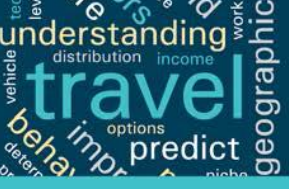

UNDERSTANDING TRAVEL BEHAVIOR
Research Scan

Emerging transportation technologies coupled with changing public attitudes have resulted in unprecedented shifts in the travel behavior of Americans. Electric vehicle adoption is on the rise, the sharing economy continues to provide many alternatives to driving and vehicle ownership, and technology has significantly promoted the growth of teleworking and online commerce. Understanding and forecasting these changes is highly complex and requires considerable improvement of transportation data. Traditionally, the focus of transportation data has been to measure and forecast Vehicle Miles Traveled because of the strong dependency on personal automobiles. VMT is a critical input to understanding the mobility of the nation, and forecasting VMT is necessary to understand system performance, project funding levels, and investment prioritization. As the demand for smarter cities and more diverse transportation options grow, transportation agencies need to expand their ability to understand and forecast system use and performance for all modes of travel.

This brief summarizes the key findings and recommendations from the recent final report titled *Understanding Travel Behavior Research Scan*. The objective of this report was to present a research scan of the state of knowledge in transportation to enhance understanding of travel behavior and various influencing factors on future travel needs as outlined below:

- *Present Day Travel Behavior Measurement and Research within the United States*
  - *Vehicle Miles Traveled*
  - *Person Miles Traveled*
  - *Modal Splits and Vehicle Ownership*
  - *Energy and Emissions*
  - *Telework and Telecommuting*
  - *Non-Work Travel*
- *Socio-Demographic Factors Changing Travel Behavior Today*
  - *Population growth and immigration*
  - *Income*
  - *Age Distribution*
  - *Gender*
  - *Social and Cultural Factors*
- *Transformative Technology and Systems Changing Travel Behavior Today*
  - *Emerging Modes of Travel*
  - *Alternatives to Work Travel*
  - *Alternatives to Non-Work Travel*
  - *Innovative Business Models*
  - *Multi-Modal Traveler Information*
  - *Advanced Infrastructure and Pricing*
- *Emerging Methodologies and Data for Measuring Travel Behavior Today*
- *Conclusions and Key Findings*

Present Day Travel Behavior Measurement and Research within the United States

Travel behavior is currently understood through a variety of metrics: *Vehicle Miles Traveled (VMT), Person Miles Traveled (PMT), Modal splits and vehicle ownership, Energy and Emissions, Telework and telecommuting, and non-work travel.*

VMT is currently measured with nationwide traffic sensors on a monthly basis through the Highway Performance Monitoring System (HPMS). The National Household Travel Survey (NHTS) also measures VMT through trip diaries, allowing for VMT disaggregation by trip characteristics and demographics. Since World War II, VMT has been growing steadily and consistently, except for brief interruptions due to major wars, recessions or oil crises. There was a significant decline in November 2007 due to the Great Recession. However, VMT has since rebounded, surpassing its 2007 peak in February 2015. While the recent decline was not the largest ever recorded, it has been the longest stagnation of VMT growth in U.S. history. The Federal Highway Administration has developed a new model for VMT forecasting which uses predictions in demographic and economic changes to deliver better forecasts for VMT. VMT alone however has a number of limitations for understanding travel behavior. Namely, it is unable to track mobility from non-motorized modes (e.g., public transit, bicycling, walking). Other metrics must be included to understand the larger picture of travel behavior.

PMT measures the number of miles traveled by each person on a trip, including motorized and non-motorized modes as well as passenger miles in public transit and carpool. Because PMT offers a more comprehensive picture of travel across all modes, it is becoming increasingly important to understand the overall picture of travel activity in the US. Measuring PMT is far more demanding, however, because it requires data that is difficult to obtain. Current practice measures PMT through large-scale surveys via travel diaries which translates to infrequent data collection compared to sensor-based VMT. New information and communication technology (ICT) has the potential to improve methods of PMT data collection with greater accuracy and sampling in the future.

Modal split refers to which mode of transportation people use to make trips, such as in private vehicles, by rail or bus or by walking or cycling. Local and regional travel surveys, the NHTS, and the Journey to Work section of the American Community Survey (ACS) act the current sources for mode split data. The NHTS has shown that public transit, walking and biking have each experienced increases in mode share to varying degrees in different regions across the U.S. There is also evidence that *vehicle ownership* rates are currently stagnant, and as the economy continues to recover, it will become clear whether the reason is solely economics, saturation in the population or due to other societal shifts in travel behavior.

Energy and emissions from the transportation sector can be measured by coupling vehicle fuel efficiency and fuel consumption. Tying household vehicle fleet data to VMT is captured via regional surveys and the NHTS. Vehicle registration data and VMT can also be used to model energy consumption and vehicle emissions. Emissions from the transportation sector are showing the largest growth compared to other sectors. Curbing emissions and reducing fuel consumption are playing a supporting role in influencing millennial transportation habits, but research is needed to further understand changing trends in attitudes.

Telework or telecommuting is an alternative arrangement where an employee can work remotely from a centralized workplace using available ICT like telecommunications and personal computers. Research in telework has typically relied on survey and travel diaries. Studies have associated telework with fuel savings but also the potential for more, shorter trips. As options for telecommuting and flexible work policies grow, higher quality data is needed to assess its impact on fuel consumption and VMT.

Non-work travel describes trips made for purposes other than the journey to and from work, such as shopping, personal business, accessing healthcare, and schooling. Non-work travel can be hard to measure because of its diversity in purpose and time. Recent NHTS data suggests that there is an upward trend in non-work travel. This increase is occurring due to the number of trips made, not because of an increase in the average length of the trip. Non-work travel accounts for about 80% of household trips and data that better elucidates when, how, why and where these trips are taking place can better equip policy makers to serve the travel needs of the public.

Socio-Demographic Factors Changing Travel Behavior Today

Socio-demographic factors are rapidly changing and the travel behavior of various groups require more consistent data collection to better equip policy makers with high quality information for timely decision-making. *Population growth and immigration* are changing with immigrants displaying very distinct mode splits. *Income* levels also affect travel, with higher income groups most strongly correlated with higher VMT and trip making. The rapid technology adoption of today's millennials has reduced their vehicle ownership while the baby boomers are driving more than their cohorts from previous generations showing distinct travel patterns among various *age* groups. The popularity of TNC usage has seen significant growth. *Gender* differences are evident through the prevalence of women in the workforce and therefore are driving more than ever before. Though many hold jobs outside of the home, women still retain many domestic responsibilities including the shuttling of children. All these *socio-demographic* characteristics can be captured through travel surveys but need more frequent iterations to clearly understand the future changes of the ever-changing public.

Emerging Methodologies and Data for Measuring Travel Behavior Today

Technology has also drastically changed the landscape of transportation allowing for more travel options, improved *multi-modal travel information*, demand management solutions and even driverless vehicles. The sharing economy of rideshare, carshare and bikeshare has resulted in the lowering of VMT rates. *Alternatives to both work and non-work travel* like telework, online shopping, telemedicine, social networking and online education are rapidly growing and their trends are difficult to describe adequately. The movement towards smart and walkable cities has led to more bike miles and pedestrian miles but without thorough count data to assess national patterns. *Innovative business models* have led to internet based apps that provide on-demand goods deliveries, courier network services, valet parking, traffic demand management services and privately run transit services. And the adoption of automated vehicle technology continues to grow, but its penetration speed into the household fleet remains uncertain. *Advance Infrastructure and pricing* will also continue to develop alongside the changing vehicle fleet improving both efficiency and safety.

Emerging Methodologies and Data for Measuring Travel Behavior

Much of the data needed to describe changing national trends in transportation is collected from the NHTS and other regional surveys. Because the NHTS is administered every 5 to 7 years, policy makers do not have consistently up-to-date information on the travel behavior and attitudes of the U.S. public to predict patterns in travel behavior. Questionnaire updates also need to capture new and emerging transportation modes and frequency of technology usage. Technology for collecting data has also transformed dramatically with new approaches and methods for evaluating travel using GPS/smartphone technology. Surveys can also be collected via internet web diaries or cloud-based travel diaries. These new methods can produce higher quality, real-time data for extended periods of time with less error in personal reporting. Activity-based modeling may produce more statistically sound forecasting estimation models than traditional choice-based models, but the former calls for higher accuracy trip purpose assignments based on the theory that travel is a derived demand motivated by a person's lifestyle and activities. Other data sources exist like location-based social networking, cell phone data, GPS data, and automated vehicle location systems, but to effectively use the data, future research will need to overcome the institutional and technological barriers of data sharing, data accuracy, cyber security and privacy.

Conclusions and Key Findings

The results of this research scan have yielded a number of insights and conclusions related to the state of travel behavior understanding. The recommendations, gaps and high priority information needs identified are not exhaustive but provide guidance on general initiatives that could be pursued to advance our understanding of travel behavior.

- As people are becoming more multi-modal, it is especially important to have improved measures of PMT. Additionally other information gaps include VMT, Mode Share, Telecommuting, Trip Purpose, Demographics, Attitudes, and Vehicle Occupancy.
- Future research recommendations must include better understanding Emerging Modes: sharing economy, autonomous vehicles, telework, alternatives to non-work travel, etc.
- Finally, to better collect travel measures, research must also include enhancements to current surveys, methods and data i.e. continuous NHTS, improved immigrant survey participation, supplementing travel diaries with smartphone or GPS technology, better collection/storage of real-time data, leveraged use of advanced data sources, improved surveys that capture attitudinal shifts…

The current resources and potential approaches for addressing these gaps and needs will be explored in greater detail within the companion report to this document, entitled "Understanding Travel Behavior: Data Availability and Gaps Scan." This report provides a comprehensive look at all datasets that exist today, and discusses how they can be used to provide near term coverage of the data gaps and needs discussed, as well as forward-looking insights regarding the development of these resources in the future.