Using National Performance Management Research Data Set (NPMRDS) to Generate Statewide Performance Measures

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Outline

• NPMRDS introduction
• Performance measures (mobility, reliability, delay, and others)
• Data analysis NPMRDS
• Truck GPS data analysis
• Concluding remarks
• Q & A
What is NPMRDS?

- Vehicle probe-based travel time data set acquired by the Federal Highway Administration (FHWA)
- Average travel times every 5 minutes, 24/7 on the National Highway System (NHS)
- Data is provided by HERE traffic (formerly Nokia/Navteq)
- Truck probe data is from ATRI
- Data set is available on monthly basis (July 2013 – April 2014)
NPMRDS Static Data

• Distance (length of TMC in miles)
• Road Number and local Name
• Latitude/Longitude
• Road direction (Northbound, Southbound, Westbound, Eastbound)
• Shapefile of coverage based on NHS
NPMRDS Monthly Data

- TMC code (traffic code for road segment)
- Country
- State
- County
- Date (MMDDYYYY)
- EPOCH (five-minute increment)
- Travel Time – All vehicles (seconds)
- Travel Time – Passenger vehicles (seconds)
- Travel Time – Freight vehicles (seconds)
### Sample NPMRDS Data

<table>
<thead>
<tr>
<th>TMC</th>
<th>Date</th>
<th>Epoch</th>
<th>Travel time All vehicles</th>
<th>Travel time Passenger vehicles</th>
<th>Travel time Freight trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>118N04174</td>
<td>11132013</td>
<td>180</td>
<td>113</td>
<td>115</td>
<td>113</td>
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<tr>
<td>118N04174</td>
<td>11132013</td>
<td>181</td>
<td>108</td>
<td>105</td>
<td>115</td>
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<td>118N04174</td>
<td>11132013</td>
<td>184</td>
<td>117</td>
<td>115</td>
<td>122</td>
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<tr>
<td>118N04174</td>
<td>11132013</td>
<td>185</td>
<td>113</td>
<td>112</td>
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<td>118N04174</td>
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<td>11132013</td>
<td>187</td>
<td>111</td>
<td>111</td>
<td>113</td>
</tr>
</tbody>
</table>
Performance Measures
Performance Measures

Truck Mobility

Percent of freight corridor miles in TCMA with average speed < 45 MPH in AM or PM Peak

Travel Time Reliability Index

\[ RI_{80} = \frac{80^{\text{th}} \text{ percentile Travel Time}}{\text{Travel Time at MnDOT Specified Threshold Speed}} \]

Truck Daily Delay

\[ \sum \sum \left( \frac{\text{Segment Len.}}{\text{Travel Speed}} - \frac{\text{Segment Len.}}{\text{Threshold Speed}} \right) \times \text{Vol\%} \times HCAADT_{\text{Segment}} \]

Threshold Speed = 45 MPH, Max Throughput Speed
NPMRDS Data Coverage on NHS in MN
Average Truck Speed
Nov. 2013 (PM Peak)
TCMA

Truck Speed (MPH) PM Peak
- 1.1 - 35.0
- 35.1 - 45.0
- 45.1 - 55.0
- 55.1 - 75.0
NPMRDS vs. Raw GPS Data

• NPMRDS contains processed travel time data
• Mobility measures
• Reliability measures
• NPMRDS cannot be used to compute delay due to no probe vehicle count information
• GPS raw data requires additional data processing
Truck Speed Analysis
GPS vs Sensor Speed

- Fixed station speed (sample in space)
- Instantaneous probe speeds in a roadway segment (sample in traffic flow)
GPS vs. WIM37 Vehicle Speed Comparison

I-94 WB @ Mile Post 200

Hour of Day

Speed (MPH)
Speed Comparison - Truck GPS vs. Loop Detector
(I-494 EB @ France Avenue)

- GPS Point Speed SD
- Loop Detector Speed SD
- GPS Space Mean Speed SD
- GPS Spot Speed
- GPS Space Mean Speed
- Loop Detectors (All Traffic) Speed Average

Hour of Day

GPS Space Mean Speed

Loop Detector Speed (All Traffic)

GPS Spot Speed
Truck Volume Percentage
ATR 382 vs. Probe Vehicle

Comparison of Volume Percentage by Hour

Hour of Day

Volume %

0% 1% 2% 3% 4% 5% 6% 7% 8%

0 4 8 12 16 20 24

ATR 382

Probe Vehicle
## Correlation of GPS vs. ATR Hourly Volume %

<table>
<thead>
<tr>
<th>ATR Data</th>
<th>Probe Vehicle Data</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>HCAADT</td>
<td>Route ID</td>
</tr>
<tr>
<td>----------</td>
<td>--------------------</td>
<td>----------</td>
</tr>
<tr>
<td>188</td>
<td>2,600</td>
<td>29</td>
</tr>
<tr>
<td>191</td>
<td>2,150</td>
<td>33</td>
</tr>
<tr>
<td>200</td>
<td>7,900</td>
<td>24</td>
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<tr>
<td>335</td>
<td>3,450</td>
<td>34</td>
</tr>
<tr>
<td>341*</td>
<td>5,100</td>
<td>4</td>
</tr>
<tr>
<td>351</td>
<td>1,600</td>
<td>9</td>
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<tr>
<td>352</td>
<td>1,600</td>
<td>31</td>
</tr>
<tr>
<td>353</td>
<td>1,750</td>
<td>37</td>
</tr>
<tr>
<td>365**</td>
<td>1,700</td>
<td>26</td>
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<tr>
<td>381</td>
<td>1,350</td>
<td>14</td>
</tr>
<tr>
<td>382</td>
<td>2,700</td>
<td>29</td>
</tr>
<tr>
<td>388</td>
<td>830</td>
<td>25</td>
</tr>
<tr>
<td>400</td>
<td>1,600</td>
<td>9</td>
</tr>
<tr>
<td>422</td>
<td>NA</td>
<td>1</td>
</tr>
</tbody>
</table>

* ATR341 - S OF CSAH35 (50TH ST N) IN OAKDALE (I-694)
** ATR365 - S OF CSAH116 (BUNKER LAKE BLVD NE) IN HAM LAKE (State Highway 65)
Truck Congestion
Speed < 45 MPH
PM Peak (2-7 PM)

Number of Hours
Speed < 45 MPH

0
1
2
3
4
5
## Truck Mobility Measure

<table>
<thead>
<tr>
<th>Time Period (2012 Weekdays TCMA)</th>
<th>AM Peak 5-10 AM</th>
<th>PM Peak 2-7 PM</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Miles with Average Speed &lt; 45 MPH</td>
<td>96</td>
<td>147</td>
</tr>
<tr>
<td>Total Miles of RTMC Stations in TCMA</td>
<td>774</td>
<td>774</td>
</tr>
<tr>
<td>Percentage of Miles &lt; 45 MPH</td>
<td><strong>12.4%</strong></td>
<td><strong>19.0%</strong></td>
</tr>
</tbody>
</table>
Truck Delay

\[
\sum_{\text{Segment}} \sum_{\text{Hour}} \left( \frac{\text{Segment Len.}}{\text{Travel Speed}} - \frac{\text{Segment Len.}}{\text{Threshold Speed}} \right) \times \text{Vol\%} \times HCAADT_{\text{Segment}}
\]

Threshold Speed = 45 MPH, Max Throughput Speed
Average Daily Delay and Speed

Threshold Speed 45 MPH

Total Truck Delay = 37 (+1) + 95 (-1) = 132 Hours / Day
Travel Time Reliability

\[ RI_{80} = \frac{80^{th} \text{ percentile Travel Time}}{\text{Travel Time at MnDOT Specified Threshold Speed}} \]

Threshold Speed = 45 MPH, Max Throughput Speed
Truck Reliability Index
PM Peak (2-7 PM)

- RI_{80} < 1.5 reliable
- 1.5 \leq RI_{80} < 2.0 moderate reliable
- RI_{80} \geq 2.0 unreliable
Truck Bottlenecks
<table>
<thead>
<tr>
<th>Rank</th>
<th>Location</th>
<th>Dir.</th>
<th>PM Peak Delay (hours) / Mile</th>
<th>PM Peak Reliability RI80</th>
<th>HCAADT</th>
<th>Number of Lanes</th>
<th>Length (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I-35W at I-694</td>
<td>NB</td>
<td>14.08</td>
<td>1.94 - 3.75</td>
<td>7700 - 8500</td>
<td>3</td>
<td>3.30</td>
</tr>
<tr>
<td>2</td>
<td>I-35W at I-94</td>
<td>SB</td>
<td>12.94</td>
<td>5.00</td>
<td>3250 - 8300</td>
<td>3</td>
<td>1.01</td>
</tr>
<tr>
<td>3</td>
<td>I-494 between I-35W &amp; 169</td>
<td>EB</td>
<td>11.31</td>
<td>2.05 - 4.09</td>
<td>6900 - 9100</td>
<td>2</td>
<td>4.88</td>
</tr>
<tr>
<td>4</td>
<td>I-394 between TH 100 &amp; I-94</td>
<td>EB</td>
<td>7.14</td>
<td>2.59 - 3.75</td>
<td>400</td>
<td>3</td>
<td>2.61</td>
</tr>
<tr>
<td>5</td>
<td>I-694 between I-35E &amp; I-35W</td>
<td>WB</td>
<td>6.85</td>
<td>2.37 - 3.04</td>
<td>6700 - 7800</td>
<td>2</td>
<td>3.02</td>
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<tr>
<td>6</td>
<td>I-694 at I-35W</td>
<td>EB</td>
<td>6.81</td>
<td>1.58 - 2.18</td>
<td>9000 - 12300</td>
<td>2</td>
<td>2.25</td>
</tr>
<tr>
<td>7</td>
<td>TH 62 at TH 169</td>
<td>WB</td>
<td>6.41</td>
<td>2.81 - 5</td>
<td>2450</td>
<td>2</td>
<td>2.26</td>
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<tr>
<td>8</td>
<td>US52 at I-94</td>
<td>NB</td>
<td>6.40</td>
<td>4.33</td>
<td>4800 - 5200</td>
<td>3</td>
<td>0.75</td>
</tr>
<tr>
<td>9</td>
<td>I-94 at I-35W</td>
<td>WB</td>
<td>5.95</td>
<td>2.6 - 3.25</td>
<td>6600 - 6800</td>
<td>3</td>
<td>3.27</td>
</tr>
<tr>
<td>10</td>
<td>I-94 at I-35E</td>
<td>EB</td>
<td>5.88</td>
<td>2.84 - 3.21</td>
<td>6600 - 7100</td>
<td>4</td>
<td>2.67</td>
</tr>
</tbody>
</table>
Truck Stop and Parking
Probe Truck Stops Per Day
Truck Parking at I-94 Rest Area in Maple Grove
Histogram of Parking Duration at the Rest Area on I-94 in Maple Grove

Staging?
Concluding Remarks

- Probe vehicle data is a reliable data source to generate performance measures on roadways without loop detectors.
- NPMRDS supports mobility and reliability measures.
- Delay cannot be computed from NPMRDS due to lack of probe vehicle count information.
Future Opportunities

• Generate reliable performance measures from probe vehicle data or NPMRDS
• Analyze and monitor performance measures in TCMA or statewide regularly
• Incorporate PM into forecasting & planning model (*Transportation Policy Plan 2040*)
• Take advantage of NPMRDS (NHS only)
• Truck bottlenecks
• Truck parking duration and facility needs
Acknowledgements

- MnDOT – OFCVO & TDA
- Project TL John Tompkins & other TAP Members
- ATRI – Dan Murray & other staff
- HERE Traffic
- CTS, UMN
- MTO, Civil Engineering, UMN
- FHWA
Thank You!

Questions?