Travel Time Variability For Freight Flows Along Interstate Corridors

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Introduction

- The United States transportation system moved, on average, 53 million tons of freight each day in 2002, worth $36 billion.

- This number reached 58.9 million tons per day in 2008 according to the Freight Analysis Framework (FAF)’s estimation.

- The congestion is a problem in United States. In 2007, congestion cost an extra 4.2 billion hours and 2.8 billion gallons of fuel for urban transportation., and the approx cost is $87.2 billion. (Urban mobility report, TTI)
Reliability

- Transportation system reliability
  - Travel time reliability
  - Connectivity reliability
  - Capacity reliability
- Chen et al (2003); Lyman and Bertini (2007); Tseng et al (2005): The use of the travel time reliability measure as the congestion measure.
- Most of the RTPs from the 382 of the MPOs in U.S don’t use travel time reliability measure as a congestion measure (YET!).
- FHWA recommends that transportation planners consider travel time reliability a key performance measure in evaluating transportation projects.
**Definition**

- Travel time variability is the random, day-to-day variation of the travel time that arises in congested situations even if no special events (such as accidents) occur.
- Many modern technologies, such as congestion tolls and intelligent traffic information systems, have among their main goals to reduce the variability of travel times.
- Commonly used distributional range measures, which are used to communicate TTR to targeted travelers:
  - Buffer Index
  - Planning Index
  - Travel Time Index
  - Percent Variation
Example from Portland

**Estimated Monthly Travel Time I-5 North September 2006**

**Corridor Ranking Comparison**

**FIGURE 4 PORTAL monthly**
Data and Tools

- The FHWA, in partnership with ATRI, has developed Freight Performance Measures initiative.
- It provides data for calculating average operating speeds for trucks that travel on interstate highways, calculated using several hundred thousand vehicles.
- ATRI truck speed data
  . https://www.freightperformance.org/fpmweb/
Data and Tools

- **Buffer index (%)** = \[
\frac{95\text{th percentile time} - \text{average time}}{\text{average travel time}}
\]

- These measures are relatively easy to obtain and does not necessarily rely on specific assumptions about the shape of the travel time distribution (e.g., it can apply to lognormal or normal distributions).

- In the presence of data that are too sparse to determine the 95th percentile, the 90th -50th or the 80th -50th percentile can also be used.
Data and Tools

- Data from FPM are finer to the hour of the day, for every 3 mile-point.
- Leverage this useful data, to create in-house applications using RDBMS, and custom languages (Python, VB.net).
- The period of regular and non-regular congestion events have to be pre-defined.
Trends and Measures

Annual Avg Truck Speed Variation across the I90 highway (WeekDay 6-9 hrs)

- **I90 E**
  - Mauston to Janesville
  - Average Travel Time: 1.81 hrs.
  - Buffer time 0.20 hrs.
  - (Buffer index is 0.11)

- **I90 W**
  - Mauston to Janesville
  - Average Travel Time: 1.86 hrs.
  - Buffer time 0.11 hrs.
  - (Buffer index is 0.11)
US policy makers have shown interest in applying some form of congestion-based pricing for many years. A common feature of all these projects is that the toll varies with time of the day.

Value of time for commuters is well studied, but the research on commercial value of time for carriers and shippers is still in process.

Value of Freight Delay (VOD) as the fundamental parameter influencing the private sectors’ response to public freight projects and policies such as corridor construction and tolling.
Value of Delay

- **Stated Preference (SP) survey**, for evaluating perceived value of time due to traffic delay from for truckers and fleet dispatchers.
- With multinomial logit model.

\[ U_{ni} = \theta Z_{ni} = aC_n + bT_i + \sum_{k=1}^{3} d_k R_{kn} + \sum_{k=1}^{3} e_k F_{kn} + \varepsilon \]

\( b \) is the coefficient of Travel Time Saving. \( a \) is the coefficient of payment and log size payment

- The impact of travel time variability on route level disutility/cost should be linear-additive in link level, for corridor analysis.
Survey Design

- Two hypothetical scenarios were developed for travel conditions on a congestion non-toll road.
  - Stakeholders running 30 minutes late
  - On time delivery and pickup
  - Both scenarios followed by options to gain 15, 30 and 45 minutes time savings, by paying different toll amounts.

- The survey was done by our group in Wisconsin (Mauston, Cottage Grove, Janesville, Oasis and Racine) and Texas (Austin, Houston, San Marcos, Dallas, and Fort worth)
# Results

<table>
<thead>
<tr>
<th>Question</th>
<th>Category</th>
<th>Drivers</th>
<th>Question</th>
<th>Category</th>
<th>Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Carrier</strong></td>
<td>Owner Operator</td>
<td>17</td>
<td><strong>Typical route</strong></td>
<td>Regional</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>For-hire</td>
<td>14</td>
<td></td>
<td>Long haul</td>
<td>33</td>
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<tr>
<td></td>
<td>Private-Carrier</td>
<td>35</td>
<td></td>
<td>Local/delivery</td>
<td>16</td>
</tr>
<tr>
<td><strong>Typical cargo</strong></td>
<td>Bulk</td>
<td>17</td>
<td><strong>Who decides route?</strong></td>
<td>Me (the driver)</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Average Value</td>
<td>38</td>
<td></td>
<td>Dispatcher/manager</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>High Value</td>
<td>26</td>
<td></td>
<td>Shipper</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>0</td>
<td></td>
<td>Other</td>
<td>4</td>
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<tr>
<td><strong>Truck Size</strong></td>
<td>3 axle</td>
<td>5</td>
<td><strong>How are you paid?</strong></td>
<td>By Mile</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>5 axle</td>
<td>51</td>
<td></td>
<td>By Load</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>6 axle</td>
<td>6</td>
<td></td>
<td>Percentage of Revenue</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>6</td>
<td></td>
<td>Other</td>
<td>8</td>
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<tr>
<td><strong>Trip Length</strong></td>
<td>11+ Hours</td>
<td>34</td>
<td><strong>Who pays the toll?</strong></td>
<td>I do</td>
<td>23</td>
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<td></td>
<td>5 to 11 Hours</td>
<td>31</td>
<td></td>
<td>For-hire carrier</td>
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<tr>
<td></td>
<td>2 to 5 Hours</td>
<td>4</td>
<td></td>
<td>Shipper</td>
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<tr>
<td></td>
<td>Less than 2 Hours</td>
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<td></td>
<td>Other</td>
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<tr>
<td><strong>Delivery window</strong></td>
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<td>14</td>
<td><strong>Route changes</strong></td>
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<td></td>
<td>Less than 12 hours</td>
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<td></td>
<td>Occasionally</td>
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<tr>
<td></td>
<td>less than 5 hours</td>
<td>14</td>
<td></td>
<td>Often</td>
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<tr>
<td></td>
<td>less than 3 hours</td>
<td>30</td>
<td></td>
<td>Always</td>
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</table>

<table>
<thead>
<tr>
<th>Utility function</th>
<th>Scenario_1</th>
<th>Scenario_2</th>
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<tbody>
<tr>
<td>$a$</td>
<td>0.0497</td>
<td>0.0869</td>
</tr>
<tr>
<td>$b$</td>
<td>0.0439</td>
<td>0.0924</td>
</tr>
<tr>
<td>$VOD $/min$</td>
<td>1.1322</td>
<td>0.9403</td>
</tr>
<tr>
<td>$VOD $/hr$</td>
<td>67.9343</td>
<td>56.4156</td>
</tr>
</tbody>
</table>

**Wisconsin Scenario:**
Results

- Analysis shows a VOD from $25.57 to $67.93. The type of carriers (drivers paid by miles, private carriers, owner-operators) perceive a different VOD.

- The second method using a simulation framework to assess the cost of congestion to carriers in an operational environment predicted a far higher rate within urban areas ($80 - $120/hr).

- In 2006, FHWA reported the value to be $25 to $500 for shippers and carriers.
Next Steps

- Prioritize regional flows by determining the travel time reliability indices.
- Model the interaction between the truckers’ value of delay obtained from survey and network simulation, and the travel time variations calculated from GPS data.
- Collect more survey data for logit model.
- Test the measures like tolls to alleviate the congestion, using the obtained Value of Delays.
Future Research

- The studies on multi-modal travel time reliability is the trending topic.
- The travel time reliability for multi-trip scheduling models have so far not been dug deep into. There are various interdependencies on the value of mean TT, and value of TT variation.
- Compare the statistical indices with the indices calculated, and use measures for cost-benefit analysis of corridors.