Estimating Non-motorized Traffic Accurately: How Many Counters Do We Need?

Krista Nordback

June 13, 2018

Project Team:
Research:
Kristin Tufte, Sirisha Kothuri, Dylan Johnstone
Data Wranglers:
Michelle Watkins, Lynn Tran, Carlynn DeJoya
Software Developers:
Hui Zhang, Morgan Harvey
Management: Hau Hagedorn

Expert Panel:
Mark Hallenbeck, University of Washington
Greg Lindsey, University of Minnesota
Sherry Ryan, San Diego State University

Awarding officer rep. for FHWA
Jeremy Raw, FHWA

www.hsrc.unc.edu

Portland State University
Agenda

• Purpose
• Data
• Methods
• Analysis Results
• Tool
Goal

• Create an online open-source tool to estimate annual average daily non-motorized traffic (AADNT/AADBT/AADPT) based on short duration counts.
Research Questions

• **How many** permanent pedestrian and bicycle counters are needed per factor group?

• How can we automate the **grouping** of sites by travel pattern (creating "factor groups")?

• How can we most reliably estimate pedestrian and bicycle AADNT from short duration counts? *(recommend AADNT estimation methods)*
DATA
Study Cities

- Arlington, VA  30 permanent count sites
- Boulder, CO   15 permanent count sites
- San Diego, CA 44 permanent count sites
Study Cities

• Arlington, VA  
  30 permanent count sites
• Boulder, CO  
  15 permanent count sites
• San Diego, CA  
  44 permanent count sites
• Mt Vernon, WA  
  7 permanent count sites
• Portland, OR  
  27 permanent count sites
• Seattle, WA  
  18 permanent count sites
### THE DATA

- 6 cities, 141 sites, 346 site-years

<table>
<thead>
<tr>
<th>Community</th>
<th>Time Period</th>
<th>Type of Counters</th>
<th>Number of Sites Counted</th>
<th>Total # of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arlington, VA</td>
<td>2012-2016</td>
<td>Passive infrared and inductive loop combination</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>Mt. Vernon, WA</td>
<td>2009-2011</td>
<td>Passive infrared</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>Portland, OR</td>
<td>2009-2015</td>
<td>Passive infrared, inductive loops, pneumatic tubes</td>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td>2013-2016</td>
<td>Passive infrared and inductive loop combination</td>
<td>32</td>
<td>44</td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>2014-2016</td>
<td>Passive infrared and inductive loop combination</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>80</td>
<td>141</td>
</tr>
</tbody>
</table>
Annual Average Daily Nonmotorized Traffic (AADNT)
Weekly Travel Patterns - Bicycle
Weekly Travel Patterns - Pedestrian

![Graph showing daily volume/AADPT for different cities over the week.](image)
Quality Checks

Manual visual inspection

• >48hrs of zeros

• High values:
  – >15,000 per day
  – >1,500 per hour

• Look up events on the web when spikes observed.

• Keep the data when in doubt
Boulder – 2008 Daily Volumes

Daily Nonmotorized Traffic Volumes

Date

2008-01-07 00:00:00+00:00
2008-01-16 00:00:00+00:00
2008-02-01 00:00:00+00:00
2008-02-10 00:00:00+00:00
2008-02-26 00:00:00+00:00
2008-03-06 00:00:00+00:00
2008-03-15 00:00:00+00:00
2008-03-24 00:00:00+00:00
2008-04-02 00:00:00+00:00
2008-04-11 00:00:00+00:00
2008-04-20 00:00:00+00:00
2008-04-29 00:00:00+00:00
2008-05-15 00:00:00+00:00
2008-05-24 00:00:00+00:00
2008-06-09 00:00:00+00:00
2008-06-18 00:00:00+00:00
2008-06-27 00:00:00+00:00
2008-07-13 00:00:00+00:00
2008-07-22 00:00:00+00:00
2008-07-31 00:00:00+00:00
2008-08-09 00:00:00+00:00
2008-08-18 00:00:00+00:00
2008-08-27 00:00:00+00:00
2008-09-12 00:00:00+00:00
2008-09-21 00:00:00+00:00
2008-09-30 00:00:00+00:00
2008-10-09 00:00:00+00:00
2008-10-25 00:00:00+00:00
2008-11-03 00:00:00+00:00
2008-12-03 00:00:00+00:00
2008-12-21 00:00:00+00:00

The University of North Carolina
Highway Safety Research Center
METHODS
Methods

• Indices for grouping
  • AMI: Average Morning/Midday Index
  • WWI: Weekend/Weekday Index
  • WMI: Warm Month Index

• Factors
  – Day-of-week-of-month factors (84 factors) grouped by WWI, city and mode
    • For each year, average each day of week for each month and divide by AADNT
  – Monthly factors grouped by city and mode (MADT/AADNT)

• Short Duration Scenarios
  – 24-hrs (day-of-week-of-month only)
  – 1 week (day-of-week-of-month and monthly factors)
Grouping by Weekend/Weekday Index (WWI)

Divide into 3 groups:
- Weekday Commute: Average WWI <= 0.8
- Weekly Multipurpose: 0.8 < (Average WWI) <= 1.2
- Weekend Multipurpose: Average WWI > 1.2

WWI Histogram
Analysis Method

1. Gather volume files
   - Check data quality
     - Good
     - Compute MADT
     - Compute AADT

2. Plot graphs to view patterns
   - Compute indices
     - Group sites
     - Compute factors for each site
     - Average factors within each group
     - Remove one site
     - Estimate AADB using factors and short duration counts

3. Errors
   - Compute error

4. Factors
   - MADT and AADT
Factor Group:
Weekly Multipurpose, City A, Bicycle, 2013

○ = Analysis area = count site
AADNT Estimation Error

Factor Group: Weekly Multipurpose


= Analysis area = count site

= Trial short duration analysis area
AADNT Estimation Error

Pretend we only have a week of count data at the trial short duration analysis area (count site).

○ = Analysis area = count site

● = Trial short duration analysis area
Pretend we only have a week of count data at the trial short duration analysis area (count site). (C)

Compute factors for each of the remaining analysis areas (trial group) and average them together. (M)

○ = Analysis area = count site

● = Trial short duration analysis area
Pretend we only have a week of count data at the trial short duration analysis area (count site). (C)

Compute factors for each of the remaining analysis areas (trial group) and average them together. (M)

Estimated AADNT = \( \frac{C}{M} \)
AADNT Estimation Error
Mean Absolute Percent Error (MAPE)

\[
\text{MAPE} = \frac{|\text{Estimated AADNT} - \text{Actual AADNT}|}{\text{Actual AADNT}}
\]

- For the trial short duration analysis area

Compute Error for each week of the year.
AADNT Estimation Error

Repeat for all analysis areas in the group and average errors.

New Trial Group

Pretend we only have a week of count data at a new trial short duration analysis area (count site). (C)

Compute monthly factors for each of the remaining analysis areas (trial group) and average them together. (M)

Estimated AADNT = \( \frac{C}{M} \)
AADNT Estimation Error

Repeat for all analysis areas in the group and average errors.

(C) Pretend we only have a week of count data at a new trial short duration analysis area (count site).

(M) Compute monthly factors for each of the remaining analysis areas (trial group) and average them together.

Estimated AADNT = \( \frac{C}{M} \)
AADNT Estimation Error

Repeat for all analysis areas in the group and average errors.

- Remove two analysis areas from the group

Pretend we only have a week of count data at a new trial short duration analysis area (count site).

- Compute monthly factors for each of the remaining analysis areas (trial group) and average them together.

= Analysis area = count site

= Trial short duration analysis area 2

Estimated AADNT = \( \frac{C}{M} \)
Repeat for all analysis areas in the group and average errors.

Remove three analysis areas from the group.

Pretend we only have a week of count data at a new trial short duration analysis area (count site) .

(C)

Compute monthly factors for each of the remaining analysis areas (trial group) and average them together.

(M)

Estimated AADNT = \( \frac{C}{M} \)
AADNT Estimation Error

Repeat for all analysis areas in the group and average errors.

- Analysis area = count site
- New Trial Group

Remove 4 analysis areas from the group

Pretend we only have a week of count data at a new trial short duration analysis area (count site).

(C)

Compute monthly factors for each of the remaining analysis areas (trial group) and average them together.

(M)

Estimated AADNT = \( \frac{C}{M} \)
ANALYSIS RESULTS
Scenarios

Error (MAPE) for

• Short Duration Count: 24-hours
• Short Duration Count: 1 week
• Short Duration Count: 1-week (monthly factors)
Scenario:
24-hrs
day-of-week-of-month-factors
Error for 24-hrs, day-of-week-of-month-factors Scenario

AADNT Estimation Error given 24-hr Short Duration count (day-of-week-of-month-factors applied)

MAPE of AADNT Estimation

- Bicycle
- Bicycle and Pedestrian Combined
- Pedestrian

Month
Error for 24-hrs, day-of-week-of-month-factors Scenario

AADNT Estimation Error given 24-hr Short Duration count (day-of-week-of-month-factors applied)

MAPE of AADNT Estimation

Day of the Week (Sunday = 1)

- Bicycle
- Bicycle and Pedestrian Combined
- Pedestrian
Error for 24-hrs, day-of-week-of-month-factors Scenario

AADNT Estimation Error given 24-hr Short Duration count
(day-of-week-of-month-factors applied)

MAPE of AADNT Estimation

Day of the Week (Sunday = 1)

Weekday Commute
Weekend Multipurpose
Weekly Multipurpose
Error for 24-hrs, day-of-week-of-month-factors Scenario

Error for 24-hrs, day-of-week-of-month-factors

MAPE of AANDT Estimates vs Number of Sites in Factor Group
Error for 24-hrs, day-of-week-of-month-factors

Scenario

- Weekend Multipurpose
- San Diego Bicycle
- Weekly Multipurpose
- Arlington Bicycle
- Portland Ped-Bike Combined

MAPE of AADNT estimates from 24-hour counts

- Number of Analysis Areas with AADNT values for that year in the Trial Factor Group
Scenario:
1-week
day-of-week-of-month-factors
Error for 1-week, day-of-week-of-month-factors Scenario

MAPE of AADNT estimate from 1 week of counts

Number of Analysis Areas with AADNT values for that year in the Trial Factor Group
Scenario:
1-week monthly-factors
Error for 1-week, monthly factors Scenario

Error of AADNT estimation given 1-week of short duration counts (monthly factors applied) Random groups

MAPE of AADNT Estimate

Number of sites in a factor group
## Summary of Error

<table>
<thead>
<tr>
<th>Factors</th>
<th>Short Count Duration</th>
<th>Weekday Commute</th>
<th>Weekend Multipurpose</th>
<th>Weekly Multipurpose</th>
<th>Weighted Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day-of-week-of-month</td>
<td>24-hours</td>
<td>28%</td>
<td>38%</td>
<td>34%</td>
<td>35%</td>
</tr>
<tr>
<td>Day-of-week-of-month</td>
<td>1 week</td>
<td>18%</td>
<td>22%</td>
<td>23%</td>
<td>22%</td>
</tr>
<tr>
<td>Monthly</td>
<td>1 week</td>
<td>One Group per City</td>
<td>28%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

Error is lower for
• Commute travel patterns
• Bicycle-only and combined bike/ped counts
• Short duration counts collected June - September
• For 24-hour counts Tuesday - Thursday (even for sites with high weekend volumes)
• Longer time period (1 week < error than 24-hours)
• At least 2 permanent counters per factor group compared to just one
• Data variability and quality (Arlington generally lowest error than Mt. Vernon)
• Day of week of month factors, better than monthly factors

Bike/ped traffic volume is not a big contributor.
 TOOL
Tool Components

**Input data from Bike-Ped Portal:**
User must select flow-detectors to include in analysis areas for factor creation.

**Site Grouping Module**

**Temporal Factor Calculator**

**AADT Estimator**

**Output: AADT**

**Tool Integration**

**Long Term:** This could be integrated into Bike-Ped Portal as a feature.
Analysis Tool

• Site Grouping Module
  – Groups by WWI as we did in analysis.

• Temporal Factor Calculator
  – day-of-week-of-month-factors as calculated in analysis

• AADT Estimator
  – Designed for 1 week of data or more

• Require data to be in Bike-ped Portal and user must already know “flow_detector_id”

Tools are implemented with python and SQL. Available publicly on Git Hub https://github.com/zhuitrec/BAA-AnalysisTool
Discussion & Questions

Krista Nordback, P.E., Ph.D.
nordback@hsrc.unc.edu
919-962-3493

Sirisha Kothuri
skothuri@pdx.edu

Portland State University

Highway Safety Research Center

Pedestrian and Bicycle Information Center
Annual Travel Pattern - Bicycle

![Graph showing annual travel pattern for bicycle]
Annual Travel Pattern - Pedestrian

The graph shows the daily volume per AADPT for pedestrian travel across different months and cities. The x-axis represents the months of the year, ranging from January to December. The y-axis represents the daily volume per AADPT, ranging from 0 to 2.5. Different cities are represented by distinct colors, allowing for a comparison of travel patterns between cities such as Arlington, Portland, San Diego, and Seattle.
## Error for 24-hrs, day-of-week-of-month-factors Scenario

<table>
<thead>
<tr>
<th>Scenario</th>
<th>MAPE for AADNT estimates (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weekday Commute</td>
</tr>
<tr>
<td>Bicycle</td>
<td></td>
</tr>
<tr>
<td>Arlington</td>
<td>31%</td>
</tr>
<tr>
<td>Boulder</td>
<td>29%</td>
</tr>
<tr>
<td>Portland</td>
<td>17%</td>
</tr>
<tr>
<td>San Diego</td>
<td></td>
</tr>
<tr>
<td>Seattle</td>
<td>32%</td>
</tr>
<tr>
<td>Bicycle and Pedestrian Combined</td>
<td>36%</td>
</tr>
<tr>
<td>MtVernon</td>
<td>36%</td>
</tr>
<tr>
<td>Portland</td>
<td></td>
</tr>
<tr>
<td>Pedestrian</td>
<td></td>
</tr>
<tr>
<td>Arlington</td>
<td>30%</td>
</tr>
<tr>
<td>Portland</td>
<td></td>
</tr>
<tr>
<td>San Diego</td>
<td></td>
</tr>
<tr>
<td>Seattle</td>
<td></td>
</tr>
<tr>
<td>Weighted Average</td>
<td>28%</td>
</tr>
</tbody>
</table>
## Error for 1-week, day-of-week-of-month-factors Scenario

<table>
<thead>
<tr>
<th></th>
<th>MAPE for AADNT estimates (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weekday</td>
<td>Weekend</td>
</tr>
<tr>
<td></td>
<td>Commute</td>
<td>Multipurpose</td>
</tr>
<tr>
<td>bicycle</td>
<td>18%</td>
<td>15%</td>
</tr>
<tr>
<td>Arlington</td>
<td>18%</td>
<td>22%</td>
</tr>
<tr>
<td>Boulder</td>
<td>18%</td>
<td>28%</td>
</tr>
<tr>
<td>Portland</td>
<td>10%</td>
<td>28%</td>
</tr>
<tr>
<td>San Diego</td>
<td>10%</td>
<td>14%</td>
</tr>
<tr>
<td>Seattle</td>
<td>24%</td>
<td>18%</td>
</tr>
<tr>
<td>bike-ped-</td>
<td>28%</td>
<td>20%</td>
</tr>
<tr>
<td>combined</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mt. Vernon</td>
<td>28%</td>
<td>62%</td>
</tr>
<tr>
<td>Portland</td>
<td>18%</td>
<td>15%</td>
</tr>
<tr>
<td>pedestrian</td>
<td>27%</td>
<td>29%</td>
</tr>
<tr>
<td>Arlington</td>
<td>19%</td>
<td>15%</td>
</tr>
<tr>
<td>Portland</td>
<td>29%</td>
<td>20%</td>
</tr>
<tr>
<td>San Diego</td>
<td></td>
<td>47%</td>
</tr>
<tr>
<td>Seattle</td>
<td></td>
<td>23%</td>
</tr>
<tr>
<td>Weighted Average</td>
<td>18%</td>
<td>22%</td>
</tr>
</tbody>
</table>
## Error for 1-week, monthly factors Scenario

<table>
<thead>
<tr>
<th>Mode and City</th>
<th>Weekday Commute</th>
<th>Weekend Multipurpose</th>
<th>Weekly Multipurpose</th>
<th>Weighted Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>bicycle</td>
<td>15%</td>
<td>19%</td>
<td>23%</td>
<td>20%</td>
</tr>
<tr>
<td>Arlington</td>
<td>17%</td>
<td>22%</td>
<td>19%</td>
<td>18%</td>
</tr>
<tr>
<td>Boulder</td>
<td>18%</td>
<td>29%</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>Portland</td>
<td>9%</td>
<td>14%</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>San Diego</td>
<td>16%</td>
<td>21%</td>
<td>40%</td>
<td>22%</td>
</tr>
<tr>
<td>Seattle</td>
<td>9%</td>
<td>18%</td>
<td></td>
<td>17%</td>
</tr>
<tr>
<td>bike-ped-combined</td>
<td>21%</td>
<td>18%</td>
<td>19%</td>
<td>18%</td>
</tr>
<tr>
<td>Mt Vernon</td>
<td>21%</td>
<td>28%</td>
<td>26%</td>
<td>26%</td>
</tr>
<tr>
<td>Portland</td>
<td></td>
<td></td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>pedestrian</td>
<td>13%</td>
<td>66%</td>
<td>25%</td>
<td>49%</td>
</tr>
<tr>
<td>Arlington</td>
<td>13%</td>
<td>16%</td>
<td>14%</td>
<td>15%</td>
</tr>
<tr>
<td>Portland</td>
<td></td>
<td>28%</td>
<td>23%</td>
<td>27%</td>
</tr>
<tr>
<td>San Diego</td>
<td></td>
<td></td>
<td>170%</td>
<td>82%</td>
</tr>
<tr>
<td>Seattle</td>
<td></td>
<td>575%</td>
<td>37%</td>
<td>210%</td>
</tr>
<tr>
<td>Weighted Average</td>
<td>15%</td>
<td>38%</td>
<td>23%</td>
<td>28%</td>
</tr>
</tbody>
</table>
Boulder – 2008 Daily Bicycle Volumes
Mt Vernon – 2010 Daily Bike & Ped Volumes
Arlington – 2014 Daily Bike Volumes
Arlington – 2014 Daily Pedestrian Volumes
Arlington – 2014 Daily Bike and Ped Volumes
Next Steps (if more funds for research available)

- Repeating the AADNT error analysis for day-of-year factors that have been shown by others to be more accurate than the day-of-week-of-month-factors or monthly factor approach.
- Instead of grouping by WWI, compare to having only one factor group per community (like we did for the monthly factors) for the day-of-week-of-month-factors. How much does this increase error? Might it be worth it to simplify the process?
- Estimate AADNT using published NBPDP factors to determine how much additional error one would expect using this approach. This is similar to the analysis conducted by Budowski et al. (2017).
- Repeat the analysis using applying factors from a different factor group to the short duration counts, thus deliberately using the wrong group. How much does this increase AADNT estimation error?
Next Steps for Tool (assumes additional funds)

• User Interface for selecting flow detectors continuous counters for Site Grouping Module (and Temporal Factor Calculator)

• User can choose sites to group
• User can choose WWI values for grouping
• Allow user to supply their own temporal factors
• User Interface for selecting flow detectors for AADNT Estimator Module
Quality Checks

Manual checks

• Looking for spikes
• Looking for days with zero values
• Spikes near zero values or data gaps are particularly indicative of counter malfunction.
• Erring on the side of keeping the data when in doubt.
Grouping by WWI

Boulder

Weekday Multipurpose

Weekday

Weekend

Frequency

0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 3.8 4 4.2 4.4 4.6 4.8

WWI
Grouping by WWI

Mt. Vernon

Weekday Multipurpose

Weekday

Weekend
Grouping by WWI

Weekday Multipurpose

Weekday

Weekend

Portland

Frequency

WWI
Grouping by WWI

San Diego

Weekday Multipurpose

Weekday

Weekend

Frequency

WWI

0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 3.8 4 4.2 4.4 4.6 4.8 5
Grouping by WWI

Seattle

Weekday Multipurpose

Weekday

Weekend
Data Prep & Grouping

Metadata Prep & Loading

Count Data Prep & Loading

Make Graphs per analysis area

Compute Indexes per Analysis Area: AMI, WWI, WMI

QC

Suspicious Data Table:
- Modify scripts
- Load into database

Analysis Area Table

Hui adds regions and factor groups
Dylan creates for WSDOT
Will adds Dylan’s new tables

Group Analysis areas

DONE
Factors

Analysis Area Table

ADDT Calc (Limited by data available and suspicious data)

Per Site
- Monthly factors
- day-of-week-of-month Factors

Hourly Factors

2. Estimate Error at another site

Per Region Group
- BAA: Arlington, Boulder, San Diego (3 cities x 2 models = 5 groups)
- WSDOT: Seattle, Portland, Mt. Vernon (3 cities x 2 models = 5 groups)

Per Factor Group
- 3 groups WWI factor groups
- 2 groups WSDOT hourly factors (AMI)

1. Estimate error at a site in group
3. Estimate error at a site in group
4. In another group
AMI Morning/Noon Index (T, W, R)

Divide into 3 groups: Commute and Mixed.
Blue lines indicate the potential for subdividing into other groups.

Histogram 2013

Hourly Noon Activity

Hourly Multipurpose

Hourly Commute

Frequency

Bin

0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4 3.6 3.8 4.0 4.2 4.4 4.6 4.8 More
Monthly Grouping

Bicycle WMI Histogram

Frequency

Bin

0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 3.8 4 4.2 4.4 More

- Boulder Bikes
- SanDiego Bikes
- Arlington Bikes
Warm Month Index (WMI)
Warm Month Index (WMI)

\[ WMI = \frac{\sum_{m=4}^{9} V_m}{(\sum_{m=1}^{3} V_m + \sum_{m=10}^{12} V_m)} \]

where:

- **WMI** = Warm Month Index = Average daily count for the months of April through September divided by average daily count for the months of October through March for a given year
- **\( V_m \)** = Average daily count for month \( (m) \) where the first month is January
Precision

\[ D = T_{1 - \frac{d}{2}, n-1} \frac{C}{\sqrt{n}} \]

Where:
- \( D \) = precision interval as a proportion or percentage of the mean
- \( C \) = coefficient of variation of the factors.
- \( T \) = value of student’s T distribution with level of confidence and \( n-1 \) degrees of freedom
- \( n \) = number of locations
- \( d \) = significance level

*From TMG 2013 page 3-14*
AADB Estimation from Continuous Counts

- AASHTO Method was selected for "ground truth" first cut

\[ MADT = \frac{1}{7} \sum_{j=1}^{7} \left[ \frac{1}{n_{jm}} \sum_{i=1}^{n_{jm}} Vol_{ijm} \right] \]

\[ AADT = \frac{1}{12} \sum_{m=1}^{12} MADT \]

- \( i \) = occurrence of particular day of the week in a particular month (\( i = 1 \ldots n_{jm} \)) for which traffic volumes are available
- \( Vol_{ijm} \) = traffic volume for the \( i \)th occurrence during the \( j \)th day of the week within the \( m \)th month
- \( j \) = day of the week (\( j = 1, 2, \ldots 7 \))
- \( m \) = month of the year (\( m = 1, 2, \ldots 12 \))
- \( n_{jm} \) = count of the \( j \)th day of the week during the \( m \)th month of the year for which traffic volume is available

- If time permits, Jessberger method will be used
- Reasons
  - Simple
  - Common
  - Few days with partial counts
  - Little difference in error compared to more complex methods
Error for 1-week, day-of-week-of-month-factors Scenario
Error for 1-week, day-of-week-of-month-factors Scenario

MAPE of AADNT estimate from 1 week of counts

Number of Analysis Areas with AADNT values for that year in the Trial Factor Group

- Arlington - Weekday Commute - bicycle
- Arlington - Weekend Multipurpose - bicycle
- Arlington - Weekend Multipurpose - pedestrian
- Arlington - Weekly Multipurpose - bicycle
- Arlington - Weekly Multipurpose - pedestrian
- Boulder - Weekday Commute - bicycle
- Boulder - Weekly Multipurpose - bicycle
- Boulder - Weekly Multipurpose - pedestrian
- Mt. Vernon - Weekday Commute - bike-ped-combined
- Mt. Vernon - Weekend Multipurpose - bike-ped-combined
- Mt. Vernon - Weekly Multipurpose - bike-ped-combined
- Portland - Weekday Commute - bicycle
- Portland - Weekend Multipurpose - bike-ped-combined
- Portland - Weekend Multipurpose - pedestrian
- Portland - Weekly Multipurpose - bike-ped-combined
- Portland - Weekly Multipurpose - pedestrian
- San Diego - Weekend Multipurpose - bicycle
- San Diego - Weekend Multipurpose - pedestrian
- Seattle - Weekday Commute - bicycle
- Seattle - Weekend Multipurpose - bicycle
- Seattle - Weekly Multipurpose - pedestrian

THE UNIVERSITY OF NORTH CAROLINA
HIGHWAY SAFETY RESEARCH CENTER
Error for 1-week, monthly factors Scenario

Error of AADNT estimation given 1-week of short duration counts (monthly factors applied) Random groups

MAPE of AADNT Estimate

Number of sites in a factor group

Arlington
Boulder
MtVernon
Portland
Seattle
San Diego
Error for 1-week, monthly factors Scenario

Error of AADNT estimation given 1-week of short duration counts (monthly factors applied) Random groups