Presentation Agenda

• Project needs and objectives
• Data analysis and method development (Phase I)
• Sensitivity testing and method evaluation
• Method recommendations
• Data processing tool and user guide (Phase II)
• Use case scenarios
Thank You Pooled Fund Team!

- Lynn Hanus and Russell Lewis – Wisconsin DOT (lead agency)
- John Mitchell and Raelene Viste – Idaho Transportation Department
- Brian Carlson – Iowa DOT
- Bill Hughes – Kansas DOT
- John Hackett and Gene Hicks – Minnesota DOT
- Ethan Akerly – North Dakota DOT
- Dave Gardner and Sandra Mapel – Ohio DOT
- Bill Knowles – Texas DOT
- Todd Hadden and Nicolas Virgen – Utah DOT
- Raul Avelar Moran and James Moughon – Texas A&M Transportation Institute
Project Need

• Single-tube traffic counts
  – Inexpensive, yet accurate
  – Collects axle counts, not necessarily “vehicles”

• Convert count to AADT
  – Requires axle factor conversion
  – Requires axle-based count site to develop axle factor
    • Can be costly to operate and maintain
Project Need

• Non-intrusive sensors
  – Widely-used for traffic counting
  – Accurate vehicle length data
  – How to convert to FHWA 13 class scheme?
  – How to generate axle factors?

Class 3 truck pulling trailer

Class 8 truck pulling trailer
Project Objectives

- Develops methods to
  - Derive axle factors from vehicle length data
  - Derive axle-based classification from vehicle length data
- Test methods using field-collected sample data
- Develop installation assistance tools
  - Training materials
  - Use case studies
  - Data processing tool
Data Analysis

• Baseline traffic data gathered to test alternatives
  – 61 Wisconsin sites with collocated vehicle length and axle count data collection
  – Over 491,000,000 individual records collected
Method Development

• Eight methods developed to estimate axle factors and axle classification from length data
  – Inputs evaluated include per individual record (PVR) and binned length data
  – Outputs included developing axle factors and estimating the number of vehicles in each vehicle class
Method Development

• Axle factor method alternatives
  – Use PVR axle and length data to determine axles per length group and apply to PVR length data (#1)
  – Assign PVR length data to predetermined length bands and apply a conversion algorithm (#2)
  – Use PVR axle and length data to determine axles per length group and apply to binned length data (#3)
  – Use binned length data and a conversion algorithm (#4)
Method Development

• Axle class count alternatives
  – Use PVR axle data to classify PVR length data into axle classes via parameterized function (#5)
  – Use PVR axle data to classify PVR length data into axle classes via fractional assignment (#6)
  – Use PVR axle data to classify binned length data into axle classes via parameterized function (#7)
  – Use PVR axle data to classify binned length data into axle classes via fractional assignment (#8)
Method Assessment

• Alternatives comparison
  – All methods performed with relative error smaller than 1 percent
  • When comparing to a control group of calibrated sites (i.e. homogeneity), Method 1 performed best
  • When comparing to non-control group sites (i.e. heterogeneity), Method 5 performed best
  – Method 1 and Method 5 selected for further testing
Sensitivity Testing

• Additional dataset of 17 sites from LTPP states provided for sensitivity testing of methods
Sensitivity Testing

- Breakdown of site characteristics for sensitivity testing

<table>
<thead>
<tr>
<th>Source</th>
<th>Road Character</th>
<th>Type of Facility</th>
<th>Cross Section</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
<td>Rural</td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>16</td>
<td>45</td>
<td>43, 18</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>26</td>
<td>4</td>
</tr>
<tr>
<td>LTPP</td>
<td>0</td>
<td>17</td>
<td>9, 8</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>
## Method Evaluation

- Performance metrics used to evaluate Method 1 and Method 5

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Metric</th>
<th>Description</th>
<th>Units of Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Axle Factor</strong></td>
<td>Relative Error</td>
<td>The average of the deviation of the estimated Axle Factor per unit of analysis (as a proportion) relative to the true Axle Factor</td>
<td>Per site, per test</td>
</tr>
<tr>
<td></td>
<td>Absolute Error</td>
<td>The average of the absolute deviation of the estimated Axle Factor per unit of analysis (in axle factor units)</td>
<td>Per site, per test</td>
</tr>
<tr>
<td><strong>Proportion of Vehicles per Class</strong></td>
<td>Proportion of Vehicles Misclassified</td>
<td>The ratio of the cumulative deviation of the estimated Vehicle Class proportion per unit of analysis (in number of vehicles) to the total number of vehicles</td>
<td>Per site, per test</td>
</tr>
</tbody>
</table>
Method Evaluation

- Axle factor estimation performance
  - Method 5 produced better results (mean error 0.67%) than Method 1 (0.96%)
  - Method 1 tends to slightly overestimate axle factor values
  - Method 5 tends to slightly underestimate axle factor values
  - Errors for both methods are within two percent of actual values

- Evaluation by facility type (highway/freeway) and number of lanes found same trends
Method Evaluation

- Prediction of vehicle classes (Method 5 only)
  - Evaluated real versus estimated proportions of vehicle classes based on FHWA designations
  - Performance varied between Wisconsin-only data and LTPP-only data sets
    - Likely due to difference in location of these sites
    - Performance would improve if algorithm was recalibrated using LTPP data
Method Evaluation

• Seasonal variability
  – Method 1 and Method 5 tested
    • Method 1 was unbiased for axle factor estimation in summer and fall
      – Winter showed slight overestimation
    • Method 5 showed more variability
      – Recalibrating algorithm would likely reduce this condition

![Method 1 Seasonal Performance by Facility Type](image)
Method Recommendations

• Method 1 is recommended as a reliable process to estimate axle factors
  – Ease of implementation and high accuracy

• Method 5 is recommended to estimate axle factors and axle-based classification

• Smaller relative and absolute errors, robustness against heterogeneity in data
  – Recalibration of the conversion algorithm does improve performance, but it is not necessary due to the small improvement made
User Guide

- User guide developed for application of Method 1
  - Discusses development of “seed” data
  - Provides examples of application of “seed” data to field collection situations
  - Useful for analysts wanting to apply this process in “real-world” data collection environment

<table>
<thead>
<tr>
<th>Length Class</th>
<th>Vehicle Count</th>
<th>Axle Count</th>
<th>Average Axles</th>
<th>Axle Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Class 1</td>
<td>557</td>
<td>1,119</td>
<td>2.00897666</td>
<td>0.4978</td>
</tr>
<tr>
<td>Vehicle Class 2</td>
<td>70,515</td>
<td>141,841</td>
<td>2.01150110</td>
<td>0.4971</td>
</tr>
<tr>
<td>Vehicle Class 3</td>
<td>1,716</td>
<td>5,559</td>
<td>3.23951049</td>
<td>0.3087</td>
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<tr>
<td>Vehicle Class 4</td>
<td>5,488</td>
<td>26,550</td>
<td>4.83782799</td>
<td>0.2067</td>
</tr>
<tr>
<td>SITE TOTAL</td>
<td>78,276</td>
<td>175,069</td>
<td>2.23656038</td>
<td>0.4471</td>
</tr>
</tbody>
</table>
Data Processing Tool

• Data processing tool developed to aid with Method 5
  – User inputs traffic data
    • Developing adaptability of file types
      – Data clearinghouses (e.g. MS2, High Desert)
      – Sensor equipment (e.g. Wavetronix)
  – Axle factor and FHWA vehicle classifications outputted
  – Outputs will be customizable for agency needs
Summary – Use Case Scenarios

• Method #1 applications
  – Determine axle factor for a site that only vehicle length data was collected
  – Determine ADT or AADT at a site that only axle counts were collected

• Method #5 applications
  – Determine axle factor for a site that only vehicle length data was collected
  – Classify vehicle length data into FHWA vehicle classifications
Thank You

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