Safety Analysis Methods for Planning and Project Development

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Analysis Procedures Manual (APM) Safety Analysis

• Safety analysis procedures for
  – Plans - focusing on TSPs, corridor plans, and refinement plans
  – Project development - focusing on NEPA-level projects

• Does not include Highway Safety Program or Traffic Operations procedures such as
  – Road safety audits
  – Collision diagrams
  – Benefit/cost ratio analysis
  – Final countermeasure decisions
New APM Chapter 4 – Safety

- Procedures for applying key Highway Safety Manual (HSM) methods
- Published August, 2013
- Addition of new methods and update of existing safety analysis methods
- Interim update – a more comprehensive evaluation of new safety analysis procedures is in progress
**Crash Rate Analysis**

- New recommended methods
  - HSM Critical Rate
  - ODOT published 90th percentile intersection crash rates
- Segment crash rate comparisons to statewide average
  - Segments not homogeneous
  - Short segments
  - Still applicable but may be better/supplemental methods
- Intersection crash rate rule of thumb (threshold of 1.0 crashes/MEV)
  - Replaced by new method
HSM Critical Rate Method

- HSM Part B network screening/flagging tool
- Uses standard crash rates
- ODOT spreadsheet calculator developed \(^2\)
- Intersections and segments within study area are grouped by roadway or traffic control characteristics
- Crash rates for each site are analyzed and compared statistically within their group
Reference Populations

- Intersections
  - Unsignalized versus signalized
  - 3-leg versus 4-leg

- Segments
  - Divided versus undivided
  - 2-lane versus 4-lane
  - Terrain – level, rolling, mountainous
  - Passing lane or climbing lane segments
Critical Rate Method - Ashland TSP

Intersection Crash Analysis

- Below Critical Crash Rate
- Exceeds Critical Crash Rate
## Statewide 90th Percentile Intersection Crash Rates

**Exhibit 4-1 Intersection Crash Rates per MEV by Land Type and Traffic Control**

<table>
<thead>
<tr>
<th></th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3SG 3ST 4SG 4ST</td>
<td>3SG 3ST 4SG 4ST</td>
</tr>
<tr>
<td>No. of Intersections</td>
<td>7 115 20 60</td>
<td>55 77 106 60</td>
</tr>
<tr>
<td>Mean Crash Rate</td>
<td>0.226 0.196 0.324 0.434</td>
<td>0.275 0.131 0.477 0.198</td>
</tr>
<tr>
<td>Median Crash Rate</td>
<td>0.163 0.092 0.320 0.267</td>
<td>0.252 0.105 0.420 0.145</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.185 0.314 0.223 0.534</td>
<td>0.155 0.121 0.273 0.176</td>
</tr>
<tr>
<td>Coefficient of Variation</td>
<td>0.819 1.602 0.688 1.230</td>
<td>0.564 0.924 0.572 0.889</td>
</tr>
<tr>
<td>90th Percentile Rate</td>
<td>0.464 0.475 0.579 1.080</td>
<td>0.509 0.293 0.860 0.408</td>
</tr>
</tbody>
</table>

Source: [Assessment Of Statewide Intersection Safety Performance](http://example.com), FHWA-OR-RD-18, Portland State University and Oregon State University, June 2011, Table 4.1, p. 47.
**Excess Proportion of Crash Types**

- HSM Part B Network screening tool
- Identifies locations with significantly high proportions of crash types
  - Turning
  - Rear-end
  - Angle
- ODOT spreadsheet calculator developed
**Crash Modification Factors (CMFs)**

- Identify potential crash reductions from proposed countermeasures
- Useful for relative comparisons between alternatives
- Crash Modification Factor Clearinghouse ⁵
  - Star rating system
  - Access to research
- ODOT Guidance on use of CMFs ⁶
Predictive Analysis

- HSM Part C

- Safety Performance Functions (SPFs)
  - Equations predicting crash frequency based on AADT, roadway and operational characteristics

- Data intensive - too detailed for TSPs

- New SPFs continue to be developed nationally and in Oregon

- Oregon calibration factors required for national SPFs
  - Oregon’s required crash reporting threshold higher than most other states ($1500)
  - Many minor crashes not reported
## Oregon HSM Calibration Factors

### Table 7.1: Recommended Oregon HSM Calibration Factors (based on locally derived crash proportions)

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Observed Crashes</th>
<th>Predicted Crashes</th>
<th>Calibration Factor, C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SEGMENTS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rural Two-Lane</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>394</td>
<td>529</td>
<td>0.74</td>
</tr>
<tr>
<td><strong>Rural Multilane</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRU</td>
<td>Undivided</td>
<td>364</td>
<td>990</td>
</tr>
<tr>
<td>MRD</td>
<td>Divided</td>
<td>58</td>
<td>75</td>
</tr>
<tr>
<td><strong>Urban and Suburban Arterials</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U2U</td>
<td>2-lane undivided</td>
<td>377</td>
<td>610</td>
</tr>
<tr>
<td>U3T</td>
<td>3-lanes with TWLTL</td>
<td>215</td>
<td>267</td>
</tr>
<tr>
<td>U4D</td>
<td>4-lanes divided</td>
<td>161</td>
<td>114</td>
</tr>
<tr>
<td>U4U</td>
<td>4-lanes undivided</td>
<td>506</td>
<td>803</td>
</tr>
<tr>
<td>U5T</td>
<td>5-lanes with TWLTL</td>
<td>772</td>
<td>1214</td>
</tr>
<tr>
<td><strong>INTERSECTIONS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rural Two-Lane</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R3ST</td>
<td>3-leg, minor STOP</td>
<td>108</td>
<td>344</td>
</tr>
<tr>
<td>R4ST</td>
<td>4-leg, minor STOP</td>
<td>204</td>
<td>655</td>
</tr>
<tr>
<td>R4SG</td>
<td>4-leg, signalized</td>
<td>142</td>
<td>318</td>
</tr>
<tr>
<td><strong>Rural Multilane</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>MR3ST</td>
<td>3-leg, minor STOP</td>
<td>37</td>
<td>239</td>
</tr>
<tr>
<td>MR4ST</td>
<td>4-leg, minor STOP</td>
<td>178</td>
<td>455</td>
</tr>
<tr>
<td>MR4SG</td>
<td>4-leg, signalized</td>
<td>157</td>
<td>1053</td>
</tr>
<tr>
<td><strong>Urban and Suburban Arterials</strong></td>
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<td>291</td>
</tr>
<tr>
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<td>4-leg, minor STOP</td>
<td>105</td>
<td>231</td>
</tr>
<tr>
<td>U3SG</td>
<td>3-leg, signalized</td>
<td>321</td>
<td>439</td>
</tr>
<tr>
<td>U4SG</td>
<td>4-leg, signalized</td>
<td>690</td>
<td>654</td>
</tr>
</tbody>
</table>

1 Use with caution (see discussion in text). If using the SPF's to evaluate future facilities use calibration factor of 0.64
New Safety Analysis Tools

- HSM predictive method
  - Highway Safety Manual Spreadsheets
  - Interactive Highway Safety Design Model (IHSDM)
  - HiSafe

- PlanSafe

- SSAM (Surrogate Safety Analysis Method/Model)
Level of Detail in Safety Analysis

• TSPs – least detailed
  – Identify safety priority locations for further review
  – Predictive analysis generally not appropriate

• Refinement plans and NEPA project development - mid-range detail
  – Predictive analysis appropriate for identified safety priority locations

• Design and Traffic approvals - highest level of detail
  – Collision diagrams, benefit/cost ratios
  – Design of countermeasures
Other Safety Analysis Methods

- Functional Area of an Intersection
- Sight Distance
- Conflict Points
- Access Management
- Turn Lane Criteria
- Traffic Control
- Multimodal Methods
Multimodal - Pedestrian and Bicyclist Safety Analysis

- Crash rates and CMFs
  - Limited crash database
  - Not indicative of facilities avoided by peds and bikes

- User perception rating systems
  - Level of Traffic Stress
  - Multimodal Pedestrian and Bike Level of Service

- Guidance on specific multimodal safety issues, such as
  - NCHRP 562 - Improving Pedestrian Safety at Unsignalized Crossings
General Risk Factors for Pedestrians and Bicyclists

- Wide roadway/multiple lanes to cross
- Absence of or narrow buffers
- High speeds and volumes
- Complex intersections
- Absence of or narrow ped/bike facilities/connectivity
  - Bike lanes
  - Sidewalks
  - Crossing islands
Multimodal Safety Countermeasures

- Sidewalk and bike lane improvements, buffers, off-street paths
- Curb extensions, pedestrian median islands, road diets
- Bike boxes, bike signals
- RRFB, HAWK signal, protected left turn phase
- ITS improvements
Project: Safety Evaluation in Planning and Project Development
Overview

- Comprehensive review and analysis of safety evaluation methods in planning and NEPA – level projects
- Evaluate current and potential safety analysis methods not addressed in interim APM chapter update
- Expand procedures for safety analysis in planning and project work
- Document processes/tools and outreach to ODOT groups and consultants
Project Tasks

✓ Stakeholder Survey

• Review of Existing Tools

• Evaluation of Potential Tools

• Case Studies
  – Planning
  – TIA
  – Project Development

• Documentation

• Outreach
Project Contacts

• TAC:
  – Christina McDaniel-Wilson, Agency Project Manager
  – Doug Norval, TPAU
  – Peter Schuytema, TPAU
  – Kevin Haas, TRS
  – Nick Fortey, FHWA
  – Lidwien Rahman, Rg 1
  – Rod Cathcart, Rg 4
  – Dick Reynolds, TDD

• Contractor: DKS
  – John Bosket, Project Manager
Key ODOT Safety Analysis Resources

- Analysis Procedures Manual
- Highway Safety Program
- Highway Safety Manual (HSM) in Oregon
- Highway Design Manual
- Traffic Manual
- Oregon Traffic Safety Division
- Crash Analysis and Reporting
Key National Safety Analysis Resources

- AASHTO Highway Safety Manual Home
- FHWA Safety Program
- Proven Safety Countermeasures
- FHWA Data and Safety Analysis Tools
References

1. APM V2 Chapter 4 - Safety
2. Critical Rate Calculator
3. Assessment of Statewide Intersection Safety Performance
4. Excess Proportion of Specific Crash Types Calculator
5. Crash Modification Factors Clearinghouse
6. Crash Modification Factors: Instructions
8. Improving Pedestrian Safety at Unsignalized Crossings
Questions?