Introduction

• Projected Growth will Increase Delay and Congestion

• Delay and Congestion Impact Freight Industry
  • Timely deliveries
  • Increase in emission
  • Increase in cost
  • Difficulty scheduling

• Freight Performance Measures (FPM) not widely used
  • Early focus on passenger vehicles (Schofield and Harrison, 2007)
  • Current measures may not meet needs of all users (e.g., loop sensors)
  • Better understanding of Freight reliability = Better planning/engineering

• OBJECTIVE: Develop tools for measuring impacts of congestion on freight vehicles

Supply Chain

PARTS

Manufacture

Distribution

Retailer & Customer

Delay

$ $$
Outline

• Background/Context of problem
• Description of Data Sources
• Methodology
• Case Study Results
  • Recurring Congestion
  • Non-Recurring Congestion
• Conclusions

Background

Performance Measures
  • Tools to evaluate current/future needs
  • Travel time, speed, travel time reliability
    (NCHRP, 2006)

GPS Technologies
  • Travel Time Reliability & Bottlenecks
    (ATRI, 2005), (ATRI, 2009), (Kamran and Hass, 2007)
    (McCormack et al., 2010)

Electronic Truck Transponders (Weigh-in-Motion)
  • Many freight vehicles needed
    (McCormack and Hallenbeck, 2006)
  • Rural areas in Oregon
    (Monsere et al., in Progress at PSU)

PSU direct access to Loop Sensor data from Oregon DOT
  • Recurring, Non-Recurring studies
    (Monsere et al., 2006), (Bertini et al., 2005),
    (Wieczorek et al., 2009)
Unique Contributions of this Work

- Combining Multiple Data Sources
  - GPS data from commercial trucks
  - Loop sensor data (Oregon DOT)
  - Incident data (ODOT ATMS)
- Create unbiased FPM
  - Separating trucks experiencing congestion vs rest/refuel
  - Develop alternatives to current PM
- Useful to Public Agencies
- Oregon Freight Data Mart
  in Development at PSU (Figliozzi and Tufte, 2009)
  - Web-based platform
  - Available to commercial & private carries

Description of Data Sources Available

- PORTAL (SEE: http://portal.its.pdx.edu)
  - Loop Sensor Data from ODOT
- Incident Data
  - Type, Severity, Approximate location, Start/End time (duration)
- GPS Truck Data
  - TruckID number, Date, Time
  - Position (Latitude/Longitude)
- Data Challenges
  - No common gap time btw readings
  - Multiple trips on same day
  - Different truck types (travel behavior)
Description of Data Sources Available cont.

• GPS Truck Types
  • Through
  • Partial Through
  • Partial Local
  • Local

• Develop Filter to ID Through Trucks
• Best Representation of Corridor Congestion
• Use Through Trucks to develop FPM

Methodology
• Purpose of Filter: To Identify Through Trucks for analysis

• Two Step Process:
  • Filter Process 1: Matching GPS Readings to Identify Potential Through Trucks
  • Filter Process 2: Comparison to PORTAL Average Travel Times

• Integrates available data sets and ensures no stops midway for rest/refuel

Filter Parameters
ms = Start Milepost
me = End Milepost
r = Buffer radius
tb = Threshold to clear buffer
tc = Threshold to clear corridor and buffer

Methodology cont.

Filter Process 1: Matching GPS Readings to Identify Potential Through Trucks

1. Obtain milepost measures using ArcGIS
2. Determine ms and me
3. Look at points falling in buffer ranges
4. Distinguish individual trips by each truck using time thresholds tc and tb and identify the “start” and “end” points of each trip
5. Match readings in “start” buffer to downstream reading in “end” buffer occurring within tc
Filter Process 1: Matching GPS Readings to Identify Potential Through Trucks

6. Find all intermediate readings for a truck ID falling between the trip “start” and “end” readings
7. Adjust the “start” and “end” reading timestamp and milepost to begin at $m_s$ and $m_e$ using speeds obtained from the next closest reading
8. Obtain the travel time and speed through the corridor, and identify trip direction using milepost data

Methodology cont.

Filter Process 2: Comparison to PORTAL Average Travel Times

1. Data sorted by the “start” reading timestamp into time bins of 15 minute intervals.
2. Deviation Index is calculated using the PORTAL:
   For a 15 minute time bin $t$,
   Then the Deviation Index $g_k$ is defined as
   $$ g_k = \frac{|a_t - T_k|}{\sigma_t} $$
   Where:
   $a_t$ = PORTAL average travel time at time bin $t$
   $\sigma_t$ = PORTAL day-to-day standard deviation of travel time
   $T_k$ = the corridor average travel time for truck trip $k$
3. Truck trip is too far from the expected average if:
   $$ g_k > m^* \sigma_t $$
   Where:
Methodology cont.

Filter Process 2: Comparison to PORTAL Average Travel Time

Through Truck vs PORTAL Corridor Average Travel Time

*Results following filter process 1, showing Deviation Index

![Graph showing travel time comparison]

Methodology cont.

Filter Process 2: Comparison to PORTAL Average Travel Time

Through Truck vs PORTAL Corridor Average Travel Time

*Results following filter process 2, showing Deviation Index

![Graph showing travel time comparison]
Recurring Congestion Analysis

Case Study: Recurring Congestion

Recurring Congestion

- I-5 NB
- Wilsonville, OR to Vancouver, WA
- 31.75 miles
- Feb-Aug, 2007 (weekdays)
Results: Recurring Congestion

Through Truck vs PORTAL Corridor Average Travel Time
*Results following filter process 2, showing Aggregated Data and Std Err

- Portal Feb to Aug
- GPS Feb to Aug Through

Summary of Findings:
- PORTAL tends to underestimate congestion in PM peak period
- Std Err indicates less reliability in PM peak period

Results: Recurring Congestion

Through Truck vs PORTAL CV in Corridor Average Travel Time
*Results following filter process 2, showing Aggregated Data

- Portal Feb to Aug
- GPS Feb to Aug Through

Summary of Findings:
- PORTAL tends to underestimate congestion in PM peak period
- Std Err indicates less reliability in PM peak period
Non-Recurring Congestion Analysis

Case Study: Non-Recurring Congestion

Non-Recurring Congestion
• Similar Methodology,
• *5 mile segment near incident “A”*
• Incidents Downstream of “A”

MP 304.4 Alberta St
MP 303.88 Going St

5 MI

PORAL Loop Station
Incident “A”
Downstream Incidents
GPS Range
### Results: Non-Recurring Congestion

#### Through-Incident Average Speed Crossing Incident Area

*Results following filter process 2*

<table>
<thead>
<tr>
<th>Time</th>
<th>0:00</th>
<th>2:00</th>
<th>4:00</th>
<th>6:00</th>
<th>8:00</th>
<th>10:00</th>
<th>12:00</th>
<th>14:00</th>
<th>16:00</th>
<th>18:00</th>
<th>20:00</th>
<th>22:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (mph)</td>
<td>60</td>
<td>55</td>
<td>50</td>
<td>45</td>
<td>40</td>
<td>35</td>
<td>30</td>
<td>25</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

- Portal 12-9 (No Incident)
- Portal 12-12 (Incident)
- GPS 12-12 (Incident)

### Summary of Findings:

- Downstream incidents have effect
- Smaller Std Err with truck data using Through-Incident only
- Supports that bias exists when partial/local movements included
- Few samples, difficult to look at reliability measures

#### Partial Through, Partial Local and Through-Incident Average Speed Crossing Incident Area

*Results following filter process 2*

<table>
<thead>
<tr>
<th>Time</th>
<th>0:00</th>
<th>2:00</th>
<th>4:00</th>
<th>6:00</th>
<th>8:00</th>
<th>10:00</th>
<th>12:00</th>
<th>14:00</th>
<th>16:00</th>
<th>18:00</th>
<th>20:00</th>
<th>22:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (mph)</td>
<td>70</td>
<td>65</td>
<td>60</td>
<td>55</td>
<td>50</td>
<td>45</td>
<td>40</td>
<td>35</td>
<td>30</td>
<td>25</td>
<td>20</td>
<td>15</td>
</tr>
</tbody>
</table>

- Portal 12-12 (Incident)
- Portal 12-9 (No Incident)
- GPS 12-12 (Incident)
Summary of Findings

Truck Data vs PORTAL Comparison

Through Truck & PORTAL Corridor Average Travel Time, Feb-Aug
*For aggregated data

$R^2 = 0.6863$
Research Next Steps

Work to-date is a good foundation...

• Improving complexity of programming
• Using PORTAL data dynamically
• Statistical and Sensitivity Testing
• Quantifying Costs, Emissions and Health Impacts

Conclusions

• Integrated GPS, loop sensor and incident data
• New methodology to identify local and through trucks
  • Remove bias of trucks resting/refueling
  • Through trucks best indicator of congestion
  • Indications that loop sensor data may underestimate congestion in PM peak
• Performance data useful to public agencies
  • Expand to look at bottlenecks
  • Study greater time periods
  • Local/freeway transitions
• Could be incorporated into Oregon Freight Data Mart or other web based platform
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Questions??

Nikki Wheeler  nicole.m.wheeler@gmail.com
Dr. Miguel Figliozzi  figliozzi@pdx.edu
References


