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

Task III Report: Criteria for Site Identification and Prioritization

Prepared by

Ahmed Al-Kaisy, PhD, PE – Professor & Program Manager

Kazi Tahsin Huda – Graduate Research Assistant

of the

Western Transportation Institute
College of Engineering
Montana State University
Bozeman, MT 59717-4250

Prepared for the

MONTANA DEPARTMENT OF TRANSPORTATION

in cooperation with the

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

September 2019

DISCLAIMER STATEMENT

This document is disseminated under the sponsorship of the Montana Department of Transportation (MDT) and the United States Department of Transportation (USDOT) in the interest of information exchange. The State of Montana and the United States assume no liability for the use or misuse of its contents.

The contents of this document reflect the views of the authors, who are solely responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the views or official policies of MDT or the USDOT.

The State of Montana and the United States do not endorse products of manufacturers.

This document does not constitute a standard, specification, policy or regulation.

ALTERNATIVE FORMAT STATEMENT

MDT attempts to provide accommodations for any known disability that may interfere with a person participating in any service, program, or activity of the Department. Alternative accessible formats of this information will be provided upon request. For further information, call 406/444.7693, TTY 800/335.7592, or Montana Relay at 711.

TABLE OF CONTENTS

1. INTRODUCTION

In the United States, traffic safety has become a priority for most roadway agencies given the large number of crashes and fatalities on the highway system. Agencies allocate considerable resources to implement safety improvements. As available funding is usually limited, safety improvement projects should target sites on the network that result in most safety benefits. To this end, highway safety programs involve the process of network screening for sites with less than satisfactory safety record. These sites would deserve more attention and would represent good candidates for further consideration in prioritizing safety projects. Several methods have been used in practice for the preliminary screening of the network for sites that are good candidates for safety improvement projects. Most of these methods have advantages and disadvantages in terms of data needs and the way screening results correspond to actual safety benefits at candidate locations. This interim report discusses some of the important criteria that will be used in assessing the merits (or lack thereof) of different network screening methods. The criteria discussed in this report are also important in guiding the development of Montana-specific methodology of network screening for the purpose of selecting safety improvement sites on rural low-volume roads.

2. NETWORK SCREENING CHALLENGE FOR RURAL LOW-VOLUME ROADS

Most conventional network screening methods rely heavily on crash history in selecting sites for safety improvement projects. This is reasonable and is largely acceptable based on the premise that crash occurrence is associated with the level of risk at a particular site, and thus the likelihood of being involved in a crash. However, on rural low-volume roads, traffic exposure is very low to the extent that the association between crash occurrence and level of risk is not necessarily exhibited using crash data for the analysis period (typically the most recent 3-10 years of published crash data). Specifically, the small number of crashes that occur on low-volume road network during the analysis period often appear sporadic and may not reveal higher crash frequencies at problematic locations. Further, significantly increasing the duration of crash analysis may prove impractical for issues related to crash data accessibility and more importantly for changes that occur over time and affect highway attributes and features. Therefore, relying solely on crash history in selecting sites for safety improvement projects on low-volume roads is often ineffective, and other factors should be considered in assessing the level of risk on these roads.

3. CRITERIA FOR SUITABLE NETWORK SCREENING METHODS

This section discusses the most important criteria that should be considered in assessing the suitability of a network screening method for identifying candidate safety improvement project sites. While some criteria may be more important than others, a comparison across these criteria is beyond the scope of this interim report.

3.1. Sensitivity to Level of Risk

This criterion accounts for the level of risk present at any given site on a roadway network. For the purpose of this project, the level of risk is defined as the likelihood of a crash taking place when that site is used by motorists. It is well-known that the major determinants of the level of risk are the geometric and roadside features at a site. Geometric features include cross section elements (e.g. number of lanes, lane width, shoulder width, etc.) as well as highway alignment (e.g. horizontal and vertical curves, grades, sight distance, etc.). Roadside features, on the other hand, primarily involve side slopes and presence of fixed objects within a close proximity of the highway. These physical roadway properties are often referred to as "risk factors" in the traffic safety professional community. It is important to mention that the level of risk is also affected by traffic and environmental conditions due to their impact on risk factors. Factors related to traffic involve percentage of trucks or motorcycles, running speeds, driver characteristics (e.g. age, experience, local versus tourist, etc.), and presence of non-motorized modes. Regarding environmental conditions, factors such as the presence of ice and snow on a pavement surface will increase the level of risk by reducing the tire-pavement traction. Similarly, heavy fog may restrict the sight distance and raise safety concerns when available sight distance is less than that required for a safe stopping maneuver. According to this criterion, network screening methods that are more sensitive to level of risk, (i.e. those that account for risk factors), would score high compared to other methods that do not incorporate risk factors.

3.2. Sensitivity to Economic Effectiveness

Economic effectiveness, often used in the form of benefit-cost ratio, is a major consideration for most highway agencies when selecting sites for safety improvement projects. The rationale is clear and straightforward, a site that is expected to yield higher monetary return on safety investment is more deserving to receive safety funds. Following this principle, sites with higher

crash frequencies and more severe crashes are generally associated with higher returns on safety investments. This also highlights the fact that roadways with high traffic exposure are often associated with higher crash frequencies, and therefore higher benefit-cost ratios. Besides traffic exposure, higher crash frequencies may also be related to the level of risk (or risk factors) at a particular site. However, the relationship between crash frequencies and risk factors may not be evident using crash data alone when traffic exposure is very low (e.g. rural low-volume roads). According to this criterion, network screening methods using crash frequency and severity would score higher than other methods that do not account for crash frequency or severity.

3.3. Precision

The precision criterion is used to assess whether a network screening method is able to respond to small and subtle changes of any factor related to the level of risk or crash occurrence at a particular site. Using a less precise screening method might lead to discarding potential at-risk sites, as the method may not be able to accurately assess the risk due to differences in magnitude of a risk-related feature. On the other hand, less precise methods usually tend to be fast, easy and inexpensive to implement (i.e. doesn't require much data or staff time). In the context of assessing risk, precision can be stratified into three levels: presence of a feature (e.g. segment has a horizontal curve), a range of values for a feature (e.g. segment has a horizontal curve with radius between 300 and 500 feet) and an exact value for that feature (e.g. segment has a horizontal curve with a radius of 360 feet). For example, consider a situation where screening is completed on two similar roadway sites. The two sites are located on horizontal curves, have the same traffic volume, the same cross section, and the same roadside features. However, the radius of the horizontal curve at one site is much smaller than that at the other. Consequently, a screening method that screens sites based on the presence of certain risk-related feature (in this case horizontal curvature), will yield the same score for both sites. However, sharper horizontal curves tend to impart greater risk. Therefore, a screening method that has the potential to identify this difference in the level of risk at the two sites is better able to identify the site with the sharper curve as being associated with higher risk. Consequently, a more precise network screening method receives a better score under this criterion.

3.4. Previous Performance Record

This criterion allows the scoring of network screening methods based on previous record of their performance. Only when a screening method is applied, a full understanding of the strengths and limitations of that method is achieved. The track record of a method being used in practice by more highway agencies is often associated with the practicality of the method and the level of satisfaction of users. Hence, the application of a method in practice and the number of agencies using a method is an indicator of the practicality of the method and its merits. This criterion is also important as it provides a scoring opportunity of the methods based on user feedback.

Using this criterion, a proposed network screening method that has not been used in practice would score low compared to other methods that have found use in practice. By the same token, a method that was only used by a single agency may not score as high as other methods that have been used by a larger number of agencies.

3.5. Ease of Understanding

This criterion is to assess how intuitive or easy to comprehend the prospective network screening method is to the practitioner. Since the intent of this project is to develop a screening method that can easily be applied on local and low-volume roads, ease of understanding by practitioners at both state and local agencies is essential. This criterion is also important because many local agencies (counties, townships, etc.) may not have technical experts on-staff. Therefore, an easy to understand method will help facilitate implementation and use.

Under this criterion, sophisticated methods that require more extensive technical backgrounds (e.g. statistics) would score lower than other simpler methods which only require limited skills and/or expertise.

3.6. Ease of Implementation

This criterion would assess whether a network screening method is easy to implement, and is closely related to the practicality of using a particular method. The ease of implementation considers factors such as the availability and accessibility of data and whether specially trained personnel are required. Certain methods may require special training such as those outlined in the Highway Safety Manual (HSM) (AASHTO 2010), special software (e.g. iRAP program), or detailed roadway information that is not readily accessible by agency personnel. For

example, the International Road Assessment Program methodology (iRAP, 2019) is not as easy to implement as some of the other conventional methods. Part of the iRAP method requires a road audit with sophisticated equipment and trained personnel for investigation. The data required is not readily available and therefore requires an extensive road audit. Similarly, prediction methods based on surrogate measures like conflict analysis require high precision video data, complex algorithms, and trained personnel to implement. According to this criterion, network screening methods that are more difficult to implement would receive lower scores.

3.7. Data Requirements

This criterion would assess the type, amount and precision of data required for a network screening method. Data types can be classified into three broad categories: crash data, traffic data and roadway data. Some methods may require information from only one category, while other methods may require information from all three categories. Further, within each data category, one or more information pieces may be required. For example, one method may only require information about crash frequency, while another method may require crash frequency, severity and type. Data precision is another consideration in assessing data needs. For example, one method may require information about the presence of a certain feature (horizontal curve, shoulder, grade, etc.) whereas another method may require the exact value of that feature (e.g. curve radius, shoulder width, percent grade, etc.). Under this criterion, a network screening method requiring large amounts of information from multiple data categories with high precision would score low when compared to other methods that require less information from fewer data categories, with lower precision.

3.8. Resource Requirements

This criterion accounts for the resources needed when implementing a prospective network screening method. Resources primarily involve agency personnel and staff who are involved in applying the proposed method as well as other costs involved in acquiring the data, including staff time. Network screening methods which require fewer resources for implementation would score higher than resource-intensive methods under this criterion.

4. SUMMARY

This interim task report presented a set of criteria that will be used in assessing the merits or downfalls of any proposed or existing methods for network screening to select safety improvement project sites. While not all-inclusive, the set of criteria developed attempted to capture the most important traits or metrics that can be used in testing the suitability of any network screening method. Those criteria are: sensitivity to level of risk, sensitivity to economic effectiveness, precision, ease of understanding, ease of implementation, data requirements, and resource requirements. This report did not compare the different criteria in terms of significance or importance to the network screening process, as it is beyond the scope task. This set of criteria will be applied systematically in assessing the suitability of various network screening methods gathered in the state of practice survey, as well as those methods that are reported in literature.

5. REFERENCES

American Association of State Highway and Transportation Officials (AASHTO). *Highway Safety Manual, First Edition*. Washington D.C. (2010).

International Road Assessment Program (iRAP). *Star Rating Roads for Safety. The iRAP Methodology*. https://vida.irap.org/en-gb/home. Accessed June 26, 2019.