Travel Time Reliability Application for Planning-Level Transportation Project Evaluation

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US 101 Corridor Mobility Master Plan & Travel Time Reliability

• Incorporated as part of the freeway operational analysis
• Travel Time Reliability – first application in District 5
• Travel Time Reliability represented by “Buffer Time”
• Buffer time reduction and delay reduction added to yield total monetary time saving benefits of US101 mainline improvement concepts
• Results? But first
  – what is travel time reliability?
What is Travel Time Reliability?

• **Travel time reliability is:**
  – The distribution of travel times that a traveler should anticipate if starting a trip at a given point at a given time and day.

• **Travel Time Reliability represented by “Buffer Time”**
  – Buffer Time – added increment of time required to ensure you reach your destination at the desired time 95% of the time.
  – How much earlier do you need to leave your home to ensure arriving on time.
  – Time you could spend at home (effect is assumed to be similar to when you experience delay while driving your car i.e., travel time delay)
Buffer Time

- Free Flow
- Mean
- 95th Percentile

Buffer Time

Trips < 45 mph

Travel Time (min)
## Commonly Applied Reliability Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Definition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning Time</td>
<td>95&lt;sup&gt;th&lt;/sup&gt; percentile travel time</td>
<td>The total travel time required to arrive on-time 95% of the time</td>
</tr>
<tr>
<td>Planning Time Index</td>
<td>The ratio of the Planning Time to the Ideal or Free Flow Travel Time</td>
<td>How much larger the potential total travel time is than the ideal or free-flow travel time</td>
</tr>
<tr>
<td>Buffer Time</td>
<td>The difference between the 95&lt;sup&gt;th&lt;/sup&gt; percentile travel time and the average travel time</td>
<td>The amount of buffer time required</td>
</tr>
<tr>
<td>Buffer Index</td>
<td>The 95&lt;sup&gt;th&lt;/sup&gt; percentile travel time minus the average travel time divided by the average travel time</td>
<td>The size of the buffer as a percentage of the average</td>
</tr>
<tr>
<td>Travel Time Index*</td>
<td>Actual travel time divided by the free-flow travel time for a given observation period</td>
<td>Measure of average congestion</td>
</tr>
</tbody>
</table>
What are the Causes of Unreliability?

Causes of Unreliability

- **Non-Recurring (e.g. Special Events)**: 5%
- **Poor Signal Timing**: 5%
- **Weather (Snow, Ice, Fog)**: 15%
- **Work Zones**: 10%
- **Traffic Incidents**: 25%
- **Bottlenecks**: 40%

Day-to-Day Variations in Travel Time

- 2 Incidents with Rain
- 3 Incidents
- 1 Incident with Rain
- 4 Incidents
- Rain
- 1 Incident

Travel Time (in Minutes)

- Martin Luther King Day
- Presidents Day

Observed Travel Speeds (mph) from SL005 to SL004

- AM Peak (7-9am)
- PM Peak (4-6pm)
- Travel Time Record
- Average Speed (mph)
Why is Travel Time Reliability Important?

1) Our roadway networks are more frequently operating in a near or above capacity
2) Uncertainties in travel time adversely impact us in multiple ways
3) We don’t have a way to measure the benefit of many of our strategies and investments

Why is Travel Time Reliability Important?

- **Old days (Capacity-oriented)**
  - Network build-out and expansion $\rightarrow$ increase capacity
  - Secure funding environment
  - Traditional performance metrics
  - Reduce travel time

- **New way (Reliability-oriented)**
  - How best to manage the system we have $\rightarrow$ increase capacity utilization
  - Financial, environmental and public perception problems
  - Improvements that affect reliability more than capacity
  - MAP-21 (Federal), SB 375 (CA), SB 743 (CA)
Tools for Reliability

• Measuring Reliability
  – FHWA NPMRDS travel time monitoring data set for highways
  – Data Collection

• Predicting or Estimating Reliability
  – University of Florida/FDOT spreadsheet
  – SHRP2-C11 Method
  – HCM 2010 Update (under development)
The UF/FDOT Reliability Spreadsheets

- Freeway
- Arterials

How it works

- Allocate AADT to each hour of year
- Compute recurring congestion using HCM capacities
- For each hour of 24 hour day compute travel times for 24 possible scenarios combining weather, incidents, work zones
- Assign probabilities to each scenario
- Compute reliability statistics

Lots and lots of assumptions built in

- Seasonal traffic variation, incident frequencies, weather frequencies....
Case Study – SLOCOG 101 Mobility Master Plan

- Reliability measured using Bluetooth detection
- Reliability estimated University of Florida method
- Reliability was predicted by applying UF method growth applied to measured baseline
Travel Time Reliability Prediction

Step 1: Model Based Existing Buffer Time
Step 2: Model Based Future Buffer Time
Step 3: Model Based Buffer Time Change
Step 4: Field Data Based Future Buffer Time
US 101 Reliability Measured

- 10 detectors deployed along US 101
- 9 individual segments
- Data was collected continuously for more than 4 months
Data Needs for Reliability

• To Predict or Estimate Reliability
  – Demand Variability (Seasonality)
  – Weather frequencies
    • Light, medium, heavy Rain, snow
  – Incident and work zone frequencies
    • Number of lanes blocked
    • Duration

• To Measure Reliability
  – Hourly speeds and volumes 24/7 for 6 months to a year
  – FHWA NPMRDS
Example: Travel Time Reporting

- Southbound – Los Osos Valley Road to Avila Beach Road
  - Daily observed – June 26th, 2014
Example: Travel Characteristics
SB 101 Los Osos Valley to Avila Beach (4-6 PM)

- Trip Distance (miles) 4.03
- Expected Travel Time (sec. / min.) 202 / 3:22
- Number of Trips 1214
- Average Speed (mph) 48.5
- Average Travel Time (sec. / min.) 299 / 4:59
- Standard Deviation (sec.) 146.3
- 15th Percentile (sec. / min.) 200 / 3:20
- 85th Percentile (sec. / min.) 509 / 8:29
- 95th Percentile (sec. / min.) 583 / 9:43
Example: Travel Time Reliability
SB 101 Los Osos Valley to Avila Beach (4-6 PM)

95th Percentile TT – Avg TT

- Sunday 237s – 215s = 22 sec.
- Monday 247s – 217s = 30 sec.
- Tuesday 250s – 221s = 29 sec.
- Wednesday 244s – 222s = 22 sec.
- Thursday 271s – 229s = 42 sec.
- Friday 320s – 260s = 60 sec.
- Saturday 251s – 219s = 32 sec.
US 101 Case Study in Reliability

• Objective
  – Incorporate Travel time reliability as a metric used in the B/C analysis
  – Buffer time (during typical weekday: Tuesday – Thursday)

• Approach: Existing Conditions
  – Vehicle Operating Conditions
    • Published Traffic Volumes and Counts
    • Bluetooth Data (4 months)
  – Incidents
    • Incident Inventory in PeMS (12 months)
    • CHP Reports (12 months)
  – Weather
    • Paso Robles Airport (12 months)
    • San Luis Obispo Airport (12 months)
  – Work zones
    • Caltrans Website
    • Caltrans PeMS (12 months)
US 101 Case Study in Reliability

• **Approach: Future Conditions**
  – Travel Demand
    • SLOCOG Travel Demand Model (NCHRP-255 Adjustments for Daily Volumes)
    • Caltrans K & D Factors for full 24-hour Distribution
    • UF Model
      – Expanded procedure for bi-directional results
      – Generate baseline TTR
    – Incidents (same as baseline – UF Model adjusted based on volume)
    – Weather (same as baseline – UF Model adjusted based on volume)
    – Work zones (same as baseline – UF Model adjust based on volume)

• **UF Model Procedure (recap)**
  – Compute recurring congestion using HCM capacities
  – For each hour of 24 hour day compute travel times for 24 possible scenarios combining weather, incidents, work zones
  – Assign probabilities to each scenario
  – Compute reliability statistics (buffer time, BTI, travel time, TTI etc.)

• **Delta Method: Empirical Baseline + (UF Model Future – UF Model Baseline)**
US 101 Case Study in Reliability

• Annualize 24-hour Distribution Effects on Capacity and Speeds
  – Weather
  – Incidents
  – Work zones
  – Recurring congestion
US 101 Case Study in Reliability

US 101 Case Study Corridor-wide Results

- Existing Condition Reliability on US 101
  - AM Southbound – ~7.5 minutes Buffer Time
  - AM Northbound – ~3.5 minutes Buffer Time
  - PM Southbound – ~6.0 minutes Buffer Time
  - PM Northbound – ~3.0 minutes Buffer Time
US 101 Case Study in Reliability

US 101 Case Study Corridor-wide Results

- **Future Condition Reliability**
  - AM Southbound – ~7.5 minutes Buffer Time
  - AM Northbound – ~6.0 minutes Buffer Time
  - PM Southbound – ~6.0 minutes Buffer Time
  - PM Northbound – ~3.0 minutes Buffer Time

US 101 Case Study Focus Area Results

- **Future Condition Reliability (Change)**
  - 5 City Area AM Northbound BTI (4.4% - 15%)
  - 5 City Area PM Southbound BTI (11.1% - 15.5%)
  - SLO Area PM Southbound BTI (6.9% - 12.6%)
US 101 Case Study Findings

• Travel Time Reliability on US 101
  – Generally good reliability corridor-wide
    • < 8 minutes Southbound
    • < 4 minutes Northbound
  – Anticipated to not significantly change in the future
    • Weather not a significant factor
    • Work zones not a significant factor
    • Collision rates generally at or below statewide average for like facilities
US 101 Case Study Findings

• **Travel Time Reliability on US 101**
  – Where do reliability issues occur:
    • Five-City Area and City of San Luis Obispo
      – Southbound Direction
      – Northbound Direction (Five-City Area)
  – Correlates to where the greatest congestion is projected to occur
  – Supports US101 Mobility Master Plan
    • Buffer Time Reduction Increased B/C of HOV Improvement in Segment 1 by 8%
    • Buffer Time Reduction Increased B/C of HOV Improvement in Segment 2 by 4%
US 101 Case Study Findings

• Travel Time Reliability Metric
  – We did it
    • Wasn’t too painful
    • Learned from our experience
      – More than 4-months of data (April – August)
      – Would have been nice to test other reliability tools
      – Expand analysis to weekend
    • Consistent with MAP-21 – provides greater support
    • Supports SLOCOG for examining operational improvement on US 101
Questions?