TCI SCOPING PAPER SERIES

TRAVEL MODE SHARE

Prepared for the Georgetown Climate Center and the Transportation and Climate Initiative

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Introduction

Travel mode share (TMS) describes the proportion of trips taken by various means of transportation. Fluctuations in this metric can reflect alterations in people's travel behaviors resulting from policy and investment decisions aimed at increasing the appeal or convenience of options such as biking, walking, or taking public transit, relative to single occupancy vehicles (SOVs). TMS can be measured for all modes[1], or in instances where the effects of a targeted intervention or policy action (or a subset thereof) are of interest. TMS can be thought of as a measure of "transportation choice," with high levels of biking, walking, transit use, and carpooling, indicating a wealth of viable alternatives to driving alone.

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The benefits of creating a "transportation diverse" environment are many, and typically align closely with the Transportation and Climate Initiative's (TCI's) stated intent. Specifically, reductions in the number of SOVs on the road lessen traffic congestion and the resulting generation of greenhouse gas (GHG) emissions and local air pollutants. Walking and biking are particularly appealing, not only because they do not adversely affect environmental quality (EPA, 2011), but also for the direct benefits realized by individuals who partake in these activities, such as health improvements and decreased transportation expenditures. Older and low income individuals may realize even greater benefits from living and working in a transportation diverse community, as their ability to operate and/or afford private vehicles may be limited (HUD, 2012). What's more, an environment that is visually appealing and safe for pedestrians and cyclists can realize appreciable economic growth, as the presence of both locals and tourists can bring foot traffic past local businesses (EPA, 2011).

Despite these benefits, the viability of any mode is influenced by a constellation of factors. Due to the physical exertion and relatively slow pace, bicycle and pedestrian trips tend to be short in length (on

[1] Categories can be specified to reflect the transportation options available in a particular study area. For example: single occupancy vehicle, car/van pool, public transit (possibly broken down to reflect train, bus, and other types of ridership), pedestrian, and bicycle.

average, not more than five miles for the former, and two miles for the latter) (EPA, 2011), meaning that these modes are unlikely to be viable substitutes for trips between more distant locales, no matter what measures are put in place to encourage their use. It has also been found that walking, in particular, is more likely to be used for recreation, rather than as a commuting option for workers (EPA 2011).

Land use patterns and population densities also influence people's travel choices. Populous areas with compact and diversified developmental patterns are known to encourage walking and biking, as more things are reachable by these means, and the trip itself is often more pleasant. What's more, locales with these characteristics are typically better served by public transit than are less populous locations with sprawling development, making use of buses, passenger rail, and other such means as a viable alternative to driving.

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The TMS of non-SOV transportation options can be expected to change as a result of a variety of actions taken at the regional, state, or local level, making this metric an appealing "catch-all" type of indicator. At the micro-level, for example, improvements to a neighborhood's sidewalks could encourage residents to take more of their short trips on foot. At a somewhat larger scale, increasing parking meter rates within a city may lead those who are able to do so to carpool or take public transit to work. Raising gasoline taxes, in contrast, could encourage people statewide to seek out alternatives to driving alone.

There are a number of measurement techniques available to track TMS, the accuracy and sensitivity of which varies by data source and study area specification. The following discussion focuses on the available approaches to monitoring this metric, as well as the advantages and disadvantages of each.

Household Travel Surveys

Surveys of household travel behaviors are thought to provide the most accurate information related to transportation mode choice, as well as the frequency, length and purpose of trips. Regularly administrated surveys of the population within the study area[2] (Clark et al, 2005; EPA, 2011) could be expected to capture alterations in travel behaviors resulting from policy and investment decisions designed to encourage the use of alternatives to SOVs.

One major advantage of relying on household travel surveys is that, unlike analytical efforts based on existing data sources, the survey design process provides the opportunity to gather unique, project-specific data. The American Community Survey[3], a publicly-accessible source of data which often forms the basis of TMS analyses, for example, does not collect data specific to the use of alternative fuel vehicles or recreational travel behaviors -- topics of considerable interest in determining travel mode share. A household travel survey, in contrast, could be written so as to query respondents on these and other specific topics of interest.

One major advantage of relying on household travel surveys is that, unlike analytical efforts based on existing data sources, the survey design process provides the opportunity to gather unique, project-specific data.

Despite the appeal of household travel surveys, survey design, administration, and the resulting data management activities can be quite resource intensive (EPA, 2011), making this something of a “gold standard” in indicator tracking. It can also be difficult to obtain a sample size large enough to be considered statistically significant. This is particularly the case for non-automobile modes (MDOT, 2011).

If instances exist in which a preexisting survey regime is in place (such as in conjunction with Metropolitan Planning Organization (MPO)-level efforts), it may be possible gather the resulting data to

[2] Depending on the nature of the intervention, the study area could be quite small (for example, a municipality targeted for transit-oriented development) or extremely large (for instance, a multi-state region where highway tolls have been adjusted to encourage carpooling).
[3] Discussed at length below.

compile a travel mode share profile for the area, and/or to add questions to, or alter existing questions within, the instrument to facilitate this process.

Advantages of Household Travel Surveys	Disadvantages of Household Travel Surveys
Considered the best way to obtain information about the mode, purpose, and duration of all forms of travel	Can be costly to design, administer and analyze
Can be tailored to include questions related to specific interventions, investments, and decisions of interest	Obtaining statistically significant samples can be difficult, particularly for non-automobile modes.

GPS/GIS

Using modern technology, it is possible to more reliably obtain the type of data on individual travel behaviors that are usually gathered using a survey. Information on people's whereabouts and speed can be gathered from handheld GPS-equipped devices that have been distributed to participants, and input using GIS to determine origin, destination, time, mode, and rate of travel. This type of application reduces the input error characteristic of survey data, namely, that which derives from reporting mistakes, and omissions and incorrect entries in conjunction with data transfer (Stenneth, et al, 2011).

In order to quantify TMS using GPS and GIS, a classification model that reflects mobility patterns must first be built using historical data. Travel mode can then be determined by gathering information from mobility sensors and feeding it into the classification model. Most recent attempts have improved upon preliminary efforts by including an accelerometer with the GPS unit, allowing one to distinguish between individuals who are walking, running, biking, or using a form of motorized transport – the type of motorized transport, however, cannot be identified (Stenneth, et al, 2011).

Improvements to the classification model through the incorporation of transportation network data would allow for a much higher degree of modal specificity. Knowing the bus schedules and station locations and creating spatial polyline representations of rail lines, for example, would make it possible to distinguish users of these modes from those traveling in personal vehicles (Stenneth, et al, 2011). In this way, the accuracy of TMS determinations could be increased significantly.

Some organizations, such as the New York Metropolitan Transportation Council, have investigated the use of GPS units as a replacement for household travel surveys; but at the present time, surveys still remain the norm. As New York discovered, the accuracy of GPS positioning can be compromised a result of the "canyon effect" which occurs in areas characterized by many high rise buildings. GPS devices are also not suitable for tracking movement on underground subways (Lawson et al, 2008).

What's more, using a GPS/GIS-based approach does not serve to remedy two of the greatest weaknesses of household travel surveys. Like surveys, technology-assisted approaches are very expensive. Also, it is still quite difficult to obtain sample sizes that are large enough to be statistically significant (MDOT, 2011).

Clearly, some sampling bias exists, as only the movements of individuals in possession of such devices can be monitored. It can be difficult, however, to obtain a representative sample using traditional surveys as well,[4] a reality which often forces researchers to weight their data to create a more accurate depiction of the population at large.[5]

Advantages of GPS/GIS	Disadvantages of GPS/GIS
Offers same type of information as household travel surveys	Can be costly to design, administer and analyze
Can reduce reporting and data entry-based errors characteristic of household survey data	Obtaining statistically significant samples can be difficult, particularly for non-automobile modes.

Travel Demand Models

Travel demand models[6], such as those often created at the MPO level, can forecast alterations in travel behaviors in response to certain types of interventions, investments, and policy decisions (Gallivan et al, 2008; KYDOT, 2012). TDMs are appealing for their specificity and ability to forecast changes in

[4] For example, telephone surveys that rely exclusively on landlines, while less expensive to administer than those that include cell phones, tend to oversample older respondents.

[5] "Weighting" is a practice whereby a multiplier is applied to response data such that the statistical importance of the answers provided by each subgroup is the same as if a representative sample had been obtained.

[6] For a detailed discussion of travel demand models' uses, data requirements, strengths and weaknesses, see the Greenhouse Gas Emissions Indicators and Approaches scoping paper in this series.

travel behaviors, and as travel mode information is a standard component, they may be quite useful in TMS analyses.

TDMs are not the “silver bullet” for determining travel mode shares within any study area, however. In some instances, models have been developed for entire states, but these are often rather rudimentary in their design. More sophisticated TDMs are typically developed at the sub-state level (often by MPOs); but whether designed for an entire state, or a subset thereof, these models are typically time consuming and resource intensive to create and run. For this reason, it is common to find that within a given state, not all areas are represented by TDMs, and for those that are, considerable differences may exist in the design, assumptions, and data needs of the existing models. Taken together, this means that TDMs can most reliably be used to conduct TMS analyses on study areas that fall wholly within the extent of a single existing model; while the conduct of similar analyses at larger scales, or for areas where no model exists, may prove difficult (Gallivan et al, 2008; KYDOT, 2012).

Another potential source of inaccuracies in TMSs created using TDMs is worth noting: namely, their sensitivity to small changes in mode use, particularly non-motorized options. In general, TDMs are faulted for their inability to capture effects of small scale interventions, such as improvements to pedestrian facilities in a targeted area (EPA, guide to sustainable). What’s more, while traditional models are thought able to reliably forecast usage trends for motorized modes, their ability to predict alterations in people’s reliance on bicycles and walking is limited. Models that focus on the activities people perform are better able to calculate future trends in non-motorized transport (EPA, 2011).

Advantages of Travel Demand Models	**Disadvantages of Travel Demand Models**
TDMs already exist at the MPO and other sub-state levels.	Existing models likely differ in specification, data sources, and other important characteristics.
If focused on travel activities, may be able to make accurate forecasts of impacts on non-motorized travel	Data intensive to create and run
	Not all areas and/or road types are modeled.
	Ability to reflect impacts of small changes is limited
	Ability to forecast changes in the use of non-motorized modes is often limited

American Community Survey

Of the national surveys that collect transportation-related data[7], the US Census Bureau's American Community Survey (ACS), is the only one conducted with sufficient frequency, and on a large enough sample of the population to be deemed useable for analyses of travel mode share at all study scales. Because of this, TMS-focused efforts typically make use of information available from this single source, which provides data on an annual basis related to "*how* people live[8]."

Data for TMS analyses is generated by a single question, which requests information from participants about their mode of travel to work. A broad spectrum of answer choices are enumerated, including "car, truck, or van;" "railroad;" and "bicycle." Respondents who indicate taking a "car, truck, or van" to work are directed to answer a follow-up question designed to determine the number of people occupying the vehicle.

ACS data are often relied upon as the basis for travel mode share analyses, both because they are readily available and updated on a regular basis, and because queries can be specified at a variety of geographical scales, ranging from as large as the nation as a whole, to as small as the Census block group[9] (Polzin et al, 2005). This is not to say that the ACS can serve as a "one stop shop" for all travel mode share analyses; in fact, there are a number of factors that may limit its applicability in the TCI context.

First, and perhaps most importantly, the ACS collects information on travel to work, rather than on the travel modes used for all trips. While this may accurately reflect overall use of some modes, it is unlikely to capture many of the trips made by "greener" transportation alternatives (such as walking and biking) (EPA, 2011), which TCI-related efforts are explicitly intended to encourage.

[7] Namely, the National Household Travel Survey, the BTS Omnibus Survey, and National Survey of Bicyclist and Pedestrian Attitudes and Behavior (EPA Draft, 2012).
[8] Emphasis taken from the source: http://www.census.gov/acs/www/guidance_for_data_users/guidance_main/
[9] Block group data are only available in the form of 5 year estimates.

The ACS is not an exhaustive survey of US households, but rather, reports data collected from a sampling of approximately 2 million housing units nationwide[10]. Specific state totals range from a high of just over 300,000 in California, to less than 8,000 in Wyoming and the District of Columbia; and although an elaborate sampling methodology is employed to ensure as accurate a representation of the total population is obtained as possible, the totals reported are estimates and contain margins of error. Further, while efforts are made to obtain spatially representative samples, it is entirely possible that ACS data will not satisfactorily reflect changes in travel mode share within spatially restricted areas due to targeted policy and investment actions; this is particularly the case if recreational travel impacts are of interest.

Advantages of the ACS	**Disadvantages of the ACS**
Data are free and readily available	Data reflect travel to work only
Data are compiled on an annual basis	Data are estimates and contain margins of error
Data are available for the nation as a whole and can be filtered to reflect a variety of spatial extents	Data may not reflect changes in travel mode share resulting from small scale investments and policy decisions, particularly as they impact recreational travel behaviors

Calculating Total TMS Using ACS Data

It is possible to calculate the total percentage of workers commuting via various transportation modes at numerous study levels using data from the ACS. The calculation itself is simple, and involves dividing the number of individuals traveling to work by a particular mode (or modes) by the total number of workers in the study area, then multiplying the quotient by 100 to obtain the percentage.[11] Performing this calculation using data from successive years will allow for trend identification and tracking (HUD, 2011).

[10] Over 3 million addresses were initially selected, but the number of final interviews was just over 2 million. Source: http://www.census.gov/acs/www/methodology/sample_size_data/index.php

[11] For detailed instruction on how to access ACS data, see the Office of Sustainable Housing and Communities: Guidance on Performance Measurement and Flagship Sustainability Indicator Fact Sheets, available at:

Formula:
PMSTP=(MSTP÷TTP)x100

Where:

Variable Name	**Data**	**Data Source**
MSTP	Mode-Specific Transportation Population	American Community Survey, factfinder2 web portal
TTP	Total Transportation Population	American Community Survey, factfinder2 web portal
PMSTP	Percentage Mode-Specific Transportation Population	

National Transit Database

Unlike many other travel modes for which the ACS represents the only reliable, national source of data on which to conduct TMS analyses, information about unlinked trips taken on public transit is readily available from the National Transit Database (NTD) (Polzin et al, 2005). Obviously, as this source only reports transit trips, it cannot be used alone to generate travel mode shares, but its utility in tracking people's usage pattern of this important, non-SOV transportation option makes it worthy of consideration here.

There are several approaches whereby NTD data can be used to calculate the volume of travel done by transit. If the study area encompasses a transit agency's (or transit agencies') entire service area(s), the NTD is an ideal data source. The NTD reports annual transit trips (in the form of unlinked trips) by agency; and these totals can be summed to obtain yearly usage statistics, which are then divided by population totals[12] to derive per capita transit use.

In instances where the study area does not completely encompass the transit service area(s), it may be possible to obtain usage statistics from local MPOs. If local data are not available or reliable,

[12] Obtained from the ACS.

NTD totals can be allocated to the geographic regions of interest according to the proportion of the total population within the relevant service area(s) that exists within the study boundaries, yielding the total number of transit trips taken within the study area. To do this, a simple formula is applied (ICF, 2011).

Formula:
TTTSA=(SAP÷TSAP)xTTT

Where:

Variable Name	Data	Data Source
TTTSA	Total Transit Trips for the Study Area	
SAP	Study Area Population	American Community Survey
TSAP	Transit Service Area Population	American Community Survey
TTT	Total Transit Trips for the relevant service area(s)	National Transit Database

Alternately, the same measure can be derived from the same data sources by another formula (EPA Draft, 2012).

Formula:
TTTSA=(TTT÷TTCSA)xTTCLSA

Where:

Variable Name	Data	Data Source
TTTSA	Total Transit Trips for the Study Area	
TTT	Total Transit Trips for the relevant service area(s)	National Transit Database
TTCLSA	Total Transit Commuters in the Service Area	American Community Survey
TTCLSA	Total Transit Commuters in the Local Study Area	American Community Survey

To obtain per capita transit use statistics, simply divide the Total Transit Trips for the Study Area by the Total Population for the Study Area.

Advantages of Using the National Transit Database	Disadvantages of Using the National Transit Database
Publically-accessible source of data on unlinked all transit trips for all agencies nationwide	A single trip may consist of more than one "unlinked transit trips" if the rider switches modes or vehicles in the course of their travel.

	These data allow for the calculation of total or per capita transit trips, not transit mode share.
	Totals are reported by agency service area, and must therefore be allocated according to study area population for analysis.

Recommendations

The table below briefly summarizes the appropriateness of the indicators outlined throughout this paper for use at the sub-state, statewide, and TCI-wide scales

Recommended Approaches at the Sub-State, State and TCI-Wide Levels			
Method	**Preferred for Sub-State Level Analyses**	**Preferred for State-Level Analyses**	**Preferred for TCI-Wide Analyses**
Household Travel Surveys	✓		
GPS/GIS	✓		
Travel Demand Models	✓	✓	
American Community Survey-Based Analyses	✓	✓	✓
National Transit Database-Based Analyses	✓	✓	✓

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