

UNDERSTANDING TRAVEL BEHAVIOR

Data Availability and Gaps Scan

Travel Behavior is rapidly changing, and understanding trends represents a critical foundation for efficient planning, design, operation, maintenance and management of our transportation systems. Identifying and forecasting these changes to address policy needs and inform decision making is highly complex and requires considerable improvement of transportation data. Acquiring this information is considered a challenging task for transportation professionals especially since different transportation agencies have different information needs and data availabilities. The companion report to this document, *Understanding Travel Behavior: Research Scan* performed a literature scan of travel behavior research and associated socioeconomic, demographic and technological factors and concluded by identifying information gaps referred to as High Priority Information Needs (HPINs).

This report develops and presents a methodology to demonstrate how different and diverse data sources could be evaluated and ranked to answer travel behavior information needs. In order to assess the suitability and potential of existing data sources for addressing a specific set of eight High Priority Information Needs, this document provides an inventory and assessment of 23 current and potential data sources that can be used to identify and quantify emerging trends in travel behavior. The report is organized as follows:

- *Traditional Data Sources*
- *Niche and Other Potential Data Sources*
- *Data Characterization for High Priority Information Needs*
- *Evaluation and Ranking of Data Sources*
- *Summary, Key Findings and Future Work*

Traditional Data Sources are discussed in the second chapter of this report. An overview of the major traditional data sources currently used to identify and quantify travel behavior trends are detailed with their characteristics, primary uses, benefits and limitations, and possible extensions. Table 1 lists the data sources presented.

Table 1. Traditional Data Sources	
1. National Household Travel Survey (NHTS)	4. Other travel surveys
2. Highway Performance Monitoring System (HPMS) and Traffic Volume Trends (TVT)	- GPS- and cellphone-based travel surveys
3. American Community Survey (ACS) and Census Transportation Planning Package (CTPP)	- Activity-based surveys
	5. Travel survey repositories (Local Surveys)
	- NREL's Transportation Secure Data Center (TSDC)
	- Metropolitan Travel Survey Archive (MTSA)

Niche and Other Potential Data Sources identifies relevant data sources that could contribute to the understanding of emerging trends in travel behavior along with a brief outline of the main characteristics of these data sources and explanations of their potential relevance to travel behavior models. Table 2 lists the data sources discussed in this section.



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Table 2. Niche Data Sources	
1. Trace Data – GPS-Trace Data: National Performance Management Research Data Set (NPMRDS/HERE)	5. Strategic Highway Research Program (SHRP2) Naturalistic Driving Study (NDS)
2. AirSage, Cellphone Trace Data	6. Waze, travel app
3. American Time Use Survey (ATUS)	7. Metropia, travel app
4. National Transit Database (NTD)	8. Uber, ridesourcing RideScout
Other Potential Data Sources	
1. Department of Motor Vehicles (DMV) Insurance	– University of Michigan’s Inter-university Consortium for Political and Social Research (ICPSR)
2. Highway Statistics Series (HSS)	– Other Omnibus Surveys
3. National Transportation Statistics (NTS)	7. USPS Mail Survey
4. American Housing Survey (AHS)	8. ITS/RIITS (Los Angeles County Metropolitan Transportation Authority’s Regional Integration of Intelligent Transportation Systems)
5. Location Based Social Network Data (LBSND)	9. Research Data Exchange
6. Omnibus surveys – Bureau of Transportation Statistics Omnibus Surveys – Pew Research Center	

Data Characterization for High Priority Information Needs assesses all traditional, niche, and other potential data sources presented in the previous sections with respect to their suitability for addressing the eight HPINs identified in the *Research Scan*. Based on this assessment, seven most promising data sources are identified as the best suited for addressing the eight High Priority Information Needs. The eight HPINs and their respective data gaps identified in the *Research Scan* are summarized in Table 3.

Table 3. High Priority Information Needs and HPIN Data Gaps		
1	Vehicle Miles Traveled (VMT) • currently tracked through Highway Performance Monitoring System • misses activity on local roads and may have other measurement errors • measured frequently, but estimation procedures may be inaccurate	HPIN 1: VMT • Improve measurement • Better accuracy
2	Person Miles Traveled (PMT): • currently measured through the NHTS and regional travel surveys	HPIN 2: PMT Frequency • More frequent intervals
3	Mode Share (MS): • derived from regional travel surveys and the ACS journey to work data • needed on more frequent time intervals and better spatial resolution	HPIN 3a: MS Frequency • More frequent intervals HPIN 3b: MS Resolution • Better spatial resolution
4	Telecommuting (Telecom): • challenging mode to define/measure, yet exceedingly important mode	HPIN 4: Telecommuting • Better measurements
5	Trip Purpose (TP Char) Work v. Non-work: • infrequently measured data point for travel, currently supplied by surveys • difficult to understand distinctions between work and non-work travel, mode share, distance, time of day, discretionary nature, and other attributes	HPIN 5: TP & Characteristics • Better understanding of travel characteristics • Better spatial resolution & frequency
6	Demographics as crossed with Travel Metrics (Tr. Demog.): • limited data on demographic distributions as related to travel measurements (mode split, VMT, PMT) • only supplied by NHTS and other regional travel surveys.	HPIN 6: Trip Demographics • Association of demographic distributions with travel data (mode split, VMT, PMT)
7	Attitudes & Public Perceptions (Tr. Demog): • attitudinal shifts across generations impacts choices made by travelers • limited information on how attitudes change • limited abilities to forecast attitude changes.	HPIN 7: Public Attitudes • Attitudes towards mobility across generations • Effect of attitude changes
8	Vehicle Occupancy (Veh. Occ.): • difficult data point to obtain, yet critical for better HOV enforcement • allows better understanding of impacts of ridesharing services	HPIN 8: Vehicle Occupancy • Identify real-time vehicle occupancy • Measure historical vehicle occupancy

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Each of these HPINs was characterized against the 23 traditional, niche and other potential data sources via a three-step qualitative method. The first step collectively examined whether the data source included HPIN relevant information. The second step employed a more detailed approach where information of each data source was further characterized according to eight specific factors (covers HPIN need; data availability; data reliability; potential usefulness; data cost; national trends; geographic, socioeconomic and demographic factors and niche mode choice and travel behavior). Results of this characterization allowed for general ranking of the data sources with respect to each HPIN. By combining all rankings developed in the second step, the third and last step established a general collective ranking for all data sources and identifies the seven most promising data sources suitable for addressing this set of HPINs. These data sources found in Table 4 span over all three groups of data: traditional, niche and other potential ones.

Table 4. Most Promising Data Sources for Addressing Identified HPINs

Type of Data Source	Promising Data Sources
Traditional (Potential) Data Source	1. Continuous National Household Travel Survey (NHTS)
Niche Data Source	2. American Time Use Survey (ATUS)
Other Potential Data Source	3. Omnibus Surveys
Traditional Data Source	4. American Community Survey (ACS) and Census Transportation Planning Package (CTPP)
Traditional Data Source	5. National Household Travel Survey (NHTS)
Other Potential Data Source	6. American Housing Survey (AHS)
Traditional Data Source	7. Local Surveys
Niche Data Source	8. Cellphone Trace Data: AirSage

Evaluation and Ranking of Data Sources: This chapter describes the adoption of the Multi-Attribute Decision Making (MADM) model to rank the seven top data sources in terms of their prospects for addressing this set of HPINs. Five different evaluation runs were developed and presented followed by a sensitivity analysis of the ranked data sources. Results of the evaluation runs produced consistent results: ATUS and omnibus surveys seemed to consistently rank as the top two most promising data sources, followed by ACS. NHTS ranked in the middle followed by the local surveys. At the end were AirSage and AHS. The last of the five evaluations introduced the continuous NHTS, which ranked at the top, indicating it would be the most promising data source solution.

Summary, Key Findings and Future Work: The seven data sources in Table 4 were recognized as the most promising for addressing the data gaps, but none is independently capable of addressing all of the eight HPINs. Since the motivation of this project was based on observations of unprecedented and unpredicted behavioral trends, particularly at the national level, it seems logical that the reason these trends were not predicted relates to existing data gaps. Accordingly, it seems logical that the existing data sources were found not to include all the needed information. *ATUS* and *Omnibus surveys* consistently received high marks from the various evaluation methods. The ATUS is continually updated with several travel behavior variables, but its limitation is that it captures only self-reported travel times and no travel distances. Though there are currently no travel-focused Omnibus surveys, they have great potential to capture specific travel trends at specific locations and times due to their

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flexibility and low cost. The *National Household Travel Survey* is undoubtedly the richest and most comprehensive travel behavior data source in the United States, but in its current state does not rank at the top of the evaluated data sources due to low scores in data periodicity and its ability to capture impacts of emerging modes and niche behavior. Due to being conducted every 5-7 years, updates of questionnaire to capture emerging modes and niche behavior is infrequent. A *continuous NHTS* was found to earn the top ranking because regularly scheduled frequent updates would solve the two greatest weaknesses of the current survey.

The report has led to the discussion of *future research opportunities*:

Data Fusion: While none of the assessed data sources was found to be completely and independently capable of addressing all eight HPINs, different data sources exhibited different levels of strengths with different HPINs. Accordingly, it could be highly beneficial to build data fusion models that capitalize on the strengths of the different data sources to find better and more accurate answers to travel behavior questions.

Continuous NHTS: Since a continuous NHTS ranked highest in terms of its potential to address the eight HPINs, it would be beneficial to perform more comprehensive research that identifies and quantifies potential costs, benefits, and limitations associated with a continuous NHTS.

ATUS: Since ATUS consistently ranked at the top of the evaluated data sources, it seems particularly promising to capitalize on the existence of this data source to address some of the existing data gaps. ATUS seems particularly promising because it is a national, annual and freely available data source. In addition, it captures many aspects of an individual's travel behavior during an entire day.

Omnibus Surveys: Since omnibus surveys persistently ranked at the top of the evaluated data sources, it would be beneficial to conduct a comprehensive research project to identify particular travel behavior trends that would be most suitable to answer using this data source. Such research would include a cost-benefit analysis of the suitability of omnibus surveys to answer these specific travel behavior questions.

It is very clear that travel behavior in the United States is experiencing major shifts. In addition, with the continual emergence of new technologies and the near expectations of self-driving vehicles and automated transportation systems, these shifts may continue to exist and possibly shift even further or again. Since understanding of travel behavior represents a critical foundation for efficient planning, design, operation, maintenance, and management of our transportation systems, this leaves transportation professionals with a challenging task. Niche and other potentially useful data sources could be valuable in addressing existing or potential information gaps. The data source evaluation tool used in the *Data Scan* could be utilized to assess and rank the usefulness of different data sources for addressing a specific data gap or set of data gaps. This should improve the quantity and quality of tools in the toolbox, and improve policy makers' understanding of travel behavior and all associated and dependent benefits.