Validating the Cost Effectiveness Model for California’s Freeway Incident Management Program

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Presentation Outline

- Introduction – California’s FSP Program
- FSP Beat Evaluation (FSPE) Model
- Methodology – FSPE Model Validation
- Data Sources – FSPE Model Validation
- Observations about the Data
- Results – FSPE Model Validation
- Concluding Remarks
California’s FSP Program

The CA-FSP program is a congestion management program, focused on quick identification and clearance of collisions, disabled/stranded vehicles and other obstructions from California’s freeways.

California Statewide FSP Program (Fiscal Year 2012-13)

- 9 of the 12 Caltrans districts
- 193 FSP beats
- 364 weekday PM trucks
- 1,810 centerline miles
- 825,600 (tow) truck-hours
- 651,300 motorist assists
- $25,500,000 state funding
- 7.8-to-1.0 benefit-to-cost ratio
FSP Beat Evaluation (FSPE) Model

**FSPE Model Inputs**
- **FSP beat info**
  - Length (miles)
  - Freeway lanes
- **FSP service**
  - Number of FSP vehicles
  - Hours of operation
  - FSP costs
- **FSP assists**
  - Count by assist types
  - Duration
- **Traffic conditions**
  - Hourly volumes
  - Capacities

**FSPE Model Outputs**

<table>
<thead>
<tr>
<th>Daily/Annual (Total)</th>
<th>Daily</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savings-Performance Measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delay (veh-hrs)</td>
<td>36.14</td>
<td>9,036</td>
</tr>
<tr>
<td>Fuel Consumption (gal)</td>
<td>62.13</td>
<td>15,532</td>
</tr>
<tr>
<td>Emissions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROC (kg/day, kg/yr)</td>
<td>0.00</td>
<td>1</td>
</tr>
<tr>
<td>CO (kg/day, kg/yr)</td>
<td>0.04</td>
<td>9</td>
</tr>
<tr>
<td>NOx (kg/day, kg/yr)</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>PM10 (kg/day)</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>CO2 (kg/day)</td>
<td>546.74</td>
<td>136,686</td>
</tr>
<tr>
<td>N2O (kg/day)</td>
<td>0.01</td>
<td>2</td>
</tr>
<tr>
<td>CH4 (kg/day)</td>
<td>0.02</td>
<td>6</td>
</tr>
<tr>
<td>CO2e (kg/day, kg/yr)</td>
<td>553.58</td>
<td>138,395</td>
</tr>
<tr>
<td>Cost Effectiveness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delay Benefits ($/day, $/yr)</td>
<td>$531</td>
<td>$132,826</td>
</tr>
<tr>
<td>Fuel Benefits ($/day, $/yr)</td>
<td>$247</td>
<td>$61,819</td>
</tr>
<tr>
<td>Total Benefits ($/day, $/yr)</td>
<td>$779</td>
<td>$194,645</td>
</tr>
<tr>
<td>Cost of the FSP Service</td>
<td>$361</td>
<td>$90,139</td>
</tr>
<tr>
<td>B/C Ratio</td>
<td></td>
<td>2.16</td>
</tr>
</tbody>
</table>
FSP Beat Evaluation (FSPE) Model

Deterministic Queueing Model

Inputs:

- **Incident Durations**
  - With FSP
  - Without FSP

- **Traffic Demands**
  - Hourly volumes
  - PeMS (if available)

- **Freeway Capacities**
  - Base capacity
  - During incident
Methodology – FSPE Model Validation

Components of Congestion (Congestion Pie)

- Linear models, freeway delays apportioned:
  1. Incidents
  2. Special events
  3. Lane closures
  4. Adverse weather conditions
  5. Potential reduction by ramp metering
  6. Residual delay, attributed mostly to excess demand
# FSPE Model Validation “Beats”

<table>
<thead>
<tr>
<th>FSP Beat</th>
<th>County</th>
<th>Freeway</th>
<th>Beat Limits</th>
<th>One-way Beat Length (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ALA</td>
<td>24</td>
<td>I-580 to Contra Costa County Line</td>
<td>4.39</td>
</tr>
<tr>
<td></td>
<td>CC</td>
<td></td>
<td>Contra Costa Co. Line to Oak Hill Road</td>
<td>6.25</td>
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<tr>
<td></td>
<td>ALA</td>
<td>980</td>
<td>Interstate 580 to Interstate 880</td>
<td>2.03</td>
</tr>
<tr>
<td></td>
<td>880</td>
<td></td>
<td>7th Street to Jackson Street</td>
<td>2.04</td>
</tr>
<tr>
<td>12</td>
<td>CC</td>
<td>80</td>
<td>San Pablo Dam Rd to Cummings Skyway</td>
<td>8.39</td>
</tr>
<tr>
<td>16</td>
<td>SCL</td>
<td>17</td>
<td>Junction SR-9 to Summit Road</td>
<td>7.07</td>
</tr>
<tr>
<td>18</td>
<td>SCL</td>
<td>880</td>
<td>Junction SR-237 to Alameda County Line</td>
<td>2.08</td>
</tr>
<tr>
<td></td>
<td>ALA</td>
<td></td>
<td>SCL County Line to Mowry Avenue</td>
<td>7.18</td>
</tr>
<tr>
<td>22</td>
<td>ALA</td>
<td>580</td>
<td>Santa Rita to Grant Line Road</td>
<td>16.48</td>
</tr>
<tr>
<td>29</td>
<td>SOL</td>
<td>80</td>
<td>Magazine Street to Abernathy Road</td>
<td>14.04</td>
</tr>
<tr>
<td>34</td>
<td>SOL</td>
<td>80</td>
<td>Abernathy Road to Vaca Valley Road</td>
<td>12.54</td>
</tr>
<tr>
<td>37</td>
<td>SOL</td>
<td>80</td>
<td>Junction I-505 to Richards Boulevard</td>
<td>16.40</td>
</tr>
</tbody>
</table>
Data Sources – FSPE Model Validation

PeMS
- VMT, VHT, delays (freeway loops, stationary)
- Incidents / collisions (CHP incident logs)

INRIX (probe vehicles)
- Delays: “all vehicles” on a corridor
  “per vehicle” on a corridor

Components of Congestion methods
  ➔ Expected delays (VHT) per collision-minute

FSP Beat Evaluation Model
  ➔ FSP delay savings (VHT) per collision-minute
Observations about the Data

Daily Traffic Delays, State Route 24 (FSP Beat #1)
Caltrans Fiscal Year: July 1, 2012 → June 30, 2013

Delays below threshold (free flow) speed = 60 mph

- PeMS Corridor (stationary source, mainly loops)
- INRIX Analytics (probe vehicles)

\[ y = 0.8606x \]
\[ R^2 = 0.8412 \]
## Observations about the Data

### Correlations between Traffic Delays and Collisions

<table>
<thead>
<tr>
<th>Bay Area FSP Beat</th>
<th>Correlation: INRIX-Delays to CHP-Collisions</th>
<th>Correlation: PeMS-Delays to CHP-Collisions</th>
<th>Average PeMS Station Spacing (miles)</th>
<th>PeMS/INRIX Correlation Ratio (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beat 1</td>
<td>0.250</td>
<td>0.218</td>
<td>1.67</td>
<td>87.1%</td>
</tr>
<tr>
<td>Beat 12</td>
<td>0.365</td>
<td>0.357</td>
<td>0.48</td>
<td>97.9%</td>
</tr>
<tr>
<td>Beat 16</td>
<td>0.246</td>
<td>n/a</td>
<td>14.40</td>
<td>n/a</td>
</tr>
<tr>
<td>Beat 18</td>
<td>0.477</td>
<td>0.460</td>
<td>0.81</td>
<td>96.4%</td>
</tr>
<tr>
<td>Beat 22</td>
<td>0.463</td>
<td>0.450</td>
<td>1.09</td>
<td>97.1%</td>
</tr>
<tr>
<td>Beat 29</td>
<td>0.236</td>
<td>0.128</td>
<td>2.48</td>
<td>54.0%</td>
</tr>
<tr>
<td>Beat 34</td>
<td>0.309</td>
<td>n/a</td>
<td>25.00</td>
<td>n/a</td>
</tr>
<tr>
<td>Beat 37</td>
<td>0.344</td>
<td>0.208</td>
<td>3.47</td>
<td>60.4%</td>
</tr>
</tbody>
</table>
Observations about the Data

Correlations between Traffic Delays and Collisions
Observations about the Data

PeMS volumes & delays compared with downstream stations
Results – FSPE Model Validation

- Graph showing the relationship between Empirically Estimated Traffic Delays and FSPE Model Predicted Delay Savings.
Results – FSPE Model Validation
Results – FSPE Model Validation

![Graph showing FSPE Model Predicted Delay Savings vs. Empirically Estimated Traffic Delays]

- PeMS
- INRIX
- PeMS+INRIX

Equation Labels:
- $y = 1.0139x$
- $y = 0.5426x$
- $y = 0.5223x$
Concluding Remarks

- Overall, the FSP beat evaluation model replicated delay savings that were in the range of the empirically estimated traffic delays.
- There is some evidence that FSPE’s deterministic queueing methods might be underestimating delay savings.
- Future FSPE model improvements & research