Developing a Total Peak Period Travel Time Performance Measure

An Updated Concept Paper

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Background

Transportation performance measures based on travel time quantities satisfy a range of mobility purposes. They can show the effect of many transportation and land use solutions, and they are relatively easy to communicate to a range of audiences. Traditional roadway and transit capacity additions, operational improvements, and commute options can all be used to alter the supply of, and demand for, transportation services. Land use development design and density are also used to provide residents, visitors, and travelers a variety of arrangements for homes, offices, shops, and other trip destinations and thereby change transportation system performance. However, traditional measures may not capture all of the effects of these changes. A variety of different measures can be created to show the effect of mobility problems and solutions on individuals, regions, businesses, and the economy.

One aspect that some applications have not fully accommodated is the modal shift and travel changes that come with significant investments in public transportation or land development pattern changes. These actions typically encourage more transit, walk, and bicycle trips—trip types that are not included in many models and in few transportation agency datasets. When a vehicle trip is converted into a transit, bike, or walk trip, it disappears from consideration in many analyses. The effect of the trip change is displayed in the lower vehicle and person volume accommodated on the roadway network, but the full effect of the improvement on the trip maker is likely not illustrated. With denser land uses there is a possibility that there are more short trips to nearby stores or offices. With significant public transportation facilities and operations there may also be a mode shift toward transit.

A performance measure that has been used for multi-modal system evaluations is total travel time (the door-to-door sum of all travel times regardless of mode or travel path). This measure is one of the easiest to explain and understand and relates well to the goals for transportation—minimizing the amount of time spent traveling by any mode. A typical before/after analysis of a land use diversification and densification program might, for example, see many trips converted from long-distance travel to short trips to nearby destinations. Those short trips might be more likely to use bike, walk, or transit modes, or to accomplish travel objectives while remaining at home, in the office, etc.

The main element of a total travel time measure that should be addressed or recognized before inclusion in a typical set of mobility performance measures is that there is insufficient data to estimate all travel by all modes. Roadway inventory and travel datasets contain the information required to estimate several aspects of vehicle and person travel on major roads by private vehicle. Transit agency data may be available to estimate rail, bus, and other public transportation service information. But there are few datasets at the national or regional level that provide similar information about travel by bicycle and walk modes or the share of work at home "trips". The ideal data might be obtained from a combination of individual travel surveys for each development pattern type and additional count and travel time/distance data for alternative modes (e.g., sidewalks, bike paths or lanes). These data can be used to develop or improve travel models that accommodate a broader range of travel modes.

For the purposes of introducing the total travel time measure as part of the *Urban Mobility Report* (*UMR*), these shortcomings and deficiencies were addressed using some simplifying assumptions. The description below and the resulting measures should be limited, as with other information in the *Urban Mobility Report*, to explaining trends at a regional level rather than being used for detailed sub-regional analyses.

The Concept

The initial implementation of the total travel time measure in the *Urban Mobility Report* uses the Report's primary datasets and combines it in a different way to estimate the total travel time by road users during the peak period. As described in the final section, this initial concept will be expanded as more data become available and as the TTI research team has more time to examine possible data and performance measure options.

If travel time is important, why do most analyses measure "delay"? In many cases, delay is a quantity that indicates where the problems are, what the solutions might be, and how beneficial the investments are. As noted above, there are good data, appropriate measures, and adequate models to estimate travel delay. The basis of the total travel time measure is also rooted in the interests of travelers and urban residents, and may indicate a different conclusion. Consider these two simplified cases:

- A suburban commuter travels 20 miles to work in 24 minutes on freeways.
- An urban commuter travels 2 miles to work in 10 minutes on streets.

The summary statistics for these two commuters are presented in Exhibit 1.

Of the four measures typically used to evaluate transportation service (highlighted in yellow), three of them favor the suburban commuter trip. Only the travel time measure shows a benefit—14 minutes of "not driving" or because of a shorter trip. In this example, the suburban commuter can travel at higher speeds and experiences less delay in congestion. The urban commuter travels at slower speeds and experiences more delay, but gets to work in 14 fewer minutes of travel than the suburban commuter. **This shows the power of the total travel time measure.** It focuses on one of the elements that travelers seem to care about—short travel times. Of course, they also care about schools for their children, proximity to parents or one spouse's job, health care options, homes with large yards, and several other determinants of the location of key activities.

Exhibit 1. Illustration of Total Peak Period Travel Time Measure

Measure	**Suburban Commuter**	**Urban Commuter**
Distance	20 miles	2 miles
Free-Flow Speed	60 mph	30 mph
Free-Flow Travel Time	20 minutes	4 minutes
Travel Time	24 minutes	**10 minutes**
Average Speed	**50 mph**	12 mph
Delay	**4 minutes**	6 minutes
Travel Time Index	**24/20 = 1.20**	10/4 = 2.50

Note: "Better" value (as that judgment is normally defined by traveler desires) of the quantities normally used as a performance measure noted in bold.

Although travel delay and the Travel Time Index are good measures of the effects of congestion, they rely on an estimate of the speed that travelers choose to travel if there is no congestion (in this case, 60 mph on freeways and 30 mph on streets). These assumptions are reasonable for many situations and can be customized to a greater degree with speeds from specific sections of road. Travelers in high density areas, however, may not expect to travel at free-flow conditions. These areas are typically smaller than vast suburban regions and contain closely spaced activities; even at slow speeds, many locations are within a few minutes. So, while delay and the Travel Time Index are not irrelevant or incorrect, in denser developments they may not illustrate the aspects of travel that are important to the *travelers in those areas*.

The benefits of using a total travel time measure become even more apparent for a variety of trip types in the dense areas if walk, bike, and work/shop at home trips are accounted for. These trips are accomplished at much slower speeds than the same trip in a suburban setting, but both urban and suburban travelers accomplish the same goal—get to the destination. A vehicle-based set of congestion measures may overstate the average delay for all travelers (including walk, bike, and public transportation) in densely developed areas. Many types of measures including peak period travel time can illustrate the benefits of moving trips to off-peak periods with tele-work technologies.

A total travel time measure also has aspects of an "accessibility" measure. The many forms of accessibility measures attempt to illustrate the effects of transportation and land use development investments, policies, and practices on mobility levels (i.e., the ability to travel without congestion) and on the creation of many possible destinations in close proximity. Measuring the total travel time will show when trips are made in less time because they are for shorter distances **or** are made at faster speeds **or** not made at all.

Calculation Details

A meaningful total travel time measure requires that most of the trip be incorporated into the calculation during the time when trip times are longest—the morning and evening peak periods. Delay measures, on the other hand, can be relevant if they are only focused on major roads.

The key total peak period travel time data elements included were:

1. The number of miles traveled on each roadway classification (freeway, arterial, collector, and local streets);
2. Speed, both free-flow and congested; and
3. Commuter population—those driving regularly during the peak, usually work trips.

The *Urban Mobility Report* dataset contains these three elements for freeway and arterial roadways but not for collector and local streets. The *Urban Mobility Report* used data contained in the Highway Performance Monitoring System (HPMS) database but adjusted the freeway and arterial data to create classification consistency between each state and to account for urban area boundary updates. These modifications, however, were not performed on raw HPMS data for collector and local street data (e.g., miles, lane-miles, total daily vehicle-miles traveled). Freeway and arterial vehicle-miles were subtracted from the total vehicle-miles to obtain a minor road vehicle-miles traveled value. This was apportioned into collector and local street classifications using the same proportions found in the two classifications in the raw HPMS dataset.

Preparing the Data

The HPMS dataset presents three major concerns that were addressed before the data could be used in the total peak period travel time measure:

1. Through trips by non-residents were included in the data.
2. Data quality of minor roadway VMT (since less was known about the data and less data were collected in this category).
3. HPMS volumes represent a seven day week; the total peak period travel time measure only represents the five-day work week.

HPMS is based on road sections rather than trips, and the data for major roads is more reliable than minor road data. TTI researchers, therefore, adjusted the HPMS data based on general estimates of the data that would be collected if HPMS and other datasets were collected in a way that was more consistent with the total travel peak period time measure.

1. Removing Through Trips

Through trips add some amount to the total VMT in an urban area. This is especially a problem in smaller areas with high through truck traffic; in larger areas the through traffic is a relatively smaller portion of urban area traffic. Through trips inflate the total peak period travel time for some urban areas. If the high number of through non-local trips were not removed, it would appear that local drivers traveled farther (for longer) than they may have actually driven.

Because data on the amount of through trips in each urban area are not readily available, this analysis examined total daily VMT per capita (as reported by HPMS) in each urban area size group to estimate and remove any excessive amounts of VMT that might be attributable to through trips. Researchers hypothesized that VMT per capita values more than one standard deviation above the urban area population size group average are in error and should be adjusted downward to an upper limit of one standard deviation above the average to adjust for an abnormally high number of through trips. Researchers then applied the adjustments to VMT in each of the four roadway classifications using the original HPMS proportions from before the adjustment.

2. Assessing Minor Roadway Data Quality

After through trips were "removed," minor roadway VMT was assessed for quality assurance and control. Anomalies in minor VMT were identified by examining the percentage of total VMT in each roadway classification. Urban areas with a combined collector and local street (minor) VMT proportion higher than one standard deviation above the average for the urban area population size group were capped at one standard deviation above the average percentage. Total VMT and minor VMT were recalculated using the capped proportion. Collector and local street VMTs were recalculated using the new minor road VMT and the same proportions found in the original HPMS dataset.

3. Adjusting from a Seven to Five Day Week

Once the VMT for each roadway classification was adjusted for these factors, the volumes had to be converted from representing a full seven day week to a five day work week. Based on previous research[1] of annual average daily traffic (AADT), Saturday and Sunday volumes represent only 90 percent and 80 percent, respectively, of the average annual daily traffic. Conversely, Monday through Thursdays represent 105 percent and Fridays represent 110 percent of AADT for any given day. When considering VMT, weekdays represent, on average, six percent more VMT than weekends. Therefore, the HPMS VMT was increased by six percent to adjust the average day of week travel volumes to travel estimates for weekdays only (excluding weekends).

Travel Time Calculation

INRIX's dataset does not contain a robust set of speeds for collector and local streets in each region like those found for freeways and arterials. U.S. INRIX data contain information on over 850,000 miles of freeway and arterial roads as compared to approximately 25,000 miles of collector and local streets. Researchers used the available minor road speed data from individual urban areas grouped together to estimate free-flow and congested speeds for both collector and local streets. Exhibit 2 details the speeds estimated for each road category and urban area size. As more data are collected, researchers will refine these speeds for specific urban areas.

[1] Roadway Usage Patterns: Urban Case Studies. Prepared for Volpe National Transportation Systems Center and Federal Highway Administration, July 22, 1994.

Exhibit 2. Minor Roadway Free-Flow and Congested Speeds for Groups of Urban Areas

	Collector Streets		Local Streets	
Urban Area Size	*Free-Flow Speed*	*Congested Speed*	*Free-Flow Speed*	*Congested Speed*
Very Large	32 mph	28 mph	27 mph	24 mph
Large	32 mph	28 mph	27 mph	24 mph
Medium	30 mph	28 mph	26 mph	24 mph
Small	29 mph	28 mph	25 mph	24 mph

Source: INRIX data and TTI analysis

The total peak period travel time estimate was created by adding two components: peak delay and estimated free-flow peak period travel time. These quantities are integral to the typical *Urban Mobility Report* calculations; the total peak period travel time calculation, however, was extended to include the minor road classes in an attempt to capture total travel time. The same peak periods used for the *Urban Mobility Report* calculations were used: 6:00 a.m. to 10:00 a.m. and 3:00 p.m. to 7:00 p.m.

Equation 1 is the peak free-flow travel time equation which used the free-flow speeds from Exhibit 2 and adjusted VMT to compute the amount of time needed to travel at the free-flow speeds during the weekday peak hours. This equation was used for each of the four roadway classifications. The sum of the four calculations is the time that would be required to travel the miles traveled in the peak if there were no congestion.

$$\begin{matrix}\text{Peak Free-Flow}\\ \text{Travel Time}\\ \text{(Person-Hours)}\end{matrix} = \frac{1}{\begin{matrix}\text{Free-Flow}\\ \text{Travel Speed}\end{matrix}} \times \begin{matrix}\text{Daily}\\ \text{Vehicle-Miles}\\ \text{of Travel}\end{matrix} \times \begin{matrix}\text{1.25 Persons}\\ \text{per Vehicle}\end{matrix} \qquad \text{(Eq. 1)}$$

**This value is computed for all four roadway classes for all 15-minute intervals during the day.*

Peak period daily delay is the amount of extra time spent traveling during the morning and evening peak periods due to congestion. Equation 2 is the same calculation procedure used in the *Urban Mobility Report*.

$$\begin{matrix}\text{Peak Period}\\ \text{Daily Delay}\\ \text{(Person-Hours)}\end{matrix} = \left[\left(\frac{\begin{matrix}\textit{Vehicle-Miles}\\ \textit{of Travel}\end{matrix}}{\textit{Actual Speed}}\right) - \left(\frac{\begin{matrix}\textit{Vehicle-Miles}\\ \textit{of Travel}\end{matrix}}{\textit{Free-Flow Speed}}\right)\right] \times \begin{matrix}\text{1.25 Persons}\\ \text{per Vehicle}\end{matrix} \qquad \text{(Eq. 2)}$$

**This value is computed for all four roadway classes for all 15-minute intervals during the day.*

The four roadway classifications were grouped into two categories: primary roads (freeways and arterials) and minor roads (collectors and local streets). Peak period travel time is the sum of peak period delay and peak period free-flow travel time for each roadway type (both primary and minor roads) as shown in Equation 3. The measure used auto commuters rather than the total population to reflect the estimated travel time for those experiencing the congestion. Travel time during the peak period was reported in daily minutes per auto commuter.

$$\begin{matrix}\text{Daily Peak}\\ \text{Period}\\ \text{Travel Time per}\\ \text{Auto Commuter}\\ \text{(Minutes per}\\ \text{Auto Commuter)}\end{matrix} = \left(\frac{\left[\begin{matrix}\text{Primary Road}\\ \text{Peak Delay}\\ \text{(Person-Hours)}\end{matrix} + \begin{matrix}\text{Minor Road}\\ \text{Peak Delay}\\ \text{(Person-Hours)}\end{matrix}\right] + \left[\begin{matrix}\text{Primary Road}\\ \text{Peak Free-Flow}\\ \text{Travel Time}\\ \text{(Person-Hours)}\end{matrix} + \begin{matrix}\text{Minor Road}\\ \text{Peak Free-Flow}\\ \text{Travel Time}\\ \text{(Person-Hours)}\end{matrix}\right]}{\text{Auto Commuters}}\right) \times \begin{matrix}\text{60 Minutes}\\ \text{per Hour}\end{matrix} \qquad \text{(Eq. 3)}$$

Results

Total peak period travel time can provide additional explanatory power to a set of mobility performance measures. In the *Urban Mobility Report* context where trends are important, values for similar-sized urban areas and/or congestion levels can be used as comparisons. Year-to-year changes for an area can also be used to help an evaluation of long-term policies. Regions developed in a relatively compact urban form will score well, which is why the measure may be particularly well-suited to public discussions about regional plans and how transportation and land use investments can support the attainment of community goals.

Exhibits 3, 4, 5, and 6 list the total peak period travel time results and ranking for each urban area size category published in the *2012 Urban Mobility Report*, Table 7, for 2010 data. Travel time values are shown in minutes during the daily peak periods (morning and evening) per commuter; this is the amount of time the average auto commuter can expect to spend traveling each weekday during **both peak periods**. Note that many of the urban area travel time values are close together and, as with several of the mobility measures, a slight change in minutes can dramatically increase or decrease an urban area's ranking. For example, there are only four minutes separating a ranking of 9 and 30.

Exhibit 3. Total Peak Period Travel Time (TPPTT) for Very Large Urban Areas (Minutes per Day)

Urban Area	TPPTT	Rank	Urban Area (cont.)	TPPTT	Rank
Washington DC-VA-MD	53	1	Miami FL	45	15
Atlanta GA	50	2	Chicago IL-IN	44	21
New York-Newark NY-NJ-CT	50	2	Seattle WA	44	21
Boston MA-NH-RI	48	4	Houston TX	44	21
Los Angeles-Long Beach-Santa Ana CA	48	4	Phoenix AZ	43	27
Detroit MI	47	8	Dallas-Fort Worth-Arlington TX	42	34
San Francisco-Oakland CA	47	8	San Diego CA	41	36
Philadelphia PA-NJ-DE-MD	45	15			

Exhibit 4. Total Peak Period Travel Time (TPPTT) for Large Urban Areas (Minutes per Day)

Urban Area	TPPTT	Rank	Urban Area (cont.)	TPPTT	Rank
Orlando FL	48	4	Buffalo NY	39	49
Indianapolis IN	48	4	Cleveland OH	39	49
St. Louis MO-IL	46	11	Riverside-San Bernardino CA	38	56
Charlotte NC-SC	45	15	Louisville KY-IN	38	56
Nashville-Davidson TN	45	15	Milwaukee WI	38	56
Minneapolis-St. Paul MN	44	21	Portland OR-WA	37	61
Tampa-St. Petersburg FL	43	27	New Orleans LA	37	61
Kansas City MO-KS	43	27	Baltimore MD	37	61
Raleigh-Durham NC	43	27	Providence RI-MA	36	64
Jacksonville FL	43	27	Columbus OH	36	64
Virginia Beach VA	41	36	San Jose CA	36	64
Memphis TN-MS-AR	41	36	Sacramento CA	36	64
San Antonio TX	40	45	Austin TX	35	72
Denver-Aurora CO	40	45	Pittsburgh PA	34	73
Cincinnati OH-KY-IN	39	49	Salt Lake City UT	33	78
Las Vegas NV	39	49	San Juan PR	27	92

Exhibit 5. Total Peak Period Travel Time (TPPTT) for Medium Urban Areas (Minutes per Day)

Urban Area	TPPTT	Rank	Urban Area (cont.)	TPPTT	Rank
Tucson AZ	47	8	Albuquerque NM	36	64
Birmingham AL	45	15	Rochester NY	34	73
Oklahoma City OK	45	15	New Haven CT	34	73
Knoxville TN	43	27	Allentown-Bethlehem PA-NJ	34	73
Richmond VA	41	36	Fresno CA	34	73
Omaha NE-IA	41	36	Albany-Schenectady NY	33	78
Bridgeport-Stamford CT-NY	41	36	Oxnard-Ventura CA	32	82
Hartford CT	41	36	Honolulu HI	31	85
Grand Rapids MI	40	45	Sarasota-Bradenton FL	31	85
Baton Rouge LA	40	45	Poughkeepsie-Newburgh NY	30	87
Tulsa OK	39	49	El Paso TX-NM	30	87
Springfield MA-CT	39	49	Akron OH	29	89
Charleston-North Charleston SC	38	56	Lancaster-Palmdale CA	29	89
Dayton OH	38	56	McAllen TX	26	93
Toledo OH-MI	36	64	Bakersfield CA	25	95
Wichita KS	36	64	Indio-Cathedral City-Palm Springs CA	23	98
Colorado Springs CO	36	64			

Exhibit 6. Total Peak Period Travel Time (TPPTT) for Small Urban Areas (Minutes per Day)

Urban Area	TPPTT	Rank	Urban Area (cont.)	TPPTT	Rank
Pensacola FL-AL	46	11	Madison WI	33	78
Columbia SC	46	11	Provo UT	32	82
Little Rock AR	46	11	Boise ID	32	82
Jackson MS	44	21	Salem OR	29	89
Worcester MA	44	21	Eugene OR	26	93
Greensboro NC	43	27	Laredo TX	25	95
Cape Coral FL	42	34	Brownsville TX	25	95
Spokane WA	41	36	Boulder CO	23	98
Beaumont TX	41	36	Stockton CA	23	98
Winston-Salem NC	39	49	Anchorage AK	22	101
Corpus Christi TX	33	78			

Communication Aspects

The total peak period travel time measure is not only a congestion or mobility measure; it incorporates the effects from transportation investment, land use patterns, urban economics, housing policy, and other factors. It can be used to characterize urban travel conditions, but it must overcome a lack of discussion about the travel times for all trips and all modes. Total peak period travel time is a comparatively large value (whether expressed in minutes per day or hours per year) and without some comparison, travelers may have difficulty interpreting the measure. In the *Urban Mobility Report* context where trends are important, values for urban areas of similar size and/or congestion levels are used for comparisons. Year-to-year changes for an urban area can also be used to help evaluate long-term policies.

There may also be a lack of data for regional planners and transportation decision-makers to make a connection between travel conditions, development patterns, and the expectations for acceptable travel. The travel time measure is produced in travel demand models and yet few transportation planning agencies use the statistic in their reporting. The measure, however, is particularly well-suited for comparing different long-range planning scenarios as it would show the combined effect of different transportation investments and land use arrangements.

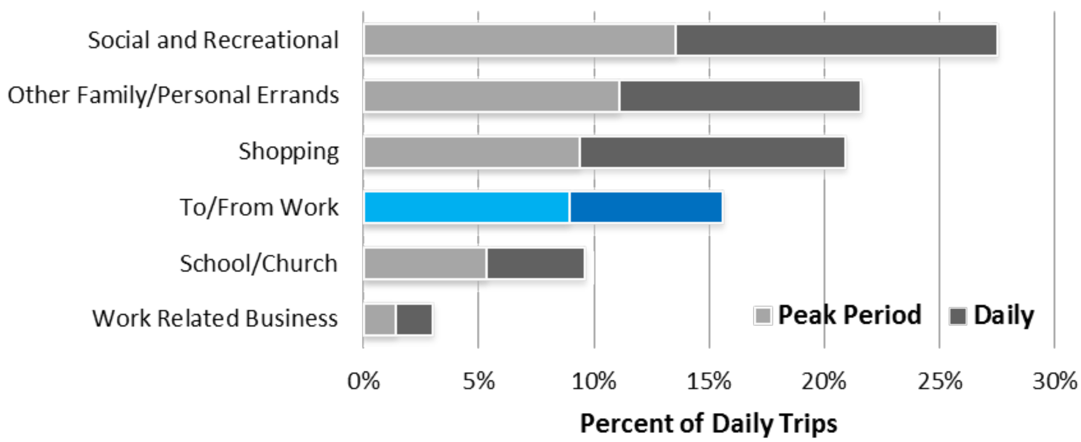
Travel Time and the Census

The U.S. Census Bureau's American Community Survey (ACS) provides an average travel time measure for work trips in urban areas in its Journey to Work data section. It is important that planners and policy makers understand the differences between and use caution when comparing the *Urban Mobility Report* total peak period travel time measure with that found in the ACS. The two are constructed in different ways using dramatically different datasets. The ACS travel times are generally eight or fewer minutes larger than the travel times calculated here. However, there are some cases where the ACS travel times differ from the *Urban Mobility Report* total peak period travel times by more than 30 minutes.

What makes the ACS travel times so much different?

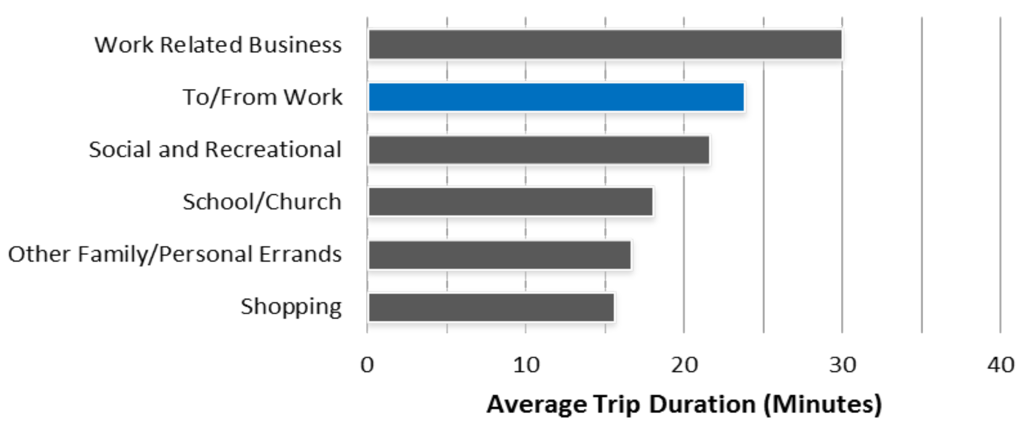
- **Trip to Work vs. Any Trip during the Peak**: The ACS asks how long it took to ***travel to work from home last week*** (Question 34). According to the last National Household Travel Survey (NHTS) in 2009, trips to work were only the fourth most frequent trip purpose (16% of daily trips were to/from work; 9% of daily trips are peak period work trips) (Exhibit 7). The NHTS trips to and from work included "chained" trips. For example, if a person stopped at the drycleaners and the daycare on his or her way to work, the NHTS counted this as a single work trip. Trips for work-related business and to/from work, however, took the longest amount of time (Exhibit 8). The *Urban Mobility Report* total peak period travel time calculation includes **all trips** taken during the peak hours (for example, trips to and from work, shopping, personal errands, and social trips).

Exhibit 7. Other Trips Are More Frequent Than Trips to Work



Source: National Household Travel Survey: Trip Purpose, Federal Highway Administration, 2009, http://nhts.ornl.gov

Exhibit 8. Work Trips Take Longer

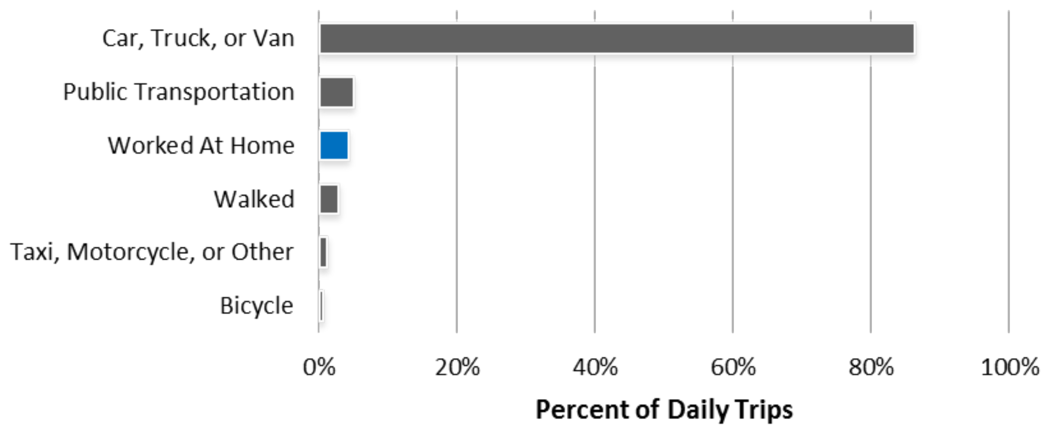


Source: National Household Travel Survey: Trip Purpose, Federal Highway Administration, 2009, http://nhts.ornl.gov

- **Geographical Differences:** Though the ACS and the HPMS data published by the Federal Highway Administration (FHWA) offer information by urban area (the most appropriate geography for analysis in the *Urban Mobility Report*), the two geographies may not be the same. A footnote in the HPMS dataset confirms that the geographies are based on areas delineated as urbanized areas by the U.S. Census Bureau, but it also notes that some urban areas may have been combined for reporting purposes. These combinations are not listed, though researchers have determined that, for example, the Raleigh, NC and Durham, NC urban areas have been combined in the HPMS dataset.
- **Survey vs. Calculated Data**: The ACS measures were summarized from survey data. Respondents were asked to give approximate values (as accurate as memory allowed). The Census Bureau developed statistical methods to reduce problems with rounding (respondents typically note their travel time in five or ten minute intervals) and other respondent issues. The *Urban Mobility Report* total peak period travel time was calculated by analyzing aggregated speed data from millions of point observations of speed data in combination with HPMS data collected from the FHWA. Both methods provide a representation of travel time, but as stated earlier, they measure different traits.
- **Trips to Other Urban Areas**: The wording of question 34 in the ACS questionnaire allowed for trips to and from different metropolitan areas, whereas the *Urban Mobility Report* total peak period travel time measure was designed to estimate trip travel times within a single urban area (and, the *UMR* method therefore makes an effort to exclude exterior or pass-through trips). For example, a person who lives in Bridgeport, CT and commutes to work in New York City, NY would be counted in the ACS travel time to work in New York City. The *Urban Mobility Report* total peak period travel time calculation attempts to exclude this type of trip because it travels outside the Bridgeport urban area. Because of the question's wording, if this same worker from Bridgeport took a business trip to Los Angeles the week before the ACS survey and flew for six hours, this trip could have been recorded as a six-hour commute and been reflected in the ACS travel time.

- **Different Modes**: The ACS measure includes several different modes in its travel time measure; the *Urban Mobility Report* total peak period travel time measure only examined vehicle travel. However, trips made by car, truck, or van make up 87% of all trips during the day (Exhibit 9); understanding the auto mode is crucial to creating a reliable travel time measure. One other element of travel time that should be reflected is the number of telecommuters (those working at home). The ACS travel time measure does not include workers who worked from home, yet according to the 2007 to 2011 ACS, those who work from home is near the number of those that take public transit—a significant number of work commuters (Exhibit 9). Including this segment of the population will illustrate the effect that travel options have on mitigating congestion and reducing travel time within an urban area. Future iterations of the *Urban Mobility Report* total peak period travel time measure will include the effects of transit, bicycle, walking, telecommuting and other modes as data and methods become available for each area.

Exhibit 9. Trips Made by Travel Mode, American Community Survey, 2007 to 2011



Source: American Community Survey 2007 to 2011, Table B08301, U.S. Census Bureau, http://census.gov

Future Research

Total peak period travel time can provide additional explanatory power to a set of mobility performance measures by providing some of the desirable aspects of accessibility measures, while at the same time being a travel time quantity that can be developed more frequently using actual travel speeds. There are challenges to a general understanding of the numerical values, but as one measure in a set of measures, it can improve the information provided to technical and lay audiences—particularly as data improve. The data to estimate the total peak period travel time measure, however, require more research into the definitional inconsistencies or other variations that can explain unusual patterns. Four primary refinement areas will be investigated in the coming years:

1. Collector and Local Street Data—More data, specifically volume and speeds on collector and local streets, are needed to increase the accuracy of the measure. Additional data would increase the robustness and accuracy of assumptions made in the calculations.
2. Through-Trip Extraction—Identifying and removing trips that pass through a region (especially freight trips) will reduce the artificially large VMT values.
3. Population Estimates—Matching the geographic boundaries of the FHWA and U.S. Census data will increase the accuracy of urban area travel, population, and commuter estimates.
4. Mode Share—Estimating the number of commuters and travel time for bike, walk, and public transportation and then deciding on a method to incorporate those who work at home will improve the total travel time measure and show the effect of several non-road solutions.

Addressing these issues will create a useful tool for transportation planners, policy makers, and the public. There will always be a role for delay-based measures that focus on identifying regional and corridor problems in the transportation system, but total travel time can provide another view of regional mobility.