Forum Agenda

Travel Behavior Survey Summary

ABM2

Induced Travel
Travel Behavior Survey Summary

Ziying Ouyang
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Travel Behavior Survey Summary

<table>
<thead>
<tr>
<th></th>
<th>Unweighted*</th>
<th>Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households</td>
<td>6,139</td>
<td>1,113,624</td>
</tr>
<tr>
<td>Persons</td>
<td>12,089</td>
<td>2,922,537</td>
</tr>
<tr>
<td>Person Trips</td>
<td>208,943</td>
<td>11,665,894</td>
</tr>
<tr>
<td>Trips/Household</td>
<td></td>
<td>10.48</td>
</tr>
<tr>
<td>Trips/Person</td>
<td></td>
<td>3.69</td>
</tr>
</tbody>
</table>

(* Weekday Only)
Travel Behavior Survey Summary

Household Size

<table>
<thead>
<tr>
<th>Household Size</th>
<th>MOVE ONLY</th>
<th>DIARY ONLY</th>
<th>TOTAL</th>
<th>ESTIMATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 person</td>
<td>21.9%</td>
<td>32.9%</td>
<td>24.5%</td>
<td>21.8%</td>
</tr>
<tr>
<td>2 people</td>
<td>11.3%</td>
<td>13.1%</td>
<td>11.9%</td>
<td>14.9%</td>
</tr>
<tr>
<td>3 people</td>
<td>15.8%</td>
<td>10.1%</td>
<td>14.5%</td>
<td>14.9%</td>
</tr>
<tr>
<td>4 people</td>
<td>18.5%</td>
<td>16.7%</td>
<td>17.7%</td>
<td></td>
</tr>
<tr>
<td>5 or more</td>
<td>32.5%</td>
<td>32.4%</td>
<td>30.7%</td>
<td></td>
</tr>
</tbody>
</table>

Legend: 1 person | 2 people | 3 people | 4 people | 5 or more people
Travel Behavior Survey Summary

Household Income

<table>
<thead>
<tr>
<th>Household Income Range</th>
<th>RMOVE ONLY</th>
<th>DIARY ONLY</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under $30,000</td>
<td>13.3%</td>
<td>22.0%</td>
<td>21.5%</td>
</tr>
<tr>
<td>$30,000-$59,999</td>
<td>21.9%</td>
<td>26.7%</td>
<td>23.5%</td>
</tr>
<tr>
<td>$60,000-$99,999</td>
<td>23.6%</td>
<td>37.9%</td>
<td>23.6%</td>
</tr>
<tr>
<td>$100,000-$149,999</td>
<td>19.2%</td>
<td>7.0%</td>
<td>18.7%</td>
</tr>
<tr>
<td>$150,000 or more</td>
<td>7.0%</td>
<td>9.8%</td>
<td>14.5%</td>
</tr>
</tbody>
</table>
Travel Behavior Survey Summary

Household Vehicles

- **RMOVE ONLY**
  - 0 (no vehicles): 2.8%
  - 1 vehicle: 44.5%
  - 2 vehicles: 29.2%
  - 3 or more vehicles: 23.5%

- **DIARY ONLY**
  - 0 (no vehicles): 11.1%
  - 1 vehicle: 38.3%
  - 2 vehicles: 32.0%
  - 3 or more vehicles: 20.8%

- **TOTAL**
  - 0 (no vehicles): 5.7%
  - 1 vehicle: 39.3%
  - 2 vehicles: 32.0%
  - 3 or more vehicles: 23.1%
Travel Behavior Survey Summary

Age Distribution

- Under 5 years old: 5.9%
- 5-15 years: 14.2%
- 16-17 years: 13.5%
- 18-24 years: 13.3%
- 25-34 years: 8.8%
- 35-44 years: 6.9%
- 45-49 years: 6.2%
- 50-54 years: 5.9%
- 55-59 years: 1.7%
- 60-64 years: 1.7%
- 65-74 years: 1.4%
- 75-79 years: 0%
- 80-84 years: 2%
- 85 years or older: 4%
travel behavior survey summary

employment status

- 16-17 years: 78.6%, 36.5%, 19.8%, 16.9%, 20.6%, 16.4%, 26.3%, 43.7%, 70.9%, 86.7%, 96.3%, 98.5%, 13.4%, 48.8%
- 18-24 years: 24.1%, 26.1%, 69.0%, 70.7%, 63.9%, 66.6%, 60.1%, 9.7%, 6.0%, 0.7%, 0.5%, 4.8%
- 25-34 years: 10.1%, 10.8%, 10.8%, 14.0%, 14.0%, 11.9%, 7.0%, 9.6%, 6.0%, 0.7%, 0.5%, 4.8%
- 35-44 years: 6.0%, 6.0%, 6.0%, 6.0%, 6.0%, 6.0%, 6.0%, 6.0%, 6.0%, 6.0%, 6.0%, 6.0%
- 45-49 years: 3.4%, 3.4%, 3.4%, 3.4%, 3.4%, 3.4%, 3.4%, 3.4%, 3.4%, 3.4%, 3.4%, 3.4%
- 50-54 years: 1.1%, 1.1%, 1.1%, 1.1%, 1.1%, 1.1%, 1.1%, 1.1%, 1.1%, 1.1%, 1.1%, 1.1%
- 55-59 years: 0.7%, 0.7%, 0.7%, 0.7%, 0.7%, 0.7%, 0.7%, 0.7%, 0.7%, 0.7%, 0.7%, 0.7%
- 60-64 years: 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%
- 65-74 years: 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%
- 75-79 years: 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%
- 80-84 years: 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%
- 85 years or older: 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%
- Total: 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%
Travel Behavior Survey Summary
Travel Behavior Survey Summary

Miles to Work by MSA

Average Commute Distance:
North City: 10.7
East Suburban: 13.3
Total: 11.8
Travel Behavior Survey Summary

Trip Mode Choice by Tour Purpose

<table>
<thead>
<tr>
<th>Mode</th>
<th>WORK</th>
<th>UNIVERSITY</th>
<th>MAINTENANCE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto SOV</td>
<td>78.6%</td>
<td>48.3%</td>
<td>41.0%</td>
<td>46.4%</td>
</tr>
<tr>
<td>Auto 2 Person</td>
<td>4.2%</td>
<td>13.1%</td>
<td>6.4%</td>
<td>18.7%</td>
</tr>
<tr>
<td>Auto 3+ Person</td>
<td>10.5%</td>
<td>15.1%</td>
<td>23.9%</td>
<td>24.0%</td>
</tr>
<tr>
<td>Walk</td>
<td>8.3%</td>
<td>14.5%</td>
<td>27.7%</td>
<td>13.1%</td>
</tr>
<tr>
<td>Bike/Moped</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Transit</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>7.9%</td>
</tr>
<tr>
<td>School Bus</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Travel Behavior Survey Summary

Trip Departure

![Graph showing trip departure times with three categories: Total, Work, and Individual Discretionary. The x-axis represents time from 3:00 AM to 3:00 AM, and the y-axis represents the percentage of trips.]
Active Transportation Trip Destinations
Travel Behavior Survey Summary

Survey Report Available

ABM2

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Background

- 2016/2017 Household Travel Behavior Survey
- 2015 Transit OnBoard Survey
- Focus: calibration and validation
- For 2019 Regional Plan
ABM2

A Suite of Travel Models

- Core model
  - San Diego resident model

- Special market models:
  - Airport passenger models- two of them
  - Visitor model
  - Crossborder model
  - Tour-based commercial travel model (CTM)
  - External models
  - Truck model
## Differences: ABM1 vs. ABM2

<table>
<thead>
<tr>
<th></th>
<th>ABM1</th>
<th>ABM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year</td>
<td>2012</td>
<td>2016</td>
</tr>
<tr>
<td>Surveys</td>
<td>HHTS</td>
<td>2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2016/2017</td>
</tr>
<tr>
<td>OnBoard</td>
<td>2009</td>
<td>2015</td>
</tr>
<tr>
<td>CTM</td>
<td>Trip-Based</td>
<td>Tour-Based</td>
</tr>
<tr>
<td>Travel Time Reliability</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Escort Model</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Assignment/Skimming</td>
<td>TransCAD</td>
<td>EMME</td>
</tr>
</tbody>
</table>
ABM2

Observed travel trend changes

- Higher trip/tour rates
- Declining transit boarding’s

San Diego Regional Transit Boardings

<table>
<thead>
<tr>
<th>Year</th>
<th>Boardings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>359,810</td>
</tr>
<tr>
<td>2013</td>
<td>359,450</td>
</tr>
<tr>
<td>2014</td>
<td>369,640</td>
</tr>
<tr>
<td>2015</td>
<td>373,834</td>
</tr>
<tr>
<td>2016</td>
<td>353,442</td>
</tr>
<tr>
<td>2017</td>
<td>327,517</td>
</tr>
</tbody>
</table>

-5%  -12%
ABM2

Calibration & Validation

- Observed data sources
- Goal: hitting multiple targets simultaneously
  - By model component
  - By modeling segmentation
  - By geography
  - By data source
Quality Assurance/Quality Control (QA/QC)

- Plan of Excellence
- Calibration & Validation is QA/QC
- QA/QC is NOT only calibration & validation
- Additional QA/QC
  - Population/households
  - Land use (employment etc.)
  - Networks
Draft results

- Not final
- Example results
  - A lot more in final report
  - Results by travel market, trip purpose, person type, time of day, geography, etc.
- Production mode
  - July 2018
ABM2

Draft results - Auto Ownership

![Bar Chart: Modeled vs Observed Auto Ownership]
ABM2

Draft results - Tour Rates
Draft results - Tour Mode Choice

ABM2

Modeled

Observed

Auto SOV
Auto 2 Person
Auto 3+ Person
Walk
Bike/Moped
Walk-Transit
PNR-Transit
KNR-Transit
School Bus
Draft results - Home to Work Distance
Draft results - Non Mandatory Tour Length

Modeled

Observed
ABM2

Draft results - Tour Time of Day Choices

[Graph showing modeled and observed tour times]
ABM2

Draft results - Assignment
# Draft results - Assignment

## Number of links within Gap Range

<table>
<thead>
<tr>
<th>Gap Range</th>
<th>freeways</th>
<th>ramps</th>
<th>arterials</th>
<th>collectors</th>
<th>all</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10% ~ +10%</td>
<td>417</td>
<td>102</td>
<td>126</td>
<td>95</td>
<td>740</td>
</tr>
<tr>
<td>-20% ~ +20%</td>
<td>564</td>
<td>176</td>
<td>241</td>
<td>184</td>
<td>1165</td>
</tr>
<tr>
<td>-30% ~ +30%</td>
<td>615</td>
<td>271</td>
<td>366</td>
<td>247</td>
<td>1499</td>
</tr>
<tr>
<td><strong>total links</strong></td>
<td><strong>657</strong></td>
<td><strong>438</strong></td>
<td><strong>583</strong></td>
<td><strong>598</strong></td>
<td><strong>2276</strong></td>
</tr>
</tbody>
</table>

## Root Mean Square Error (RMSE)

<table>
<thead>
<tr>
<th>RMSE percent</th>
<th>13%</th>
<th>39%</th>
<th>37%</th>
<th>60%</th>
<th>23%</th>
</tr>
</thead>
</table>

## Trend Line Slope

| Slope         | 1.00 | 0.94 | 0.88 | 0.77 | 0.99 |
Draft results - Assignment (NB I-15)
ABM2

Draft results - Assignment (SB I-5)

I-5 SB Validation of Modeled and Observed Daily Volumes

Park Blvd.

Bay Blvd.

SANDEAG

33
**ABM2**

**Draft results - VMT**

<table>
<thead>
<tr>
<th></th>
<th>VMT Regional Total</th>
<th>VMT per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observed</strong></td>
<td>83,763,007</td>
<td>25.49</td>
</tr>
<tr>
<td><strong>Modeled</strong></td>
<td>82,538,860</td>
<td>25.20</td>
</tr>
<tr>
<td><strong>Modeled/Observed</strong></td>
<td>99%</td>
<td>99%</td>
</tr>
</tbody>
</table>
ABM2

Travel Model Validation and Reasonability Checking Manual 2nd Edition (TMIP)
ABM2

What’s Next?

- Between now and July 2018
  - Wrapping up calibration & validation
  - Sensitivity tests
  - Final report

- July 2018 to Fall 2019
  - 2019 RP application

- Spring 2019
  - Model re-estimation
  - Model for 2023 Regional Plan
Induced Travel

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Induced Travel

What is Induced Travel?
- A widely used term to describe the observed increase in traffic volume that occurs soon after a new highway is opened or a previously congested highway is widened.

Is Induced Travel real?
- Additional demand to travel can occur as a result of decreasing generalized cost of travel.
  - Travel Time
  - Out-of-Pocket cost
Induced Travel

What is Latent Demand?
- Trips that have been suppressed due to the high cost of travel

Is Latent Demand Induced Travel?
- Lowering the generalized cost of travel can convert previously suppressed trips to actual trips

[Diagram]
- High Travel Costs
- Increase Capacity
- Reduced Travel Costs
- Increase Travel
Induced Travel

CAN’T WAIT FOR THE ROAD TO BE WIDENED!

FINALLY!
Induced Travel

Is Induced Travel only associated with highway capacity improvements?
- No: reducing generalized cost to any transportation system can lead to changes in behavior that will result in increased use of that system

Where does the additional travel come from?
- Behavioral changes
- Relocation of people and economic activity
- Increase in commercial vehicle activity
Induced Travel

What does research in this area tell us?

- **FHWA**
  - ‘The term "Induced Travel" is highly controversial but typically misunderstood by both highway advocates and opponents.’
  - ‘Induced travel can have both positive and negative consequences.’
  - ‘…use of any single demand elasticity value to estimate induced travel is highly unreliable.’
    - [https://www.fhwa.dot.gov/planning/itfaq.cfm](https://www.fhwa.dot.gov/planning/itfaq.cfm)

- **Duranton & Turner**
  - ‘High levels of induced demand do not necessarily imply that improvements to the highway system are not in the public interest’
    - *The Fundamental Law of Road Congestion*
    - [http://www.nber.org/papers/w15376](http://www.nber.org/papers/w15376)
Induced Travel

What does research in this area tell us?

- Milam, Birnbaum, Ganson, Handy & Walters

  - ‘In general, almost all of the induced vehicle travel effect can be accounted for by using advanced travel forecasting models that account for the feedback effects of travel time (or travel cost) savings on travel behavior and long-term land use allocation.’
  
  - ‘The induced vehicle travel effect size is influenced by other costs associated with driving, such as parking and fuel prices.’
  
  - ‘The induced vehicle travel effect is influenced by the starting level of congestion.’

  - [Closing the Induced Vehicle Travel Gap Between Research and Practice](https://trrjournalonline.trb.org/doi/abs/10.3141/2653-02)
Induced Travel

What does research in this area tell us?

- SB743 Technical Advisory
  - ‘Most of these studies express the amount of induced vehicle travel as an “elasticity,” which is a multiplier that describes the additional vehicle travel resulting from an additional lane mile of roadway capacity added’
    - [http://opr.ca.gov/docs/20171127_Transportation_Analysis_TA_Nov_2017.pdf](http://opr.ca.gov/docs/20171127_Transportation_Analysis_TA_Nov_2017.pdf)

- CARB
  - ‘…found no evidence that public transit service affects VMT, suggesting that whatever interactions do occur tend to cancel each other out.’
  - Short-run impacts have an elasticity range of 0.3-0.6, long-run impacts have an elasticity range of 0.6-1.0.
    - [https://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf](https://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf)
Induced Travel

What is Demand Elasticity?

- An indicator used to measure how much consumption of a good or service to expect in response to a change in other factors, such as cost.
Induced Travel

Are Demand Elasticities Reliable?

- Elasticity calculations can change depending on
  - Study area definition
  - Time frame of the analysis
- Challenging with different levels of congestion
- Using one demand elasticity value is not reliable
- Indiscriminate application can over-estimate impacts
Induced Travel

What other factors can influence travel?

Energy / Savings & Loan Crises
Mid-East War & Oil Price Shock
Dot-Com Bust
Subprime Mortgage Crisis

Correlating Vehicle Miles of Travel (VMT) with Economic Conditions

Induced Travel

What other factors can influence travel?

- Income
- Land use quality
- Work location
- School location
- Auto ownership
- Development accessibility
Induced Travel

What are the impacts of enhancing capacity?

- **Short Term** – *shifting equilibrium*
  - New path, destination, mode, and/or departure time

- **Mid Term** – *stable environment*
  - New capacity gets consumed but an offset is observed on parallel routes and/or other modes

- **Long Term** – *eventual decay*
  - Observed offset ultimately consumed by continued population and employment growth
  - Potential to induce new development
Induced Travel

What components of travel can be induced?
- Mode Choice
- Destination Choice
- Path Choice
- Departure Time Choice
- Trip / Tour Generation
- Development
Induced Travel

Mode Choice

- Investments in the transit network that reduce costs and travel times can induce new travelers from other transit routes as well as other modes of travel
  - *I used to drive alone to work, but now I ride the Purple Line because it saves me time and money*

Destination Choice

- Investments in the transportation system can lead to travelers changing a destination to satisfy the same trip purpose
  - *I used to grocery shop at the local Walmart, but now I can get to Vons in the same amount of time*
Induced Travel

Path Choice
- Investments in new network connections can induce a new route that leads to the same destination
  - It used to take me 30 minutes to drive 15 miles to the office, but now it takes 20 minutes to drive 10 miles to the office

Departure Time Choice
- Investments in the transportation system can lead to travelers changing the time they depart to the same destination
  - I used to leave home at 7:00 am to get to the office, but now I can leave home at 7:10 am and still get to the office at the same time
Induced Travel

Trip / Tour Generation

- Investments in the transportation can result in new trips being made (only applicable to discretionary trip purposes)
  - *Now that I have some additional free time (and income), I can make a new trip to go surfing*

Development

- Investments in new transportation facilities that provide accessibility to green fields can result in leap frog developments to otherwise isolated areas
  - *As a developer, it is my job to maximize profits by speculating land value*
## Induced Travel

Are Travel demand models sensitive to induced travel?

<table>
<thead>
<tr>
<th>Inducement Type</th>
<th>4-Step Model</th>
<th>ABM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode Choice</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Destination Choice</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Path Choice</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Departure Time Choice</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Trip / Tour Generation</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Development</td>
<td>Yes *</td>
<td>Yes *</td>
</tr>
</tbody>
</table>
Induced Travel

Development is not a travel component, how can “Induced Development” be analyzed via a travel model?

- Feedback Loop
  - Iteratively running the Growth Forecast and the ABM through horizon years can result in *leap frog* development
Induced Travel

Feedback Loop

Growth Forecast
- Employment Forecast
- Residential Forecast
- Land Use Characteristics

Transportation Model

2012

Growth Forecast
- Employment Forecast
- Residential Forecast
- Land Use Characteristics

Transportation Model

2020

Growth Forecast
- Employment Forecast
- Residential Forecast
- Land Use Characteristics

Transportation Model

2035
Induced Travel

Yes * travel models can analyze “Induced Development” with the following limitations

- General Plan
  - Induced development will not exceed the underlying General Plan of any jurisdiction

- Feedback Lag
  - The network being fed back into the Growth Forecast is from the previous Regional Transportation Plan
    - Need an adopted Regional Plan to feed back
    - Need a stable Growth Forecast for Alternatives Analysis
Induced Travel

Has the ABM undergone sensitivity testing?
- 2015 Request by California Air Resource Board
- SB 375 CARB-defined elasticities
  - Freeway Capacity
  - Auto Operating Costs
  - Transit Fares
  - Transit Frequency
  - Land Use Density

Induced Travel

Capacity and Auto Operating Costs

Table 1 Summary of VMT and Elasticity of VMT to Freeway Capacity and AOC

<table>
<thead>
<tr>
<th>Scenario</th>
<th>VMT</th>
<th>% of VMT Difference</th>
<th>Elasticity</th>
<th>Elasticity in CARB White Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012 baseline</td>
<td>79,554,226</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce Freeway Capacity by 50%</td>
<td>72,624,153</td>
<td>-8.71%</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Double freeway Capacity</td>
<td>82,891,012</td>
<td>4.19%</td>
<td>0.3</td>
<td>0.3 to 1.0</td>
</tr>
<tr>
<td>Increase AOC by 50%</td>
<td>78,317,785</td>
<td>-1.55%</td>
<td>-0.03</td>
<td>-0.02 to -0.1</td>
</tr>
<tr>
<td>Increase AOC by 25%</td>
<td>78,781,407</td>
<td>-0.97%</td>
<td>-0.04</td>
<td></td>
</tr>
<tr>
<td>Reduce AOC by 25%</td>
<td>80,424,737</td>
<td>1.09%</td>
<td>-0.04</td>
<td></td>
</tr>
<tr>
<td>Reduce AOC by 50%</td>
<td>81,525,803</td>
<td>2.48%</td>
<td>-0.05</td>
<td></td>
</tr>
</tbody>
</table>
## Induced Travel

### Transit Fares and Frequencies

Table 2 Summary of Transit Trips, Boardings and Elasticity to Frequency and Fare

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Transit Trips</th>
<th>% Diff of Transit Trips</th>
<th>Elasticity (Transit Trips)</th>
<th>Boardings</th>
<th>% Diff of Boardings</th>
<th>Elasticity (Boardings)</th>
<th>Elasticity in CARB White Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012 Baseline</td>
<td>225,985</td>
<td></td>
<td></td>
<td>359,485</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce fare by 50%</td>
<td>329,375</td>
<td>46%</td>
<td>-0.9</td>
<td>525,691</td>
<td>46%</td>
<td>-0.9</td>
<td>-0.4 to -1.0</td>
</tr>
<tr>
<td>Reduce fare by 25%</td>
<td>271,859</td>
<td>20%</td>
<td>-0.8</td>
<td>432,605</td>
<td>20%</td>
<td>-0.8</td>
<td></td>
</tr>
<tr>
<td>Increase fare by 25%</td>
<td>190,282</td>
<td>-16%</td>
<td>-0.6</td>
<td>301,797</td>
<td>-16%</td>
<td>-0.6</td>
<td></td>
</tr>
<tr>
<td>Increase fare by 50%</td>
<td>161,681</td>
<td>-28%</td>
<td>-0.6</td>
<td>255,684</td>
<td>-29%</td>
<td>-0.6</td>
<td></td>
</tr>
<tr>
<td>Increase frequency by 50%</td>
<td>287,526</td>
<td>27%</td>
<td>0.5</td>
<td>493,718</td>
<td>37%</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Increase frequency by 25%</td>
<td>252,414</td>
<td>12%</td>
<td>0.5</td>
<td>413,869</td>
<td>15%</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Decrease frequency by 25%</td>
<td>210,624</td>
<td>-7%</td>
<td>0.3</td>
<td>328,012</td>
<td>-9%</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Decrease frequency by 50%</td>
<td>198,027</td>
<td>-12%</td>
<td>0.6</td>
<td>303,610</td>
<td>-16%</td>
<td>0.6</td>
<td></td>
</tr>
</tbody>
</table>
## Induced Travel

### Mode Shift

#### Table 3 Mode Share for 2012 Tests and Baseline

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Drive Alone</th>
<th>Carpool</th>
<th>Transit</th>
<th>Walk &amp; Bike</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012 Baseline</td>
<td>42.02%</td>
<td>42.93%</td>
<td>1.91%</td>
<td>11.74%</td>
<td>1.39%</td>
</tr>
<tr>
<td>Increase AOC by 50%</td>
<td>41.56%</td>
<td>42.28%</td>
<td>2.08%</td>
<td>12.68%</td>
<td>1.40%</td>
</tr>
<tr>
<td>Increase AOC by 25%</td>
<td>42.01%</td>
<td>42.74%</td>
<td>1.99%</td>
<td>11.85%</td>
<td>1.38%</td>
</tr>
<tr>
<td>Reduce AOC by 25%</td>
<td>42.04%</td>
<td>43.12%</td>
<td>1.84%</td>
<td>11.62%</td>
<td>1.37%</td>
</tr>
<tr>
<td>Reduce AOC by 50%</td>
<td>42.06%</td>
<td>43.33%</td>
<td>1.78%</td>
<td>11.49%</td>
<td>1.30%</td>
</tr>
<tr>
<td>Reduce fare by 50%</td>
<td>41.74%</td>
<td>42.54%</td>
<td>2.79%</td>
<td>11.63%</td>
<td>1.30%</td>
</tr>
<tr>
<td>Reduce fare by 25%</td>
<td>41.89%</td>
<td>42.76%</td>
<td>2.30%</td>
<td>11.70%</td>
<td>1.35%</td>
</tr>
<tr>
<td>Increase fare by 25%</td>
<td>42.13%</td>
<td>43.09%</td>
<td>1.61%</td>
<td>11.76%</td>
<td>1.41%</td>
</tr>
<tr>
<td>Increase fare by 50%</td>
<td>42.23%</td>
<td>43.21%</td>
<td>1.37%</td>
<td>11.78%</td>
<td>1.42%</td>
</tr>
<tr>
<td>Increase frequency by 50%</td>
<td>41.69%</td>
<td>42.73%</td>
<td>2.43%</td>
<td>11.76%</td>
<td>1.39%</td>
</tr>
<tr>
<td>Increase frequency by 25%</td>
<td>41.88%</td>
<td>42.86%</td>
<td>2.14%</td>
<td>11.74%</td>
<td>1.38%</td>
</tr>
<tr>
<td>Decrease frequency by 25%</td>
<td>42.10%</td>
<td>42.99%</td>
<td>1.78%</td>
<td>11.74%</td>
<td>1.39%</td>
</tr>
<tr>
<td>Decrease frequency by 50%</td>
<td>42.17%</td>
<td>43.05%</td>
<td>1.67%</td>
<td>11.71%</td>
<td>1.39%</td>
</tr>
</tbody>
</table>
Induced Travel

Land Use

Table 5 Resident VMT and VMT Difference in 2035 Land Use Density Tests

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Resident VMT</th>
<th>Resident VMT Difference</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline - Series 13 Growth Forecast</td>
<td>60,989,959</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Land Use - Multiple Dense Core</td>
<td>59,833,247</td>
<td>(1,156,711)</td>
<td>-1.9%</td>
</tr>
<tr>
<td>Alternative Land Use - Smart Growth</td>
<td>60,647,442</td>
<td>(342,517)</td>
<td>-0.6%</td>
</tr>
</tbody>
</table>

Table 6 Mode Share Summary for 2035 Land Use Density Tests

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Drive Alone</th>
<th>Carpool</th>
<th>Transit</th>
<th>Walk &amp; Bike</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline - Series 13 Growth Forecast</td>
<td>39.5%</td>
<td>42.3%</td>
<td>3.1%</td>
<td>13.3%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Alternative Land Use - Multiple Dense Core</td>
<td>39.3%</td>
<td>42.4%</td>
<td>3.1%</td>
<td>13.5%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Alternative Land Use - Smart Growth</td>
<td>39.0%</td>
<td>42.5%</td>
<td>3.3%</td>
<td>13.6%</td>
<td>1.7%</td>
</tr>
</tbody>
</table>
Induced Travel

What are the limitations of using a travel demand model to analyze induced travel?

- Based on observed travel behavior
  - Travel models require empirical data for estimation
- Not a crystal ball
  - Best practice is for Alternatives Analysis
- Resources
  - Agency priorities, processing time, and staff costs limit the number of model scenarios that can be run
Induced Travel

Conclusions

- Use an Activity Based Model
- Incorporate a Feedback Loop between Growth Forecast models and Travel Demand Models
- Carefully define study areas
- Analyze existing congestion levels
- Understand if latent demand exists
- Use elasticities discriminately
Forum Agenda

Travel Behavior Survey Summary

ABM2

Induced Travel

Next Transportation Model Forum:
December 12, 2018