Use of GPS Devices to Enhance Travel Behavior Diaries

2017 CE Survey Methods Symposium
Washington, D.C.
July 18, 2017

Josh DeLaRosa
Overview

1. Understanding of Household Travel Surveys (HTS)
2. Limitations of Travel Diaries
3. GPS and Cellular Assisted Enhanced Diaries
4. Logistical, Privacy and Technical Considerations
Summary

A. HTS: capture key data to understand travel behavior
B. Detailed data = respondent burden
C. GPS/cellular data to minimize measurement error & item-nonresponse
D. GPS/smartphone data introduces project management & measurement issues
Understanding Travel Behavior

- Travel Demand Modeling
  - Transportation planning
- High Resolution
  - Spatial
  - Temporal
- Household
  - Number of vehicles
- Person
  - Demographics
- Trip
  - Purpose of trip
  - Mode

## HTS Study Design

<table>
<thead>
<tr>
<th>Household Survey</th>
<th>Roster</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Demographics</td>
</tr>
<tr>
<td></td>
<td>Contact information</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Person Level Travel Diary</th>
<th>Address - Geocodable to the Census block</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time (HH:MM)</td>
</tr>
<tr>
<td></td>
<td>Purpose (e.g. school, shopping, work, etc.)</td>
</tr>
<tr>
<td></td>
<td>Mode (vehicle, transit, etc.)</td>
</tr>
</tbody>
</table>
Travel Diary Data Quality

- Item nonresponse
  - Zero trip days
  - Unreported trips
- Measurement error
  - Trip times
  - Trip locations
GPS Data Enhancements

- Subsample given GPS logger or smartphone app
- Location data is collected passively at prescribed intervals
- Purpose inferred by location
- Mode inferred by speed
Typology of Location Data

- Trace files
- Cellular Tower Data
- WiFi
- Bluetooth Beacons
- GPS
GPS Logging

- Devices log location and time
- Data processed ex post facto
- Diary data matched and compared to device data
- Develop underreported trip estimate
Prompted Recall

- Location data processed near real time (GSM/Wifi)
- Parsed GPS are transformed to trips (O/D)
- Machine Learning is used to pre-fill diary
- Respondent verifies/edits trips

Trip counts
Prompted Recall vs Diary

Singapore

Trip counts
Prompted Recall vs Diary

Location Quality Issues

- Location data vulnerable to measurement error
  - User error
  - Device error
  - Processing error
  - GPS signal quality

Logistical and Privacy Issues

- Data privacy
- Recruitment Bias?
Logistical and Privacy Issues (2)

- Smartphone ownership
- Cost
  - Device/shipping cost
  - GSM cost
  - App cost

<table>
<thead>
<tr>
<th>% of U.S. adults who own the following devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any cellphone</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Men</td>
</tr>
<tr>
<td>Women</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>Hispanic</td>
</tr>
<tr>
<td>Ages 18-29</td>
</tr>
<tr>
<td>30-49</td>
</tr>
<tr>
<td>50-64</td>
</tr>
<tr>
<td>65+</td>
</tr>
<tr>
<td>Less than high school graduate</td>
</tr>
<tr>
<td>High school graduate</td>
</tr>
<tr>
<td>Some college</td>
</tr>
<tr>
<td>College graduate</td>
</tr>
<tr>
<td>Less than $30,000</td>
</tr>
<tr>
<td>$30,000-$49,999</td>
</tr>
<tr>
<td>$50,000-$74,999</td>
</tr>
<tr>
<td>$75,000+</td>
</tr>
<tr>
<td>Urban</td>
</tr>
<tr>
<td>Suburban</td>
</tr>
<tr>
<td>Rural</td>
</tr>
</tbody>
</table>

Source: Survey conducted Sept. 28-Nov. 6, 2018.
Pew Research Center
Conclusion

• Travel diaries have a high level of respondent burden
• GPS and cellular data can improve the quality of travel diary data
• Passive location data add complexity and cost
• Location data is subject to error
• Diaries still need to capture attitudes and opinions
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Josh_delarosa@abtassoc.com