Advances in Measuring Travel Time
Delay and Reliability

Wisconsin Department of Transportation

Mid-Continent Transportation Research Symposium
October 24th, 2016
People relate to Delay and Reliability in their day to day travel.

Sample travel scenario:

- 20 minutes
- Multiplied by 1.5 PTI
- Equals 30 minutes

A PTI of 1.5 means travel is moderately unreliable. A traveler going for a 20 minute trip during a peak period would be assured of completing the trip in 30 minutes or less at least 95 percent of the time.
• People relate to Delay and Reliability in their day to day travel

• The causes of delay can be investigated and explored
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• Resources can go towards the greatest need
• People relate to Delay and Reliability in their day to day travel
• The causes of delay can be investigated and explored
• Resources can go towards the greatest need
• Supports analysis and is measurable
Defining Delay and Reliability

Delay is the Number of vehicles \* Travel time

12.4 M Vehicle Hours in 2015

Reliability is an Index, or Ratio
Planning Time Index = \( \frac{TT_{95}}{TT_{ff}} \)
Advances in Measuring Travel Time Delay & Reliability

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<thead>
<tr>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
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<td>Introduce</td>
<td>Trends</td>
<td>USDOT Metrics</td>
</tr>
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<td>Delay and</td>
<td>Event Impacts</td>
<td></td>
</tr>
<tr>
<td>Reliability</td>
<td>Active Management</td>
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</tbody>
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2014
Introduce Delay and Reliability

2015
Trends
Event Impacts
Active Management

2016
USDOT Metrics
Measures Meet Application
Introduce New Performance Measures

MAPSS Performance Improvement

Proposed Performance Measure: Hours of Delay

- Report Date: January 2014
- Data Frequency: Quarterly
- Division: Transportation System Development

Why is it Important? Traffic congestion can be recurring or caused by several other factors including accidents, weather, work zones, and special events. Congestion creates delays that affect travelers and increase costs for auto and freight movements. Reducing the hours of delay on a facility improves travel reliability and efficiency.

Performance measure draft target: The department’s goal is to reduce monthly delay within the Capitol Corridor to 20,000 hours.

Figure: Capitol Corridor Monthly Hours of Delay

2015 User Delay Cost by Corridor

- I-94 Eau Claire to Minnesota
- I-90/94 Madison to Eau Claire
- I-94 Badger interchange to Marquette interchange
- I-94 Eau Claire to Minnesota
- I-90 Tomah to Minnesota
- I-43/94 Beloit to Mitchell interchange

Annual passenger user delay cost = $13,674,200
Annual commercial user delay cost = $8,183,130
Total annual user delay cost = $21,857,330

Urban Reliability

Segment: Urban Freeway Segment 10

Planning Time Index

- Winter (Dec - Feb)
- Spring (Mar - May)
- Summer (Jun - Aug)
- Fall (Sep - Nov)

Urban Freeway Segment 6
Urban Freeway Segment 7
Urban Freeway Segment 8
Urban Freeway Segment 9
Urban Freeway Segment 11

Passenger Cars
Commercial Vehicles

*Year-to-date
Special Reports

Wisconsin Department of Transportation

Spring 2014

Travel Time Reliability and Delay Report

Travel Time Reliability
The Wisconsin Department of Transportation wants travelers to arrive safely and on time at their destinations. Having a high level of confidence and certainty of on-time arrival are measures of the reliability of the transportation system.

Planning Time Index (PTI) value

- 1.0–1.30 reliable
- 1.31–1.60 moderately reliable
- 1.61–2.0 unreliable

To calculate reliability, the department developed a Planning Time Index that gives a numerical value for travel reliability.

Sample travel scenario

- 20 minutes x 1.5 PTI = 30 minutes

2013 Spring Quarter
For 24 urban freeway and highway segments:

<table>
<thead>
<tr>
<th>Segment</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

2014 Spring Quarter
For 28 urban freeway and highway segments:

<table>
<thead>
<tr>
<th>Segment</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

Efforts to improve
Many things can adversely affect travel time reliability, including traffic incidents, weather, special events, holiday traffic and work zones. Reducing or mitigating the impact of these factors serves to improve travel time reliability.

The department is working to improve traffic signal systems, ramp meters, maintenance and work zone management to reduce traffic congestion. As part of the Zoo Interchange reconstruction in southeast Wisconsin, an integrated corridor management system is in place to improve traffic flow during construction. Travelers can also get real-time traffic information from the 511 Traveler Information System and choose to avoid congested routes. Some travelers are willing to accept delay as long as reliable information is available about the length of the delay.

Travel Time Delay
Highway congestion occurs when traffic demand exceeds the available capacity of the highway system. Congestion can be recurring (regular peak periods) or unexpected (incidents and bad weather). Whatever the cause, congestion results in slower speeds, longer trip times, higher levels of harmful emissions and increased costs for auto, bus and freight.

Reducing the annual total hours of vehicle delay and user delay cost improves the highway’s efficiency and supports regional economic productivity and development.

How are we doing?

- **Total Hours of Delay during a one year period:** 7.4 million
- **Total User Delay Cost during a one year period:** $226.5 million

2013 Spring Quarter
- Hours decreased by 395,513

2014 Spring Quarter
- Hours decreased by 511,080

Statewide hours of vehicle delay decreased by 395,513 hours during the 2014 spring quarter compared to the 2013 spring quarter.

Efforts to improve
Any interference of the normal flow of traffic because of special events, peak period traffic, crashes, construction or poor weather adversely affect actual travel time. The department uses a variety of traffic management strategies that include efforts to:

- Deploy more advanced Intelligent Transportation System technologies
- Maximize existing roadway space to match peak period demands
- Share information through electronic message boards and 511 Traveler Information System
- Clear disabled vehicles more quickly
- Encourage drivers to select alternative routes
- Provide efficient and timely winter weather management
- Expand highway capacity through highway improvement projects

Know before you go! For details on Wisconsin travel, go to www.511wi.gov or dial 511.
Sample travel scenario

20 minutes x 1.5 PTI = 30 minutes

A PTI of 1.5 means travel is moderately unreliable. A traveler going for a 20 minute trip during a peak period would be assured of completing the trip in 30 minutes or less at least 95 percent of the time.

Planning Time Index (PTI) value

- 1.0 – 1.30 reliable
- 1.31 – 1.80 moderately unreliable
- 1.81 – 3.0 unreliable

WisDOT tracks nine Interstate corridors and 28 urban freeway and highway segments.

How do we measure travel delay?

GOAL: Reduce vehicle delay and user delay cost

The Department of Transportation has established a travel delay mobility performance measure as part of its MAPSS Performance Improvement Program.

Delay

Defined as the extra time spent driving in congested road conditions as compared to free flowing travel conditions.

Hours of delay

Calculated by measuring the number of vehicles on a corridor and then comparing actual travel times to the amount of time it would take to travel the same corridor at the posted speed limit.

User delay cost

Calculated by multiplying user value of time, vehicle delay and vehicle occupancy rates.
Vehicle Delay Visualization

Reliability

Vehicle travel delay caused by traffic congestion, from both recurring and non-recurring causes, adversely affects all travelers and increases the cost of freight movement. Hours of vehicle delay reports the total amount of delay on Wisconsin’s freeways. The fall quarter result was affected by the change in speed limit from 65 to 70 mph, adjusted user cost and the inclusion of I-41. Our 2016 goal is to reduce hours of delay on a corridor basis from the same season in 2015.

How is this measure trending?
Unfavorable

Mobility: Delivering transportation choices that result in efficient trips and no unexpected delays.

For more information:

About Measure
Scorecard

Corridor
- I-90/94 Madison to Eau Claire
- I-94 Badger interchange to Marquette interchange
- I-94 Eau Claire to Minnesota
- I-90 Tomah to Minnesota
- I-43/894 Beloit to Mitchell interchange

Hours of Vehicle Delay
I-94 Eau Claire to Minnesota

*2016 Total Hours of Delay = 232,524 hours
2015 Total Hours of Delay = 723,050 hours

www.511wi.gov

*Year-to-date
Eau Claire to Minnesota
229,578 hours
$6,949,214 user delay

Madison to Eau Claire
462,440 hours
$13,873,796 user delay

Tomah to Minnesota
158,785 hours
$4,994,261 user delay

Milwaukee to Madison
1,045,383 hours
$33,635,709 user delay
Planning Time Index for peak periods
• AM (6-9 am)
• PM (3-6 pm)
Trends

Fox Valley Delay (Veh-Hours)

- 16Q2
- 16Q1
- 15Q4
- 15Q3

SB I-41 PTI

- PTI AM
- PTI PM
Event Impacts

A nine day, half-mile lane closure began September 14, and ended September 22, 2015.
## Event Impacts

### User Delay Cost per Day (Thousands)

- Includes 6-10 AM and 2-7 PM peaks
- Averages include Mon-Fri weekdays, Labor Day excluded

### Average Before: $129,000 / day

### Average During: $306,000 / day

### Average After: $158,500 / day

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AM Average Cost per Day</td>
<td>$20,000</td>
<td>$15,000</td>
<td>$20,500</td>
<td>$24,500</td>
<td>$58,000</td>
<td>$20,500</td>
<td>$26,000</td>
<td>$25,500</td>
<td>$36,500</td>
</tr>
<tr>
<td>PM Average Cost per Day</td>
<td>$112,000</td>
<td>$110,500</td>
<td>$94,500</td>
<td>$122,500</td>
<td>$248,000</td>
<td>$144,000</td>
<td>$107,500</td>
<td>$120,500</td>
<td>$155,500</td>
</tr>
<tr>
<td>Total Average Cost per Day</td>
<td>$132,000</td>
<td>$125,000</td>
<td>$115,000</td>
<td>$147,000</td>
<td>$306,000</td>
<td>$164,500</td>
<td>$133,500</td>
<td>$146,000</td>
<td>$192,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average Delay per Day (Veh-Hrs)</th>
<th>AM</th>
<th>PM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workzone Sep 14-22</td>
<td>600</td>
<td>3,500</td>
<td>4,100</td>
</tr>
<tr>
<td>Sep 23 - Sep 28</td>
<td>500</td>
<td>3,500</td>
<td>4,000</td>
</tr>
<tr>
<td>Sep 28 - Oct 2</td>
<td>600</td>
<td>3,000</td>
<td>3,600</td>
</tr>
<tr>
<td>Oct 5-9</td>
<td>800</td>
<td>3,800</td>
<td>4,600</td>
</tr>
<tr>
<td>Oct 12-16</td>
<td>800</td>
<td>4,900</td>
<td>6,000</td>
</tr>
</tbody>
</table>

| Total Cost in Time Frame | $661,000 | $626,000 | $576,000 | $588,000 | $2,141,000 | $493,500 | $666,000 | $729,500 | $961,000 |
| Total Delay in Time Frame (Veh-Hrs) | 20,700 | 19,600 | 18,000 | 18,500 | 67,200 | 15,500 | 20,800 | 22,900 | 30,000 |
PM Peak User Delay Cost per Day
NB I-41/94 Mon-Wed 2-7 PM

Day of incident had about **26 times more user delay cost** than typical

- Passenger Vehicles
- Freight Vehicles
Reliability Sensitivity

Reliability is an index that represents a Ratio of travel times Actual/Desired OR Actual/Median

How do we set expectations and set targets?
To understand the impact, we looked at how the Index changed in a current work zone on I-94 with a reduced speed declaration.

![Work Zone Location]

### WB I-94 - Work Zone Analysis Limits

<table>
<thead>
<tr>
<th>Selected Free Flow Speed</th>
<th>AM Peak PTI</th>
<th>Difference in PTI 55 → 70</th>
<th>Difference in PTI 65 → 70</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>65</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Summer 2014</td>
<td>65</td>
<td>No</td>
<td>1.07</td>
</tr>
<tr>
<td>Summer 2015</td>
<td>70</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>Difference in Quarterly PTI</td>
<td>0.03</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Fall 2014</td>
<td>65</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>Fall 2015</td>
<td>55</td>
<td>Yes</td>
<td>1.00</td>
</tr>
<tr>
<td>Difference in Quarterly PTI</td>
<td>-0.01</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td>Winter 2015</td>
<td>65</td>
<td>No</td>
<td>1.00</td>
</tr>
<tr>
<td>Winter 2016</td>
<td>55</td>
<td>Yes</td>
<td>1.00</td>
</tr>
<tr>
<td>Difference in Quarterly PTI</td>
<td>0.00</td>
<td>-0.01</td>
<td>-0.01</td>
</tr>
</tbody>
</table>
Delay
Queueing
Speed declaration

I-43 work zone in Manitowoc County

Project location
I-94 FALL TRAVEL TIME PERFORMANCE (September - October - November 2016)

WESTBOUND

6 - 9 A.M.
WORST TRAVEL TIMES
13 MINUTES & UP
Reliability index 1.94

3 - 6 P.M.
WORST TRAVEL TIMES
17 MINUTES & UP
Reliability index 2.49

EASTBOUND

6 - 9 A.M.
WORST TRAVEL TIMES
18 MINUTES & UP
Reliability index 2.45

3 - 6 P.M.
WORST TRAVEL TIMES
13 MINUTES & UP
Reliability index 1.83
SEVERE DELAY ALERT
+32 MINUTES
TO GOOD HOPE RD

SEVERE DELAYS
NEXT 10 MILES
USE ALT ROUTE
Valuing user benefits and project costs

- Predicting recurring and non-recurring delay for a benefit cost analysis tool
- Travel time estimation model within the benefit-cost tool
- Established speed-flow curves for different types of facilities using 3 years of probe data for these 6 scenarios:

<table>
<thead>
<tr>
<th>Normal</th>
<th>Incident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow</td>
<td>Crash and Snow</td>
</tr>
<tr>
<td>Crash</td>
<td>Incident and Snow</td>
</tr>
</tbody>
</table>
Incorporating Reliability into…

✓ Assessment of wider economic benefits of transportation
✓ Planning and programming
✓ Monitoring travel time reliability
✓ Design
✓ The Highway Capacity Manual

WisDOT was awarded FHWA SHRP2 grant as lead adopter of these five products
<table>
<thead>
<tr>
<th>Performance of National Highway System (NHS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of Travel Time Reliability-Statewide</td>
</tr>
<tr>
<td>Interstate &amp; Non-Interstate NHS</td>
</tr>
<tr>
<td>Peak Hour Travel Time Ratio – Milwaukee UZA</td>
</tr>
<tr>
<td>Interstate &amp; Non-Interstate NHS</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Freight Movement on the Interstate System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck Travel Time Reliability</td>
</tr>
<tr>
<td>% of Interstate mileage providing reliable truck travel times</td>
</tr>
<tr>
<td>Peak Hour Travel Time Ratio – Milwaukee UZA</td>
</tr>
<tr>
<td>% of Interstate mileage uncongested</td>
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<table>
<thead>
<tr>
<th>CMAQ Program – Traffic Congestion</th>
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<tbody>
<tr>
<td>Annual Hours of Excessive Delay per Capita – All NHS in Metro Areas</td>
</tr>
</tbody>
</table>
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