establishment surveys which the author had a role, including Dallas-Ft. Work (1994), Atlanta Region (1997), San Juan (1998) and Pittsburgh (2003). The surveys ranged in size from 165 to 270 sampled establishments of different types and sizes. The data shown here are for visitors (weighted).

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Auto occupancy may also be related to the kind of area where the business is located. According to the site-specific data, people arriving at businesses located in the urban core³ or central business district (CBD) are more likely to drive alone than people arriving at sites in the close in less dense areas (the data shown here are from the Pittsburgh region⁴), resulting in lower vehicle occupancy.

Figure 3 – Percent Drive Alone and Average Vehicle Occupancy by Industry Type and Area Type*

Industry Type	Characteristic	CBD	Urban/Dense Suburban	Suburban/Rural
General	% Drive Alone	79%	56%	74%
	Mean Veh Occy	1.3	1.7	1.4
Retail	% Drive Alone	67%	50%	65%
	Mean Veh Occy	1.4	2.2	1.5
Service	% Drive Alone	55%	52%	82%
	Mean Veh Occy	1.6	1.5	1.4

*visitor trips only

Figure 4 compares auto occupancy for retail and service business in different metro areas. Remember that area type is defined differently in different regions—all regions called the downtown core a CBD, and separately and uniquely determined what areas were urban fringe, dense suburban, or outer suburban/rural.

Figure 4 - Comparison of Average Vehicle Occupancy in Different Metro Areas*

Business Type	Area Type	Atlanta	DFW	Pittsburgh	San Juan
Retail	CBD	1.4	1.4	1.4	1.9
	Urban/Suburban	1.5	1.6	2.2	1.6
	Suburban/Rural	1.9	2.1	1.5	1.5
	Overall Retail	1.6	1.6	1.7	1.5
Service	CBD	1.2	1.2	1.6	1.6
	Urban	1.4	2.2	1.5	1.6
	Suburban/Rural	2.0	1.8	1.4	1.5
	Overall Service	1.9	1.9	1.5	1.6

*Visitor trips only

Average occupancy for commute trips, according to the NHTS, vary little by area type. Figure 5 shows the average auto occupancy for vehicle commutes by different measures of area type. Only commute trips made in very high density areas show even a nominal difference.

³ Area types are established by the planning agency contracting the sample survey—the density considered CBD or dense suburban in Dallas-Ft. Worth might be different than the density considered CBD or dense suburban in Pittsburgh.

⁴ Southwestern Pennsylvania Commission Establishment Survey, 2003

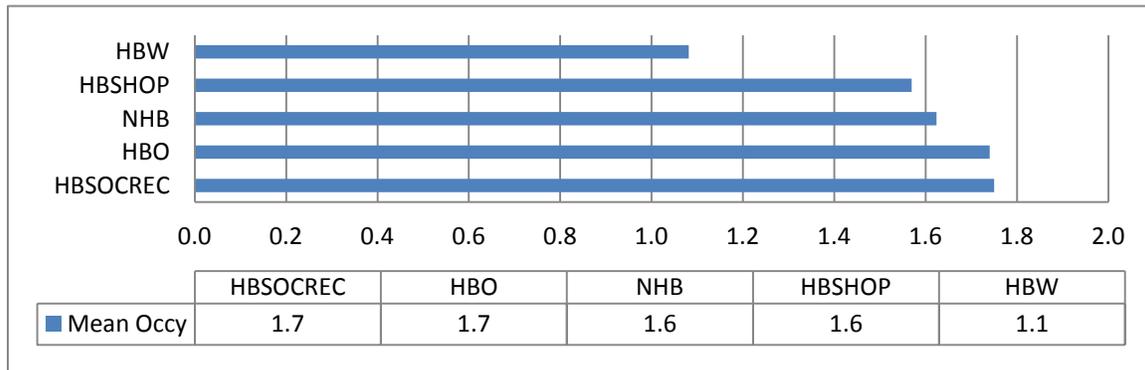
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Figure 5 – Average Commute Vehicle Occupancy by Different Area Types (NHTS 2009)

Area Designation	Work Trip Occy	Residential Density	Work Trip Occy	MSA Size	Work Trip Occy
Town and Country	1.1	Low Density	1.1	<250K	1.1
Suburban	1.1	Mid-Density	1.1	250-499K	1.1
Urban	1.1	High Density	1.1	500-999K	1.1
		Very High Density	1.2	1 mil-2.9 mil	1.1
				3 mil+	1.1

Compared to other trip purposes, home-based work trips (HBW) have the lowest occupancy rates, while social, recreational, and shopping trips have the highest (Figure 6). The occupancy estimates for home-based other and non home-based trips fall in between.

Figure 6 – Average Vehicle Occupancy by General Trip Purpose (NHTS 2009)



This quick look at some of the available data on auto occupancy leads to a few basic conclusions:

The first is that the trip purpose or destination type is an important factor in auto occupancy—at the site level recreational and entertainment services will have higher occupancy than government services, for example. This may account for the high variability in trips destined to places classified as ‘services’.

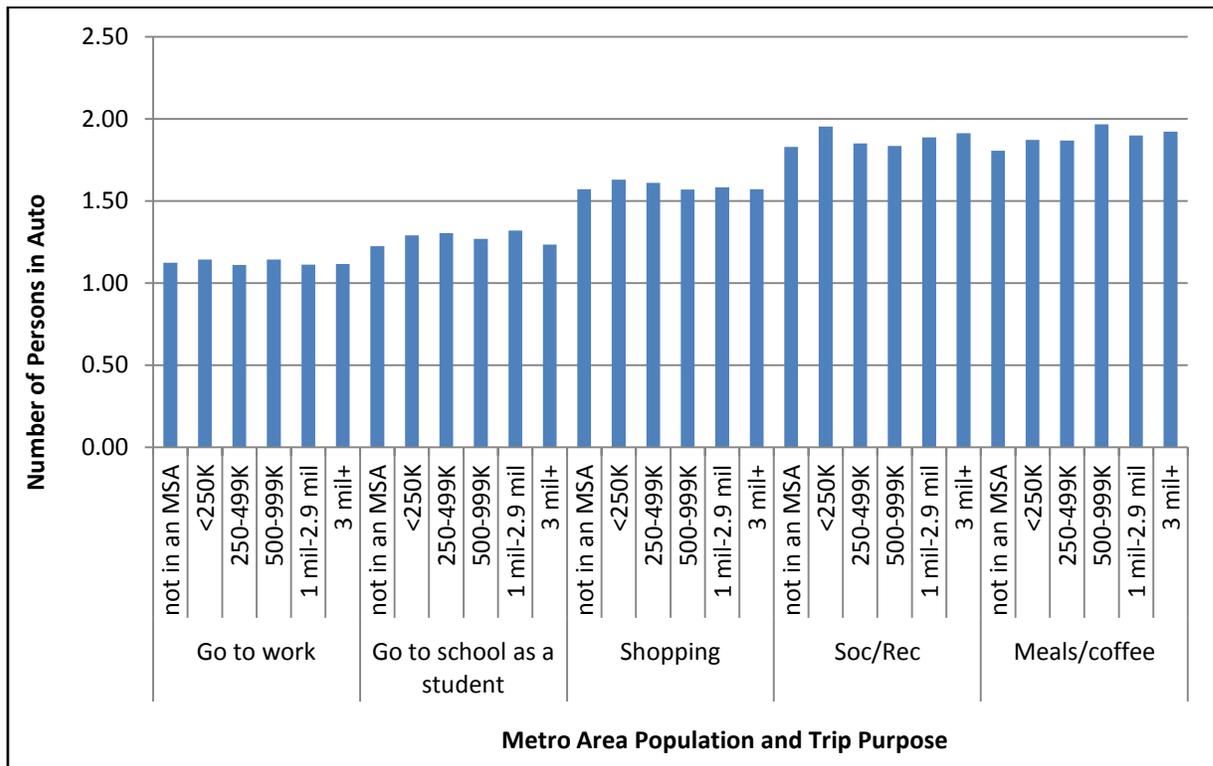
Secondly, at the site level vehicle occupancy is a function of the occupancy for visitor trips and the relative number of visitors to a site compared to workers. Worker vehicle occupancy is relatively low and stable, even for higher density areas.

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Lastly, land use characteristics may be related to vehicle occupancy, and greater detail on parking availability and cost would be useful to understand this relation. More research is necessary to fully comprehend the factors related to differences in vehicle occupancy.

In addition to trip purpose, auto occupancy is also linked to density or metro area size, as shown in Figure 7.

Figure 7 – Average Vehicle Occupancy by Trip Purpose and Metro Area Size (NHTS 2009)



Summary and Further Sources of Information

This discussion has provided an overview to some of the apparent inconsistencies between trip generation rates derived from site cordon counts and those derived from regional travel surveys. The most often used sources of information on trip generation are the ITE manual [Trip Generation](#) and a series of NCHRP reports including:

- NCHRP #716, “Travel Demand Forecasting: Parameters and Techniques”
- NCHRP #758 “Trip Generation Rates for Transportation Impact Analyses of Infill Developments”

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- NCHRP #735 “Long Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models”

But the issue of different data collection methods to calculate different trip generation rates is apparent. Household-based trip rates from the household travel survey do not include trips to the household by non-residents. Such trips—including service providers such as take-out delivery, the housekeeper or gardener, and more recently package delivery to the household from on-line purchases—may be a large and growing share of the trips attracted to dwelling units. The extent to which variability of non-resident trips per household can be explained by the socioeconomic status of the dwelling unit in a zone should be a topic of research to clarify the true range of trip generation variability.

Understanding of the differences in collection and estimation of trip generation rates is critical to applying the rates intelligently. Good practice bridges the divide between the estimation of trip attractions by land-use category and the use of regional surveys to understand the impact of socio-economics, location effects, transit usage, ridesharing, and the like.

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Table 1

Comparison of Cordon Observation and Traveler Measurement for Obtaining Trip Generation Rates

<i>Factor</i>	<i>Site/Cordon Count</i>	<i>Household Travel Survey</i>
1. Under-reporting	Not a Problem	Self-reports by travelers results in a significant understatement of travel. Usually non-work travel and stop-by trips are under-reported. Comparisons to location data (GPS) show correction factors can range from 1.10 to 1.5 depending on the type of traveler and the type of trip ¹ .
2. Day of the week (Typical data are for average weekday conditions)	Observations typically taken on a single weekday—day of week variability can be lost. Saturday or Sunday data can be obtained if needed.	Many area-wide surveys are conducted for weekdays only. The national survey data (NHTS) is for all seven days of the week. Weekends are quite different from weekdays, so NHTS data must be summarized for weekday travel to compare to site estimates.
3. Ends of trip obtained	Only origin <u>or</u> destination is obtained. Makes data and corresponding trip generation rates site specific.	Both origin and destination are obtained. Permits imputation of rates of non-residential generators, especially when the sample is large or for survey designs that explicitly obtain the characteristics of land-use at the destination.
4. Calculation of trip generation rate	Direct measurement in terms of people or vehicles. If mixed uses are at a single site, rates will reflect this mix.	Indirect except for resident trips to and from residential activities (household trip generation). Subject to sample error and non-coverage.
5. Person or modal rates	Typically observations are of vehicles, although auto occupancy may be observed and transit trips noted or estimated.	Observations and trip generation rates are usually person trips. The planning study methodology typically models mode-split and auto occupancy
6. Truck trips	Can be observed directly if needed.	Survey obtains only private vehicle travel. Commercial truck travel must be obtained in a separate survey.
7. Transferability/ Flexibility/Variability	Vehicle rates are determined for specific	Person trip rates, though imputed from samples, have low variability

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	<p>generators. Comparability among generators may be complicated because of differences in land use mix, mode split, and vehicle occupancies. Variability measures must come from comparison among generators, and differences in location, day of week, and other factors frustrate the calculations.</p>	<p>when expressed by demographic factors such as auto ownership and income. These rates have been transferred across different geographies (default parameters such as #365) and are relatively stable across time. Comparison across surveys is complicated by differences in coding, structure, and coverage/response.</p>
8. Impact of differences in socio-economic makeup of trip makers on trip generation rates	<p>Difficult to isolate since observations are limited to vehicle or person counts and physical characteristics of the site, such as size (acres or floor space).</p>	<p>Differences in socioeconomic characteristics are critical to the development of person trip rates from samples, since such differences are used in weighting as well as providing robust categories for application and transfer of rates.</p>
9. Consideration of location within the urban area and of land use mix	<p>Observations tend to be made where individual land uses can be isolated for a cordon count. The spectrum of observations may therefore be slanted toward isolated, single land use sites.</p>	<p>Rates can be developed for elements within mixed land uses and for different locations within an urban area, thereby reflecting different amounts of walk trips and availability of transit.</p>

ⁱ Zmud, Johanna and Jean Wolf (2003). Identifying the Correlates of Trip Misreporting - Results from the California Statewide Household Travel Survey GPS Study, paper presented at the 10th International Conference on Travel Behaviour Research, Lucerne, August 2003