Evaluating Adaptive Ramp Metering through Partial Least Squares Path Modeling
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Abstract
We use Partial Least Squares Modeling (PLS-PM) to view how the Adaptive Ramp Metering (ARM) system impacts certain freeway metrics when compared to a baseline Coordinated Ramp Metering (CRM) system. We collect data from two comparable freeways: I-80 East (ARM) and I-280 South (CRM). Next, we use path modeling to build a relationship between measures of traffic, safety, efficiency, and travel time reliability. By using the binary variable arm to indicate which freeway each observation comes from, we were able to quantify the difference between the two systems.

Research Questions
• Research was based on Mineta Transportation Institute grant.
• Three types of CRM systems
  (1) Fixed Ramp Metering
  (2) Local Traffic Responsive Metering
  (3) Adaptive Ramp Metering (ARM)
• Focus of research was ARM system on I-80 East, implemented in April 2017.
• Main Question: How does the ARM system impact I-80 East in terms of traffic, safety, efficiency, and travel time reliability?

Table 1: Overview of variables used in path model.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description of Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic aadt lanes</td>
<td>Measures overall traffic on freeway</td>
</tr>
<tr>
<td>Safety crashes</td>
<td>Measures safety of freeway</td>
</tr>
<tr>
<td>Efficiency vht arm</td>
<td>Measures overall efficiency of freeway</td>
</tr>
<tr>
<td>Reliability delay length arm</td>
<td>Measures overall travel time reliability of freeway</td>
</tr>
<tr>
<td></td>
<td>Total sum of hours traveled by vehicles per segment</td>
</tr>
<tr>
<td></td>
<td>Total hours of delay per segment</td>
</tr>
<tr>
<td></td>
<td>Length of segment (in miles)</td>
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</tbody>
</table>

Variable Description of Variable
Traffic aadt: Annual Average daily traffic per segment
Number of lanes per segment (excluding carpool/HOV lanes)

Safety crashes: Total number of car crashes that occurred per segment

Efficiency vht arm: Total sum of hours traveled by vehicles per segment
Binary variable: 0 if segment is from I-280, 1 if segment is from I-80

Reliability delay length arm: Total hours of delay per segment
Length of segment (in miles)
Binary variable: 0 if segment is from I-280, 1 if segment is from I-80

Project Activities or Findings
• PLS-PM uses multivariate models to quantify latent variables through manifest variables
  Latent variables: variables that cannot be measured directly
  Manifest variables: variables that can be measured directly
• Result: PLS-PM indicates that Adaptive Ramp Metering improves efficiency and travel time reliability of the freeway when compared to baseline Coordinated Ramp Metering.

Citations