Calibration and Validation of an Activity-Based Model (ABM)-The San Diego Experience

ITE Western District Annual Meeting
San Diego, California – June 19, 2017

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San Diego Association of Governments (SANDAG)
Background & Timeline

Today’s Topic

- ABM Development: 01/09-01/13
- AT Model & Preparation for SD Forward: 01/13-12/13
- SD Forward Applications: 01/14-10/15
- Enhancements & Calibration and Validation: 10/15-11/16

Future Work

- ABM Update w/ 2017 HHTS for 2019 RTP
What is a Travel Demand Model?

<table>
<thead>
<tr>
<th>HH #</th>
<th>Per #</th>
<th>Tour #</th>
<th>Purpose</th>
<th>Origin Zone</th>
<th>Destin. Zone</th>
<th>Outbound Stop1 Zone</th>
<th>Return Stop1 Zone</th>
<th>Mode</th>
<th>Outbound Time</th>
<th>Return Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1023</td>
<td>1</td>
<td>1</td>
<td>Work</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>Transit</td>
<td>7:30AM</td>
<td>5:00 PM</td>
</tr>
<tr>
<td>1023</td>
<td>1</td>
<td>2</td>
<td>Work-Based</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>Walk</td>
<td>12:00 PM</td>
<td>1:00 PM</td>
</tr>
</tbody>
</table>
What is an ABM?

1. Select Primary Destination
2. Select Departure/Arrival Period
3. Select Primary Mode
4. Select Stop Location
## Travel Surveys & ABM

<table>
<thead>
<tr>
<th>Survey</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Travel Behavior Survey</td>
<td>2006/2007</td>
</tr>
<tr>
<td>Transit On-Board Survey</td>
<td>2009</td>
</tr>
<tr>
<td>Air Passenger Survey (SDIA)</td>
<td>2009</td>
</tr>
<tr>
<td>Parking Inventory Survey</td>
<td>2010</td>
</tr>
<tr>
<td>Parking Behavior Survey</td>
<td>2010</td>
</tr>
<tr>
<td>Border Crossing Survey</td>
<td>2010</td>
</tr>
<tr>
<td>Visitor Survey</td>
<td>2011</td>
</tr>
<tr>
<td>Special Events Survey</td>
<td>2011</td>
</tr>
</tbody>
</table>
Who Uses SANDAG Model?

- SANDAG
- Caltrans
- CARB
- City of San Diego
- MTS
- NCTD
- Local Jurisdictions
- Private Developers
Calibration & Validation

- Model calibration
  - Adjust model parameters

- Model validation
  - Base years—2012, 2014, and 2015
  - Model estimated vs. observed

- Why so many calibration & validation efforts?
  - Sociodemographic changes
  - Travel behavioral changes
  - Model improvements
  - New data sources
What Changed Since SD Forward?

- **Model inputs**
  - Synthetic population (PopSyn II to III)
  - Transportation networks

- **Data sources**
  - Updated traffic counts
  - Updated calibration targets

- **Software**
  - From 13.0.0 to 13.3.0
Synthetic Population II vs. III

Synthesized Households & Population

<table>
<thead>
<tr>
<th>Households</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,206,526</td>
<td>3,143,429</td>
</tr>
<tr>
<td>1,206,503</td>
<td>3,014,440</td>
</tr>
<tr>
<td>1,206,526</td>
<td>3,143,418</td>
</tr>
</tbody>
</table>

4% less

Target: 3,143,429
PopSyn II: 3,014,440
PopSyn III: 3,143,418
What to Calibrate?

- Auto ownership model
- Coordinated daily activity pattern model
- Tour/trip mode choice models
- Crossborder model
- Military travel market
## Base Year 2012 Scenario Definitions

<table>
<thead>
<tr>
<th>Scenario</th>
<th>PopSyn</th>
<th>Version</th>
<th>Date</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>II</td>
<td>13.2.3</td>
<td>08/15</td>
<td>Calibrated w/ PopSyn II.</td>
</tr>
<tr>
<td>227</td>
<td>III</td>
<td>13.2.5</td>
<td>11/15</td>
<td>Uncalibrated w/ PopSyn III</td>
</tr>
<tr>
<td>540</td>
<td>III</td>
<td>13.3.0</td>
<td>10/16</td>
<td>Calibrated w/ PopSyn III</td>
</tr>
</tbody>
</table>
Calibration Results - Auto Ownership Model

- Model with PopSyn II
- Model with PopSyn III
- Calibrated Model with PopSyn III

-6.0% -4.0% -2.0% 0.0% 2.0% 4.0% 6.0%

4+ cars - 7.2%
3 cars - 15%
2 cars - 39.8%
1 car - 31.9%
0 car - 6.1%
Roadway Validation Results

Estimated vs. Observed - All

\[ y = 1.021x \]
\[ R^2 = 0.9602 \]
Roadway Validation Results - I-5 NB

- %Link(+) = 61%
- %Link(-) = 39%
- AvgGap(+) = 8%
- AvgGap(-) = 9%
- AvgGap(±) = 2%
- Gap1(±10%) = 77%
- Gap1(±20%) = 94%
- Gap1(±30%) = 95%
- Linear Slope = 1.022
- RMSE = 10%

- observed
- estimated
- Milepost
Roadway Validation Results - SR-52 WB

- %Link(+) = 95%
- %Link(-) = 5%
- AvgGap(+) = 25%
- AvgGap(-) = 5%
- AvgGap(±) = 24%
- GapIn(±10%) = 11%
- GapIn(±20%) = 37%
- GapIn(±30%) = 68%
- Linear Slope = 1.234
- RMSE = 26%

Daily Volume

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
-10000 -7000 -4000 -1000 0 1000 2000 3000 4000 5000 6000 7000 8000

MARIOQA CUPRAMAC MISSION GORGE MAST MAST MAST MAST SANTO SANTO I-15 SB SR-6 SB CORROY I-805 NB I-805 SD GRIESSI GRIESSI REGENTS REGENTS

-observed modeled

%_gap
Transit Validation Results - Total Transit Ridership

<table>
<thead>
<tr>
<th>Observed</th>
<th>Model w/ PopSyn II</th>
<th>Model w/ PopSyn III</th>
<th>Calibrated Model w/ PopSyn III</th>
</tr>
</thead>
<tbody>
<tr>
<td>347</td>
<td>356</td>
<td>372</td>
<td>351</td>
</tr>
</tbody>
</table>

- Transit Ridership
- Diff%
## Transit Validation Results—by Mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>2012 Observed</th>
<th>Calibrated w/ PopSyn II</th>
<th>Uncalibrated w/ PopSyn III</th>
<th>Calibrated w/ PopSyn III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012 Observed</td>
<td>Estimated</td>
<td>diff%</td>
<td>Estimated</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>5,482</td>
<td>4,410</td>
<td>-19.6%</td>
<td>5,287</td>
</tr>
<tr>
<td>Light Rail</td>
<td>123,729</td>
<td>115,834</td>
<td>-6.4%</td>
<td>116,188</td>
</tr>
<tr>
<td>Express Bus</td>
<td>1,430</td>
<td>1,297</td>
<td>-9.3%</td>
<td>1,255</td>
</tr>
<tr>
<td>Local Bus</td>
<td>216,435</td>
<td>234,877</td>
<td>8.5%</td>
<td>249,253</td>
</tr>
<tr>
<td>Total</td>
<td>347,076</td>
<td>356,417</td>
<td>2.7%</td>
<td>371,983</td>
</tr>
</tbody>
</table>
Validation Results - Regional VMT

Vehicle Miles Traveled

<table>
<thead>
<tr>
<th>Model</th>
<th>VMT</th>
<th>Diff%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>79,435</td>
<td></td>
</tr>
<tr>
<td>Model w/ PopSyn II</td>
<td>79,289</td>
<td>-0.18%</td>
</tr>
<tr>
<td>Model w/ PopSyn III</td>
<td>79,036</td>
<td>-0.50%</td>
</tr>
<tr>
<td>Calibrated Model w/ PopSyn III</td>
<td>79,269</td>
<td>-0.21%</td>
</tr>
</tbody>
</table>

Thousands

Vehicle Miles Traveled

Target: 79,435
Model w/ PopSyn II: 79,289 (-0.18%)
Model w/ PopSyn III: 79,036 (-0.50%)
Calibrated Model w/ PopSyn III: 79,269 (-0.21%)
Military Base Validations

- Traffic counts at military base gates
- Modeled vs. observed trips by base
- Modeled vs. observed trips by gate

Limitations
- Lack of behavioral data
- Military personnel treated as regular persons/households
- Matching to counts can only do this much
Military Validation Results - by Base

- Camp Pendleton
- Miramar Air Station
- More
- US Coast Guard
- North Island
- Naval Base Point Loma
- Naval Amphibious Base
- Silver Strand Training
- Naval Outlying Field
- Anti-Submarine
- VA/Balboa Hospital

Model w/ PopSyn II
Model w/ PopSyn III
Calibrated Model w/ PopSyn III

Graph showing validation results for various bases with different models.
Speed Validation

- New data source such as INRIX data makes it possible
- Data mining and processing for travel modeling needs further study
- Limited to adjusting volume delay function (VDF) parameters to match observed speed data
Volume Delay Function (VDF)

VDF Model Form

\[ T_f = T_0 \left[ 1 + \alpha_i \left( \frac{V}{C_z} \right)^\beta_i \right] + \rho \frac{c}{2} \left( 1 - \frac{g}{c} \right)^* \left[ 1 + \alpha_i \left( \frac{f \cdot V}{C_i} \right)^\beta_i \right] \]
Speed Validation Result – I-5 Corridor NB

Original Result - Average Speed by Time Period - Modeled vs INRIX along Corridor - I-5 NB

Average Speed by Time Period

Mile Stone

SAN YSIDRO
SR-905 EB
CORONADO
MAIN
PALOMAR
SR-15 NB
NATIONAL
19TH
SR-94 WB
INDIA
I-8 EB
BALBOA
GILMAN
EASTGATE
SANTA FE
PALOMAR AIRPORT
CARLSBAD VILLAGE
OCEANSIDE
BASILONE

INRIX PM
model_PM
road

SANDAG
Speed Validation Result – I-5 Corridor NB

Latest Result - Average Speed by Time Period - Modeled vs INRIX along Corridor - I-5 NB (Scenario 642)
What’s Next?

- Validation outlier analysis
- Base year 2014 calibration & validation
- Model update with 2017 HHTS
  - Re-estimate/calibrate models to reflect updated travel patterns
  - Travel time reliability model