Massive GPS Travel Pattern Data for Urban Congestion Relief in the Twin Cities

27th Annual CTS Transportation Research Conference

Paul Morris, PE
SRF Consulting Group, Inc.

November 3, 2016
Project Location

Twin Cities
Project Location

HOT Lane / BRT

HOT Lanes
DATA OVERVIEW
Study Area
Trip Starts and Ends
Data Records

- **Timeframe**
  - 3 months: February-April 2015

- **Trips**
  - Total 1,637,000 trips
  - 800,000 Internal-to-Internal trips

- **Waypoints**
  - 195,857,000 waypoints
  - Average waypoints per trip: 120
  - 53,699,000 Internal-to-Internal waypoints
  - Average waypoints per internal trip: 67
ANALYSIS PROCESS
Trip Filtering Process

- "Is_Home" Filter
- Right of Way Filter
- Speed Filter:
  - Trips eliminated if instantaneous speed of first two or last two waypoints exceeded 20 mph.
Trip Filtering Process

- Internal to Internal: 799,165
- Add Is_Home Filter: 418,300
- Add ROW Filter: 312,596
- Add Speed Filter: 296,768
Trip Filtering Process

- Remaining trips account for around 50% of total trip records

<table>
<thead>
<tr>
<th></th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>296,768</td>
<td>184,364</td>
</tr>
<tr>
<td>External</td>
<td>176,497</td>
<td>194,335</td>
</tr>
</tbody>
</table>
Route Matching Process

Goal

• Convert INRIX data records to a format understandable to travel demand modeling software

Methodology

• ArcGIS NEAR function
• RTDM path generation
• Daily volume trip scaling
The waypoints of each INRIX trip were linked to segments in GIS. Then the INRIX trips were converted into a “Node-to-Node” format.
Multiple paths were generated for each O-D pair, and were saved as a “Node-to-Node” format, in order to match INRIX paths generated using GIS NEAR function.
Trip Scaling Procedure

• Trip ends scaled to estimated trip generation totals from regional model Transportation Analysis Zones (TAZ)

• Route data scaled to traffic flows on key segments
  – Auto trips – AADT
  – Truck trips – HCADT

• Auto and truck trip tables and routes combined to evaluate complete travel patterns
Regional Movements by Route
Regional Movements by Route
I-494 From TH 62 to TH 212 - AM Peak

Legend

In/Out

Study Segment

Total Trips: 25,188
I-494 From TH 212 to TH 169 - AM Peak

Legend

In/Out

Study Segment

Total Trips: 32,656
I-494 From TH 169 to TH 100 - AM Peak

Total Trips: 38,670

Legend

In/Out

Study Segment
I-494 From TH 100 to I-35W - AM Peak

Legend:
- In/Out

Study Segment

Total Trips: 44,783
I-494 From I-35W to TH 77 - AM Peak

Legend

Study Segment

14% 22% 8% 9% 3% 0% 20%

Total Trips: 33,380
I-494 From TH 77 to TH 5 - AM Peak

Legend

<table>
<thead>
<tr>
<th>In/Out</th>
<th>Study Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>29%</td>
<td></td>
</tr>
<tr>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>59%</td>
<td></td>
</tr>
</tbody>
</table>

Total Trips: 33,174
Origin-Destination Tables

Network Assignment Using Trip O-Ds

- Build O-D tables basing on INRIX trips starting and ending points.
- Scaled up INRIX trip tables.
- Potential DTA model input.
Travel Demand Model Validation

- I-494 from TH 100 to I-35W
Selected Segment Travel Patterns
Demand Diversion Analysis
Trip End Cluster Analysis

Getis-Ord Hot Spot Score

- 1
- 2
- 3

Optimized Hot Spot Analysis

Given incident points or weighted features (points or polygons), creates a map of statistically significant hot and cold spots using the Getis-Ord Gi* statistic. It evaluates the characteristics of the input feature class to produce optimal results.
Station Area Trip Patterns

MN 7

14,300 Trips

- Station Location
Station Area Trip Patterns

Excelsior Blvd

22,300 Trips

- Station Location
Station Area Trip Patterns

Interlachen Rd

8,350 Trips

- Station Location
I-94 Minneapolis to Saint Paul Study

- Coverage of entire 7-county Twin Cities metro area
- Major increase in volume of Trips data
  - 6.1 million trip records
  - 513 million waypoint records
Trips Using I-94
Minneapolis Neighborhood/Saint Paul Precinct
Ramp-to-Ramp Analysis

*Estimated 2015 Daily Volumes
Ramp-to-Ramp Analysis

Select Link

24,400 Trips
(5%)

1,300 Trips
(5%)

19,800 Trips
(81%)

3,300 Trips
(14%)

*Estimated 2015 Daily Volumes
Ramp-to-Ramp Analysis

*Estimated 2015 Daily Volumes
## Ramp-to-Ramp Analysis

### Origin-Destination Matrix

<table>
<thead>
<tr>
<th>Direction</th>
<th>Hennepin/Lyndale Ave Off-Ramp</th>
<th>I-394 Off Ramp</th>
<th>I-94 NB Through</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-94 W Through</td>
<td>17,400</td>
<td>26,100</td>
<td>23,300</td>
<td>66,800</td>
</tr>
<tr>
<td>I-35W On Ramp</td>
<td>1,300</td>
<td>3,300</td>
<td>19,800</td>
<td>24,400</td>
</tr>
<tr>
<td>4th Ave On Ramp</td>
<td>600</td>
<td>1,600</td>
<td>4,300</td>
<td>6,500</td>
</tr>
<tr>
<td>Total</td>
<td>19,300</td>
<td>31,000</td>
<td>47,400</td>
<td>97,700</td>
</tr>
</tbody>
</table>
Trip Length Comparison

I-694
I-94
I-494
Trip Length Comparison

- I-94
- I-694
- I-494
Select Link Analysis

- Two-way link selection
- 95% traffic use I-694
- 5% traffic use I-94
- Freight trips have similar travel patterns
Passenger Vehicle Trips
Between Downtown Minneapolis and Saint Paul

Total Daily Trips = 4,570

85% Trips use I-94

Downtown Minneapolis/St. Paul Zones
Other Applications

- Select Link Map
- Select Zone Map
- Trip Diversion Map
- Cluster analysis
- Dual select zone (constrain both Origin & Destination)
- Subarea Origin-Destination Matrices

- Freeway Ramp-to-Ramp Movements
- Regional District-to-District Patterns
- Trip Generation Profiles (daily, weekly, etc.)
- Trip Length Frequency Distribution
Questions?

Thank You!