Developing a Methodology for Implementing Safety Improvements on Low-Volume Roads in Montana

Final Project Presentation

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Research Motivation

- Safety improvement programs primarily rely on crash history.
- On low-volume roads (LVRs), crash occurrence is sporadic over the network
  - Crash history is not effective in identifying candidate safety improvement sites.
- LVRs are also known for lower functional classification and lower geometric standards
  - Higher risk for crash occurrence.

Research Objective

Develop a methodology for screening sites on Montana LVRs for consideration of safety improvement projects.

Project Tasks

1. State of the Art Review
2. Criteria for Site Identification and Prioritization
3. State of the Practice Review
4. Analyze and Assess Current Approaches
5. Develop a Montana-Specific Methodology for LVR Site Screening
6. Assessing Benefits of Proposed Methodology
7. Implementation Plan
8. Final Report

Major Task Findings

2. State of the Art Review

Major Findings

- Review identified risk factors associated with roadway characteristics in relation to roadside features, cross-section elements, and alignment design.
- Reviewed and classified screening methods - Three major classes: methods using historical crash data, predictive methods, and methods using historical crash data and prediction models in combination.
- Lack of any science-based advanced screening methods for LVRs.

3. Criteria for Site Selection

- Task identified and discussed the most important criteria for assessing the suitability of different network screening methods.
- Eight criteria were identified:
  1. Sensitivity to level of risk
  2. Sensitivity to economic effectiveness
  3. Precision
  4. Previous performance record
  5. Ease of understanding,
  6. Ease of implementation,
  7. Data requirements
  8. Resource requirements

4. State of the Practice Review

- A state of practice survey was sent out to all Departments of Transportation (DOTs).
- 32 states responded.
- Major findings in relation to network screening process and safety management on LVRs are:
  1. Crash severity is the most frequently used criterion for identification of potential safety improvement sites on LVRs.
  2. Around 48 percent reported using the FHWA systemic approach in combination with one or more of other network screening criteria.

4. State of the Practice Review

3. About 80 percent had a separate method for selecting sites on state-owned LVRs from the method used for other state-owned roads with higher traffic volumes.
4. Around 90 percent of the responding DOTs involved local agencies (cities, counties, townships, etc.) in identifying safety improvement sites on non-state-owned local roads.
5. 55 percent reported using one process for identifying safety improvement sites on state-owned and non-state-owned LVRs.
6. Crash experience at sporadic sites was the most frequently reported method for identifying safety improvement sites on non-state-owned local roads.
7. 70 percent reported not allocating a set amount of funds for safety projects on non-state-owned local roads.

5. Analyze and Assess Current Approaches

- Different screening methods identified from tasks 2 & 4 were assessed and scored for their merits (or demerits).
- The set of criteria developed in Task 3 was used in the assessment.
- A scoring scheme was employed to assign weights to different criteria which were then used in scoring the alternative methodologies.

5. Analyze and Assess Current Approaches

- The methods that scored highest in the assessment are the conventional frequency, rate, and severity method and the Highway Safety Manual (HSM) empirical Bayes (EB) method.
- Network screening using surrogate safety measures scored lowest.
- The FHWA systemic approach to safety scored right in the middle. Method could have scored much higher if the cost-effectiveness criterion had accounted for the high benefit-cost ratio associated with low-cost systemic improvements.
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6. Develop Network Screening Methodology

- A screening method was developed to satisfy the following criteria:

  1. The method should be based on theoretical principles in safety science and/or empirical evidence that are well accepted in practice by the traffic safety community

  2. Method should incorporate roadway and roadside characteristics (risk factors) that are associated with crash occurrence

  3. Method should not require extensive and exact roadway and traffic data inputs

  4. Method should be easy to use by local transportation agency staff with limited resources.

6. Develop Network Screening Methodology

- The proposed method assigns scores to a site using roadway and roadside characteristics, traffic characteristics, and crash history.
- The HSM safety performance functions as well as crash modification factors (from HSM, CMF clearinghouse, and published literature) were used in method development
- Separate scoring schemes were developed for roadway segments and intersections.
- The roadway segment scoring scheme variables: *total width, horizontal curvature, grade, driveway density, side slope, roadside fixed objects, pavement presence and condition, speed, volume, and crash history.*
- The intersection scoring scheme variables: *intersection skew angle, traffic control, presence of turn lanes, presence of lighting, speed, traffic level, and crash history.*

Scoring Scheme - Roadway Segments

LVR Segments Ranking Scheme	
Safety-Related Questions	**If yes, add:**
Risk Factors	
Total width (TD)	
TD ≤ 20 ft.?	7
20 ft. < TD ≤ 24 ft.?	4
Horizontal curve?	
Flatter curve (R ≥300 ft.)	30
Sharper curve (R<300 ft.)	60
Grade steeper than ± 4%?	3
Six or more driveways per mile?	5
Side slope steeper than 1V:3H?	4
Fixed objects within 15 ft of travel lane?	4
Unpaved Road?	14
Poor pavement condition? (ruting, potholes, etc.)	7
Crash History?	
Fatal or serious injury crashes (N_1)	N_1 X 80
Other crashes (N_2)	N_2 X 5
Relative Risk Compound Score (RRCS)	
Speed ≥ 50 mph?	RRCS X 1.25
Got ADT?	
ADT *≤ 300*	RRCS X 1.0
300 < ADT ≤ 600	RRCS X 3.0
600 < ADT ≤ 1000	RRCS X 5.0
ADT > 1000	RRCS X 7.0
Global Risk Score (GRS)	

Scoring Scheme - Intersections

LVR Intersections Ranking Scheme	
Safety-Related Questions	**If yes, add:**
Baseline Score	50
Roadway Factors	
Skew angle > 20 deg ?	10
Non-controlled intersection?	60
Lighting?	-7
Left-turn lanes on non-controlled approach?	-30
Crash History?	
Fatal or serious injury crashes (N_1)	N_1 X 80
Other crashes (N_2)	N_2 X 5
Relative Risk Compound Score (RRCS)	
Got ADT?	
$ADT_{int} \leq 600$	RRCS X 1.0
$600 < ADT_{int} \leq 1200$	RRCS X 2.0
$1200 < ADT_{int} \leq 2000$	RRCS X 4.0
$ADT_{int} > 2000$	RRCS X 6.0
Global Risk Score (GRS)	

7. Assessing Benefits of Proposed Methodology

- The conventional benefit-cost analysis using the present worth of costs and benefits was used in this assessment.
- Costs involved methodology development, training resources development, training sessions, and additional agency staff.
- In using a more robust process for identifying candidate sites for safety projects, it was assumed that the crash reduction would increase upon the implementation of the proposed method.
- Crash reduction was estimated using the crash modification factors for the most common safety countermeasures on Montana LVRs.

7. Assessing Benefits of Proposed Methodology

- Using a 10-year analysis period, benefit-cost ratios for three different scenarios were calculated.
  - Crash reduction using all crashes
  - Crash reduction using fatal and serious injury crashes only
  - Crash reduction using all crashes except property-damage-only crashes
- The benefit-cost ratios for the three scenarios varied between 16 and 23.

8. Implementation Plan

- Overall implementation recommendations and guidelines stemming from all prior tasks
- Important for successful implementation of proposed methodology
- Implementation meeting (Today)
- Implementation report

9. Final Report

- Documentation of all project tasks
- Major task findings and recommendations
- Draft submitted to Tech Panel, revised to address panel comments, and resubmitted for panel approval.
- Final meeting (today)

Questions?