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Sample Calculations:
MAP-21 NPRM Subpart G

National Performance Management Measure for Assessing the Congestion Mitigation and Air Quality Improvement Program—Traffic Congestion

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Introduction

This document provides step-by-step instructions for calculating MAP-21 performance measures on a small sample data set as a demonstration. Actual implementation of these calculations will use an entire year's worth of data for a far larger number of reporting segments.

The performance measures described in this document pertain to Subpart F: *National Performance Management Measures to Assess Performance of the National Highway System* of the NPRM issued April 22, 2016 by the Federal Highway Administration (FHWA).

This document and associated sample data are available for download at http://www.cattlab.umd.edu/MAP-21/. Any future revisions will also be posted at this address.

The sample data consists of two files.

1. **MAP-21_Sample_Data_Set_TMC.csv:** This file contains 6 data records specifying TMC segments, defined by the Traffic Message Channel (TMC) location referencing system. The sample data consists of 3 eastbound and 3 westbound segments of Interstate 66 in northern Virginia.
2. **MAP-21_Sample_Data_Set_TT.csv**: This file contains 34,082 data records, the subset generated from the December 2015 National Performance Management Research Data Set (NPMRDS) and contains data for the same six reporting segments.

Each of these files uses the comma-separated values text file format with an initial header record providing the name of each sequential field contained in the subsequent rows.

Total Excessive Delay

Data needed

- Geographic range: urbanized area with a population over 1 million
- 5-minute interval travel times for entire reporting period
- Hourly volume estimation for every reporting segment
- Population for urban area

Calculating Excessive Delay

- For every reporting segment, calculate the *Excessive Delay Threshold Travel Time*

$$Excessive\ Delay\ Threshold\ Travel\ Time = \left(\frac{Segment\ Length}{Threshold\ Speed}\right) \times 3600$$

  where:

- *Excessive Delay Threshold Travel Time* = The time of travel, to the nearest whole second, to traverse the reporting segment at which any longer measured travel times would result in excessive delay for the reporting segment
- *Segment Length* = Total length of the reporting segment, to the nearest thousandth of a mile
- *Threshold Speed* = The speed of travel at which any slower measured speeds would result in excessive delay
  - 35 mph for Interstates, freeways, and expressways
  - 15 mph for all other roads

- Determine the *Reporting Segment Delay (RSD)* for each travel time reading to the nearest whole second

$$RSD = min(Travel\ Time - Excessive\ Delay\ Threshold\ Travel\ Time, 300\ seconds)$$

where:
  - *RSD* = reporting segment delay to the nearest whole second, not to exceed 300 seconds
  - *Travel Time* = a measured travel time, to the nearest whole second
  - *Excessive Delay Threshold Travel Time* = The time of travel, to the nearest whole second, to traverse the reporting segment at which any longer measured travel times would result in excessive delay for the reporting segment
- Calculate the *Excessive Delay* for each travel time reading
  - If *RSD* is greater than or equal to 0, then $Excessive\ Delay = \frac{RSD}{3600}$
  - If *RSD* is less than 0, then $Excessive\ Delay = 0$
- Calculate *Total Excessive Delay* for each reporting segment

$$Total\ Excessive\ Delay_s = \sum_{d=1}^{TD} \sum_{h=1}^{TH} \sum_{b=1}^{TB} Excessive\ Delay_{s,b,h,d} \times \left(\frac{hourly\ volume}{12}\right)_{h,d,s}$$

where:
  - $Total\ Excessive\ Delay_s$ = the sum of the excessive delay in vehicle-hours, to the nearest thousandth, for all traffic traveling through reporting segment *s*
  - *s* = a reporting segment
  - *d* = a day of the reporting period
  - *TD* = total number of days in the reporting period
  - *h* = single hour interval of the day
  - *TH* = total number of hour intervals in day *d*
  - *b* = a 5-minute bin within hour interval *h*
  - *TB* = total number of 5-minute time bins for hour *h* with reported travel times
  - $Excessive\ Delay_{s,b,h,d}$ = calculated excessive travel time, in hundredths of an hour, for 5-minute bin *b*, hour interval *h*, day *d*, and travel segment *s*
  - $\left(\frac{hourly\ volume}{12}\right)_{h,d,s}$ = hourly traffic volume, to the nearest tenth, for hour interval *h* and day *d* that corresponds to 5-minute interval *b* and reporting segment *s* divided by 12
- Calculate *Annual Hours of Excessive Delay per Capita*

$$Annual\ Hours\ of\ Excessive\ Delay\ per\ Capita = \frac{\sum_{s=1}^{T} Total\ Excessive\ Delay_s}{Total\ Population}$$

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Sample Calculation

1. Prepare the data
    a. Group 5-minute travel time readings by reporting segment
    b. Identify hourly volume estimation for each reporting segment
        i. For this example calculation, we will use the following estimated hourly volumes:

Hour of Day	Reporting Segment					
	110N04173	**110N04174**	**110N04175**	**110P04173**	**110P04174**	**110P04175**
12 AM	400	300	800	700	400	900
1 AM	200	200	500	400	200	600
2 AM	200	100	400	300	200	400
3 AM	100	100	400	300	100	300
4 AM	200	200	800	500	200	600
5 AM	700	700	2300	1100	600	1600
6 AM	1600	1500	4900	2400	1400	3600
7 AM	2000	1900	5900	3100	1800	4500
8 AM	1900	1800	4900	3000	1700	4300
9 AM	1800	1700	4200	3000	1600	4100
10 AM	1900	1800	4300	3200	1800	4300
11 AM	2100	2000	4500	3500	2000	4700
12 PM	2100	2100	4700	3700	2000	4800
1 PM	2200	2100	4800	3900	2100	5000
2 PM	2400	2300	5100	4400	2400	5500
3 PM	2600	2500	5400	5300	2800	5900
4 PM	2700	2600	5500	5800	2900	6100
5 PM	2500	2400	5100	5100	2600	5700
6 PM	2100	2000	4100	3600	2000	4700
7 PM	1600	1500	3100	2700	1500	3600
8 PM	1300	1300	2600	2300	1200	3000
9 PM	1200	1100	2300	2000	1100	2700
10 PM	900	900	1800	1600	900	2200
11 PM	600	600	1200	1100	600	1500

    c. Identify population information for the reporting urban area
        i. For this example calculation, we will use a population of 1,000,000
2. Calculate *Excessive Delay Threshold Travel Time*
    a. All six reporting segments in the sample data set are on an Interstate, so we will use the 35 mph speed threshold:

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Reporting Segment	Segment Length (miles)	Excessive Delay Threshold Travel Time (seconds)
110N04173	0.308	32
110N04174	1.862	192
110N04175	2.085	214
110P04173	1.249	128
110P04174	0.810	83
110P04175	1.763	181

3. For each travel time reading in the sample data set, find the *Excessive Delay* using the formulas described above.
4. Calculate *Total Excessive Delay* for each reporting segment

Reporting Segment	Total Excessive Delay
110N04173	4276.331
110N04174	4175.025
110N04175	5645.796
110P04173	241.903
110P04174	162.132
110P04175	6412.252

5. Calculate *Annual Hours of Excessive Delay per Capita*

$$\frac{\sum_{s=1}^{T} Total\ Excessive\ Delay_s}{Total\ Population} = \frac{20{,}913.439}{1{,}000{,}000} = 0.02\ hours\ of\ excessive\ delay\ per\ capita$$

   a. Note that in this example calculation, only a month's worth of data was used so the "Annual" designation doesn't technically apply, but the calculation method is identical

What is the CATT Lab & Why Are We Doing This?

We specialize in transportation data analytics, TSM&O, performance management, and information visualization. As a non-profit entity, our goal is to solve problems for Federal, State, and Local transportation departments and first responders through technology and data-informed policy guidance. In short, we're offering our support because it fits within our mission, we feel we have knowledge and tools that can make this less painful for everyone, and it's the right thing to do. To learn more about our other capabilities, please contact the CATT Lab Director, Michael Pack at PackML@umd.edu.