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SHRP 2 Project L03

Analytic Procedures for Determining the Impacts of Reliability Mitigation Strategies

presented to

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Transportation leadership you can trust.
The Challenge

- Team decided early on that an empirical approach should be undertaken

- Reliability is defined by a long history – at least a year – of travel times (a distribution)
  - Implies that automated equipment is the only feasible method of data collection, but...
  - Automated equipment not deployed everywhere
  - Usually deployed along with operational countermeasures (no “before” condition)

- So, how can enough empirical data be collected to study the effect on reliability?
  - Tap existing data sources as much as possible
  - Rely on a cross-sectional predictive model
A Model of Congestion and Its Sources

Traffic Control Devices

Daily/Seasonal Variation

Special Events

Physical Capacity

Demand Volume

Base Delay (“Recurring” or “Bottleneck”)

Event-Related Delay

Roadway Events

Weather

Incidents

Work Zones

Total Congestion & Reliability

= Source of Congestion

Planned

Emergencies

...determine...

...lowers capacity and changes demand...

...can cause...

...can cause...

...can cause...
Analysis Data Set

Traffic Data
- Volumes
- Speeds

Section Reliability Measures
- By Time Slice

Traffic Characteristics
- Demand
- Traffic Statistics

Incident Data

Agency Generated

Traffic.com

Weather Data

NWS Hourly Obs
- Service Patrols
- Policies

Incident Management

Geometric Characteristics
- Capacity
- Bottleneck
- Ramp Meters

Analysis Data Set
The Analysis Approach: 4-Pronged

- **Exploratory analysis**
  - Result: Understanding reliability, set research parameters

- **Before/After studies on selected study sections**
  - Not planned in an experimental sense
  - Result: reliability adjustment factors (% change)

- **Cross-sectional statistical modeling**
  - Macro-level
  - Result: $\text{Reliability} = f\{\text{volume, capacity, events}\}$

- **Congestion-by-Source**
  - Micro-level
  - Estimation method for the “Congestion Pie”
## Trends in Reliability: Atlanta Study Sections

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel Time Index</td>
<td>1.720</td>
<td>1.800</td>
<td>1.585</td>
</tr>
<tr>
<td>Average Travel Time</td>
<td>10.03</td>
<td>10.49</td>
<td>9.22</td>
</tr>
<tr>
<td>95th Percentile Travel Time</td>
<td>14.27</td>
<td>15.15</td>
<td>13.60</td>
</tr>
<tr>
<td>Buffer Index</td>
<td>0.399</td>
<td>0.428</td>
<td>0.451</td>
</tr>
<tr>
<td>80th Percentile Travel Time</td>
<td>11.87</td>
<td>12.40</td>
<td>10.99</td>
</tr>
<tr>
<td>Skew Statistic</td>
<td>1.186</td>
<td>1.196</td>
<td>1.308</td>
</tr>
<tr>
<td>VMT Change</td>
<td>+0.6%</td>
<td>-3.1%</td>
<td></td>
</tr>
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Reliability Effects of Improvements (from B/A)

- Capacity expansion projects will also improve reliability and operations improves the average/typical condition
  - FSP expansion
    - 15% reduction in unreliability (PTI)
    - 20% reduction in average travel time
  - Lane addition
    - 38% reduction in unreliability (PTI)
    - 35% reduction in average travel time

Implication: If reliability has additional costs to travelers, we’ve been missing a big part of the benefit stream for capacity projects
Statistical Modeling: Simple Method

- Results show that all reliability measures defined in the study can be predicted as a function of average Travel Time Index.

- Allows reliability prediction from a wide variety of other methods/models that predict the average TTI.

- Urban freeways, rural freeways, signalized arterials covered.
Statistical Modeling: Detailed Analysis

- Conceptual model: relate reliability to most direct influences; develop model “chain” back to improvements
  - Basic unit: “freeway sections”, 3-5 miles long

- Mean, median, 10th, 80th, 95th, and 99th %ile travel times can be predicted as a function of:
  - “Critical” demand-to-capacity ratio
    - Most significant factor
  - Lane-hours lost due to incidents + work zones
  - Hours where rainfall >= 0.05”
  - RMSEs 15-20%

- Submodels developed to predict the above independent variables
Congestion-by-Source: Special Seattle Analysis (Adjusted for “what would have happened”)

<table>
<thead>
<tr>
<th>Causes of Congestion</th>
<th>Unadj. % of Delay</th>
<th>Adj. % of Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidents (crashes, breakdowns)</td>
<td>38.5%</td>
<td>28.5%</td>
</tr>
<tr>
<td>Bad Weather (Rain)</td>
<td>17.7%</td>
<td>13.1%</td>
</tr>
<tr>
<td>Construction</td>
<td>1.2%</td>
<td>1.0%</td>
</tr>
<tr>
<td>No Cause Indicated (mostly volume/recurring)</td>
<td>42.6%</td>
<td>57.4%</td>
</tr>
</tbody>
</table>
Congestion by Source Findings

- Volume is the primary factor ("starting point") in congestion and the effect of any given type of disruption
  - Effects vary significantly from corridor to corridor, depending on the nature of the traffic volumes and routine congestion patterns

- On large (3+ lane per direction) roads, congestion is unlikely (<20 %) to form at V / C ratios below 0.8 if no disruption event occurs

- On smaller (2 lane) freeways this value can be as low as 0.6
Summary: What We Have and How It Can Be Used

- Large database that will continue to be used in other studies
  - Being used now on Project C10 and FHWA Research
  - Data management methods will inform L02 (Monitoring Programs)

- Foundational research on reliability and congestion
  - Will inform the Congestion Management Process and expected performance-based Reauthorization requirements
  - Measures and data processing methods
  - Predictive relationships for reliability
Implications of Findings (from all the research)

- Reliability is really just another attribute of congestion, in addition to temporal and spatial aspects

- **ALL** types of highway improvements will improve reliability
  - Operations, capacity additions, and demand management all contribute to improving reliability

- Volume (demand) – and its relationship to capacity – is a major determinant of reliability
  - Determines base congestion and how severe events will be
  - Volume can be used to determine when / where incident response vehicles are deployed
Implications of Findings (cont.)

- Not accounting for reliability misses a substantial portion of the benefits of transportation improvements

- “We’ve been selling ourselves short”, in an economic sense, in communicating the benefits of highway improvements
Thanks!