Big Data in the Real World

Building and Calibrating Travel Demand Models
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What is a Travel Demand Model?

Travel demand models use current travel behavior to predict future travel patterns from a sample of travel behavior data. As you might expect, models are critical tools for planners and engineers who use them to forecast the transportation needs of the communities they serve. They also help transportation professionals assess the pros and cons of different options for meeting those needs.

However, travel demand models are only as accurate as their input data. Without an accurate understanding of real-world conditions today, planners and engineers cannot predict future demand.

Keep reading this guide to find out how location data created by mobile devices – also known as “Big Data” - can help you build and calibrate travel demand models.
Creating Travel Demand Models

There are many ways to build a model, but no matter what, building accurate travel demand models requires detailed information about:

- Where groups of people go
- The ways their travel behavior changes during specific conditions

Traditionally, travel demand models use a four-step process to analyze regional transportation planning:

1. Trip generation (the number of trips to be made)
2. Trip distribution (where those trips go)
3. Mode choice (how the trips will be divided among the available modes of travel)
4. Trip assignment (predicting the route trips will take)

The results obtained through this four-step process vary widely, since they depend on the quality of the assumptions and data used, as well as the particular model’s sophistication. Micro models for small areas usually give users an estimate of highway volumes for individual roadways or intersections, where as “macro” and “meso” models look at entire counties, regions, and even state and multi-state geographies.

No matter their size, the most sophisticated models incorporate and analyze highly granular data, such as commercial truck activity, HOV lane usage, tolling behavior, and more. Route choice between the same two locations, for example, can vary dramatically depending on time of day and other factors that influence drivers.
To illustrate, let’s say that our friend Sarah needs to drive from her home in Pittsburgh’s east end to the downtown business district. Most of the time, she finds Penn Avenue to be the fastest and most enjoyable route, but she also knows it is foolish to take that route during rush hour, a sports game, a major concert, or a visit from the President.

**Ultimately, accurate travel demand models require quality input data.** Outdated or incomplete data results in inaccurate models, and your predictions could fail to account for the decisions that drivers like Sarah make almost subconsciously.
Using Big Data for Origin-Destination Matrices

One of the most important data inputs for any model is an origin-destination (“O-D”) matrix—data that tells you where people are coming from (origin) and where they are going (destination) after visiting or passing through a specific location. In the past, planners utilized surveys, a set of “gravity” assumptions, and/or license plate studies to create O-D matrices, which are all costly and typically have small sample sizes.

Transportation experts can now use Big Data to quickly create precise, accurate and comprehensive O-D matrices, using algorithmic techniques that analyze “pings” from millions of mobile devices and organize them by location and time stamp.

When transportation experts have analytics about trips from millions of devices, they can create traditional O-D matrices that represent a far greater percentage of the population and a longer timespan than could be captured through surveys or license plate studies. Planners can also capture short trips more accurately, like a quick run into the grocery store while on the commute home. Those types of short trips tend to get undercounted or completely overlooked in a typical travel survey.

In a nutshell, trips and series of activities are created by:

- Identifying the pings that occur when mobile devices begin moving (the origins);
- Following the series of pings that occur on the devices’ journeys (the route); and
- Identifying the final pings when devices come to rest (the destinations).

It’s important, however, to recognize that these data points are messy at the outset. No single person could manage trillions of data points using Microsoft Excel! That
means **sophisticated processing techniques are critical** to making these data sets manageable and effective for planning transportation projects.

Using Big Data from mobile devices for these matrices helps deliver the fine resolution needed for accurate travel demand modeling. But that's only the beginning. Trip data (the time stamps that identify devices' home and work locations) can be combined with contextual data sets, such as parcel boundaries and demographic information. Now, your traditional O-D matrices can be analyzed in terms of trip purpose.
Inferring Trip Purpose

Trip purpose is also a key input for transportation modelers to consider. With Big Data, you can infer why groups of people travel from one location to another by analyzing devices’ aggregated behavior over a longer period. Big Data can help you estimate the portion of trips in a study that are:

- Home-Based Work: Travel between home and work in either direction
- Home-Based Other: Travel to and from the home, to anywhere other than work
- Non-Home Based: All travel not to or from home

For example, StreetLight InSight®—that’s StreetLight Data’s interactive, online platform that aggregates and simplifies those trillions of data points—can provide the trip purposes for the purposes listed above for any O-D matrix in just a few minutes.

Our Trip Purpose Metric is derived from Location-Based Services data (LBS data), which are location records generated by smartphone applications where a user turns on location tracking, i.e. weather apps, bus tracking apps, etc. The advantages of LBS data are its large sample size and spatial precision.

Planners can benefit from our Home-Work Trip Purpose Metrics because they no longer need to get this information from models or surveys, which are expensive to conduct and typically have low response rates. With comprehensive analytics derived from Big Data, planners can now gather spatially precise trip purpose information using real-world data. For example, when creating a traditional, four-step, Travel Demand Model, the Home-Work Trip Purpose Metric will be a huge asset.
Data Requirements for Dynamic Traffic Assignment

Another great modeling technique where one can use Big Data is Dynamic Traffic Assignment (DTA). DTA is better at modeling user response to issues such as peak spreading, freight analysis, and congestion at fine resolutions. But DTA is a meticulous modeling technique, so it requires detailed, rigorous data to be done right. The old approach requires collection from at least 6 different sources, and many of them are very cumbersome and expensive. It also requires a huge effort to integrate, calibrate, and check that data integration. The result is not only expensive and time consuming, but also has a lot of assumptions. It’s simply clunky and messy.

Working with Big Data, you can attack DTA with a direct, data-driven approach. Using fine-tuned origin-destination studies based on Big Data, modelers can uncover precise analytics such as how left-hand turns are affected by time of day and type of trip. Route choice can vary dramatically by time of day, so understanding the ways that behavior changes during specific conditions is critical to building accurate models.

This detailed modeling technique is particularly effective for modeling user response to issues such as peak spreading, freight analysis and congestion, in fine resolution. To be effective, however, DTA modeling requires detailed, rigorous data. When you use location data from mobile devices, you can get the information you need to create a DTA quickly and easily.
Big Data Integration with Other Modeling Tools

Beyond Big Data being a great source of information on its own, it can also be easily integrated into other modeling and simulation tools. CSV files of our Metrics can be downloaded directly from StreetLight Insight, and then users can input that information into their preferred modeling tools. We have also developed a Data API that can be used to integrate our analytics into many mapping and modeling tools.

To make it even simpler, StreetLight Data has a partnership with PTV Group—a transportation modeling and forecasting software provider—where our real-world mobility data works seamlessly with their simulation software. To learn more about this partnership and process check out our tutorial.
Real-World Case Studies

Hundreds of transportation agencies are benefitting from using Big Data in travel demand models. It’s helping them understand travel behavior more comprehensively, precisely, and accurately. If your goals are to collect high quality data cost-effectively, there is no better way to understand group travel patterns.

Here are just a few of the public agencies that have used Big Data analytics from StreetLight InSight in travel demand models:

• Virginia Department of Transportation (VDOT)
• California Department of Transportation (CALTRANS)
• Colorado Department of Transportation (CDOT)
• Southeastern Michigan Council of Governments (SEMCOG)
• Napa Valley Transportation Authority (NVTA)
• Transportation Authority of Marin (TAM)
• …and many more!
Beyond Travel Demand Modeling

As we've discussed, Big Data is an essential tool for understanding the ways behavior changes during specific conditions, and building accurate travel demand models. But there are a number of other applications that are transforming transportation.

Here are seven other ways to harness the power of Big Data in your planning and projects:

1. Transportation Demand Management
2. Internal/External Studies
3. Congestion Studies
4. Project Performance Evaluations
5. Performance Measures
6. Detour Planning
7. Public Transit Design and Expansion

Ready to learn more about how Big Data can help you model travel behavior? Sign up for your personal StreetLight InSight demo today.