An Empirical Examination of Freeway Travel Reliability

Alex Skabardonis & Michael Mauch
UC Berkeley – ITS/PATH

Session #9, Where the Rubber Meets the Road – Real Results in the Age of Performance-Based Operations
US-101 Study Corridor
San Francisco to San Jose

Southbound Bottlenecks

Northbound Bottlenecks
US-101 (Northbound + Southbound)
Average Weekday Average Daily Travel (ADT)
US-101 (Northbound + Southbound)
Average Weekday Vehicle Hours Delayed (VHD)
US-101 Corridor - Corridor Demand & Congestion Trends

In heavily congested corridors, moderate changes in demand can bring about large impacts to travel delays & levels of congestion.
### Corridor Traffic Growth Trends (2014-16)

<table>
<thead>
<tr>
<th>Day(s) of Week</th>
<th>Corridor Performance Metric</th>
<th>US-101 Northbound</th>
<th>US-101 Southbound</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-holiday Weekday</strong></td>
<td>VMT</td>
<td>3.2%</td>
<td>4.6%</td>
</tr>
<tr>
<td></td>
<td>VHD</td>
<td>12.4%</td>
<td>12.4%</td>
</tr>
<tr>
<td><strong>Saturday</strong></td>
<td>VMT</td>
<td>6.5%</td>
<td>8.0%</td>
</tr>
<tr>
<td></td>
<td>VHD</td>
<td>28.0%</td>
<td>29.5%</td>
</tr>
<tr>
<td><strong>Sunday</strong></td>
<td>VMT</td>
<td>5.4%</td>
<td>7.2%</td>
</tr>
<tr>
<td></td>
<td>VHD</td>
<td>32.2%</td>
<td>43.4%</td>
</tr>
</tbody>
</table>
US-101 Corridor - Weekday Average Travel-times
US-101 Corridor – Weekday Average Vehicle-Hours Delayed

**US-101 (NB) Corridor Vehicle Hours of Delay (VHD) on an Average Weekday**

**US-101 (SB) Corridor Vehicle Hours of Delay (VHD) on an Average Weekday**
Travel Time Reliability – Buffer Index

Buffer Index (BI) is a very commonly used travel-time reliability metric. The buffer index represents the extra time (or time cushion) that travelers must add to their average travel time when planning trips to ensure an on-time arrival.

\[ BI (\%) = 100\% \times \frac{95th \% - \text{ile travel time (minutes)}}{\text{average travel time (minutes)}} \]

- The 95th percentile travel time is a reasonable upper bound for expected travel time – on very heavily congested days.
- A BI of zero means that the 95th percentile travel time and the average travel time are the same; there are no differences (or variability) in the travel times between an average day and a heavily congested day.
- A BI of 50 means that the travel times on heavily congested days are 1.50 times (or 50%) greater than on average days.
US-101 Northbound
Average Weekday Buffer-Index & Speed Contours
US-101 Northbound
Average Weekday Buffer-Index & Speed Contours
INRIX data: Mean speeds & reliability

- **Unreliable Speeds**
- **Moderate Reliability**
- **Stable Speeds**

**Highly Congested**

**Moderate Congestion**

**Freely Flowing**
US-101 Southbound
Average Weekday Buffer-Index & Speed Contours
US-101 Southbound
Average Weekday Buffer-Index & Speed Contours
INRIX data: Mean speeds & reliability

Unreliable Speeds
Moderate Reliability
Stable Speeds

Highly Congested
Moderate Congestion
Freely Flowing
Freeway travel-time reliability

Reliability = Consistency

Travel times tend to be reliable or consistent on freeway segments (and time-of-day) when traffic is always freely flowing – no congestion.

Travel times tend to be fairly reliable on heavily congested stretches – segments and times that are congested every day – not just occasionally congested.

Travel times tend to be the most unreliable on freeway segments that are congested on some days and not congested on other days – some good days & some bad days → not consistent.

Reliability gets worse as corridors transition from uncongested to moderately congested.

Reliability gets better as corridors transition from moderate to severe congestion.
Freeway travel-time reliability

Reliability = Consistency

Travel times tend to be reliable or consistent on freeway segments (and time-of-day) when traffic is always freely flowing – no congestion.

Travel times tend to be fairly reliable on heavily congested stretches – segments and times that are congested every day – not just occasionally congested.

Travel times tend to be the most unreliable on freeway segments that are congested on some days and not congested on other days – some good days & some bad days → not consistent.

Reliability gets worse as corridors transition from uncongested to moderately congested.

Reliability gets better as corridors transition from moderate to severe congestion.