Establishing a Scientific Approach for Identifying Hotspots in Montana

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Background and Objective

Background

- Different states in the USA are implementing Safety Management Systems with a 'holistic' approach rather than a 'data-driven' approach for reactive analysis.
- Most safety management systems are gradually becoming compliant with the Highway Safety Manual (HSM).
- HSM recommends a systematic process of partitioning the network by peak search or sliding window technique, computing agency-specific performance metrics and identifying hotspots. This process is known as *Network Screening*.
- *Network Screening* is followed by *diagnosis*, *treatment selection & project composition*, b*enefit-cost analysts & project prioritization* and finally *before-and-after study*.
- Montana has implemented an HSM-compliant Safety Information Management System (SIMS) that provides plenty of opportunities for partitioning the network and running different screening scenarios.

Objective

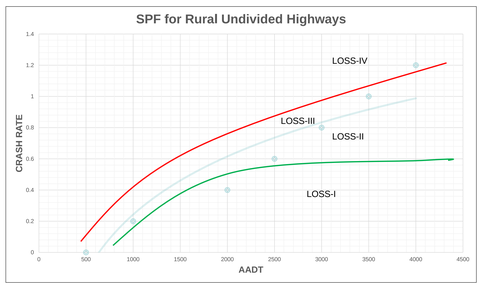
- Demonstrate agency-specific screening using a case study for Montana.
- Analyze case study results of partitioning the network by *Sliding Window* method against *Peak Search* method.
- Recommend which of these methods should be used on a regular basis for identifying hotspots in Montana.

Methods

Performance Metric

- Montana uses Level of Services of Safety (LOSS) to evaluate the degree of safety conditions on roadway segments.
- At first, the crash rate is estimated by **S**afety **P**erformance **F**unctions (SPF) that have been developed and calibrated for nine roadway types in Montana. The roadway types are classified by lane number, terrain type (rolling, flat, mountainous), rural vs. urban and access control (freeway vs non-freeway).
- The estimated crash counts are adjusted by **E**mpirical **B**ayes (EB) technique.
- Finally, LOSS for a roadway segment is determined by the following equation:
  - LOSS =I (if, EbCr <= $EsCr_{lower}$)
  - LOSS =II (if, $EsCr_{mean}$ >= EbCr >$EsCr_{lower}$)
  - LOSS =III (if, $EsCr_{upper}$ >= EbCr >$EsCr_{mean}$)
  - LOSS =IV(if, EbCr >$EsCr_{upper}$)

  Here, EbCr – EB adjusted crash rate EsCr = Estimated crash rate by SPF.
- A specific segment is identified as a hotspot when the estimated LOSS is IV.



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Abstract

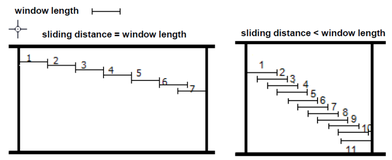
Several States are now implementing Safety asset and information management systems that go beyond the realms of simple safety data analysis to identify and treat the locations having preponderance of crashes. Most management systems follow the process recommended in the Highway Safety Manual (HSM) published by AASHTO. In order to identify the hotspots, the HSM recommends a systematic process, which involves (a) partitioning the network using either Sliding Window or Peak Search methods, (b) Identifying hotspots in the partitioned network, and (c) Identifying safety countermeasures for the identified hotspots given accident history and roadway characteristics. One of the most important factors in identifying projects in a safety work plan is how a network is partitioned for analysis, because depending on the method used, the number and density of hotspots as well as accident problems uncovered may differ. This paper presents a case study from Montana where the Department of Transportation evaluated the Sliding Window method of partitioning the network against Peak Search method, to determine which of these methods should be used on a regular basis for analysis of the entire network and identification of safety countermeasures. A set of corridors were identified in the state and analyzed using the HSM-based Safety Management System. Hotspots were identified using both Sliding Window and Peak Search methods, and using the EB adjusted performance measures as the criteria. The list of identified hotspots and list of recommended projects were compared from the perspective of ensuring that maximum safety problems are identified and addressed. Based on the analysis, the DOT established that the hotspots and projects identified using the Sliding Window method provided a more comprehensive solution to the safety needs of the selected corridors. The goal was to identify and establish the method used for hotspot identification as a standard in the State so that all cities, counties, and agencies using the safety management system can follow a consistent and standard method in the identification of hotspots and subsequent highlighting of potential candidate projects for the Highway Safety Improvement Program (HSIP).

Methods (contd.)

Case Study

- The case study was performed by running network screening for 10-yr analysis period (2004-2013) on US-93 in Montana (approximately 94.8 mile long roadway).
- The roadway was segmented for both *peak search* and *sliding window* techniques.
  - Peak Search: segmented by 0.5 mile
  - Sliding Window: segmented by 0.5 mile window and 0.2 mile step

Study Roadway (US-93)

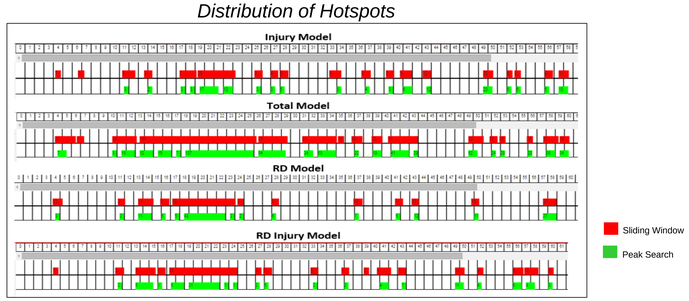


Peak Search (left) vs Sliding Window (right) segmentation

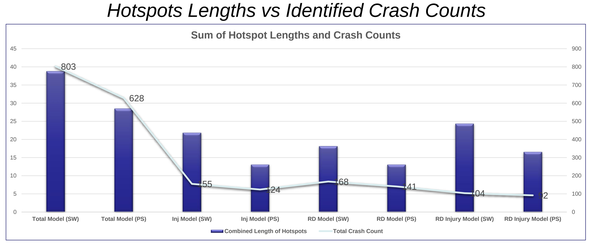
- The performance measures on the roadway was estimated by four (4) different Safety Performance Functions and LOSS is calculated for each scenarios:
  - *Total Model*
  - *Injury Model*
  - *Total Model for Road Departure Crash*
  - *Injury Model for Road Departure Crash*
- After the hotpots are identified the results are evaluated by:
  - *Distribution of Hotspots*
  - *Summation of Hotspots Lengths*
  - *Total Identified Crashes within Hotspots*
  - *Average Crash Rate (crashes/mile) Across Hotspots*
  - *% improvement in crash identification*

Results

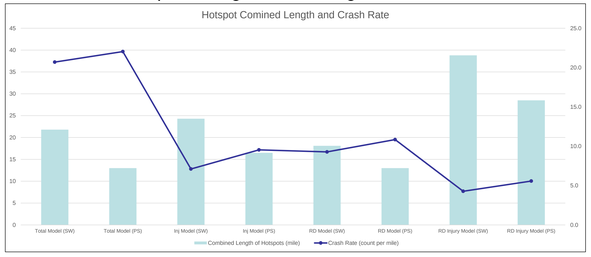
Distribution of Hotspots



Hotspots Lengths vs Identified Crash Counts



Hotspots Lengths vs Average Crash Rate



- The % improvement in crash identifications from peak search to sliding window for different SPFs can be ranked as:
  Total Model (21.8%) > Inj Model (20%) > RD Model (16.1%) > RD Inj Model (11.5%)

Conclusions and Future Directions

- Sliding window technique was found to generate longer and more continuous hotspots in all scenarios.
- The average crash rate for peak search is generally higher than sliding window in all scenarios.
- The % improvement in crash identification from peak search to sliding window is highest in Total Model and lowest in RD Injury Model.
- Due to continuity of hotspots and better identification coverage, sliding window technique is superior.
- Authors suggest other agencies to follow similar scientific approach.

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