Taking a Proactive Approach to Safety in Utah

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Abstract: Although safety has always been considered in the planning, design, operations, and maintenance of highways, it was not until 2010 that the American Association of State Highway and Transportation Officials published a new transportation safety guide, the Highway Safety Manual (HSM), in response to the realization that there was a lack of a single authoritative document to use for estimating safety impacts. With the publication of the HSM comes the challenge of implementing the guidelines outlined in the document. State Departments of Transportation (DOTs) are faced with a daunting task to take the information presented in the HSM and apply this information in their states.

The Utah Department of Transportation has taken a proactive approach to implementing the HSM. Research has been, and continues to be, conducted to implement and utilize the HSM procedures in the state. The purpose of this paper is to summarize a framework developed in Utah for highway safety mitigation that provides a logical and comprehensive context within which efforts to improve highway safety can be made. This framework, developed around the Roadway Safety Management Process contained in the HSM, incorporates predictive methods of highway safety analysis to allow transportation officials to proactively improve the safety of the transportation system. As state DOTs adopt such a framework for safety mitigation, and take a proactive approach to implementing the HSM in their state, they can begin to maximize the benefits resulting from highway safety investment.

INTRODUCTION

Safety has long been considered in the planning, design, operations, and maintenance of highways. The results of safety initiatives over the years have had a positive impact; however, more can always be done to continue to improve safety on the roadways today, and in the future.

The Safe, Accountable, Flexible, and Efficient Transportation Equity Act – A Legacy for Users (SAFETEA-LU) provided legislation that upgraded the Highway Safety Improvement Program (HSIP) to a core federal-aid program that nearly doubled the funds available for transportation safety. The HSIP requires the department of transportation (DOT) from each state to develop a Strategic Highway Safety Plan (SHSP) focused on reducing vehicle-related fatalities and injuries by implementing data-driven safety improvement projects (USDOT 2005). To fulfill the mandates outlined in the HSIP, state DOT officials needed a tool to aid in highway safety improvement decisions. As a result of this mandate, and in response to the realization that there was a lack of a single authoritative document to use for estimating safety impacts, the American Association of State Highway and Transportation Officials (AASHTO) published a new transportation safety guide, the Highway Safety Manual (HSM) (AASHTO 2010). With the publication of the HSM comes the challenge of implementing the guidelines outlined in the document. State DOTs are faced with a daunting task to take the information presented in the HSM and apply this information in their states.

The Utah Department of Transportation (UDOT) has taken a proactive approach to implementing the HSM. Research has been, and continues to be, conducted to implement and utilize the HSM procedures in the state. The purpose of this paper is to summarize a framework developed in Utah for highway safety mitigation that provides a logical and comprehensive context within which efforts to improve highway safety can be made. This framework, developed around the Roadway Safety Management Process contained in the HSM, incorporates predictive methods of highway safety analysis to allow transportation officials to proactively improve the safety of the transportation system. The results of this research have been published, or are currently under review, in the literature (Schultz et al. 2011b). As a result, the purpose of this paper is to briefly summarize the research, while providing the reader with the references necessary to obtain full analysis results in the areas of: 1) background, 2) framework for highway safety mitigation, and 3) conclusions.

BACKGROUND

Safety Analysis and Mitigation

Roadway safety is generally defined as being either subjective or objective. The subjective nature of safety corresponds to the perception of how safe the transportation may 'feel' to the observer, while the objective nature of safety is based on quantitative measures (AASHTO 2010).

When evaluating the factors that contribute to crashes, most crashes are caused by a combination of factors that generally fall into three categories: human, vehicle, and roadway/environmental. Researchers have estimated that roadway/environmental factors contribute to approximately 34 percent of crashes (AASHTO 2010, Treat et al. 1979). These roadway factors are the primary focus of most safety analyses.

Motor vehicle crashes are generally categorized by the severity of the crashes according to the KABCO scale (NHTSA 2008, NSC 2007). These crashes, regardless of severity, are generally considered both rare and random events that tend to fluctuate up and down around an expected average crash frequency. This tendency is known as regression to the mean (RTM) (AASHTO 2010). To account for the RTM, methods of safety analysis must be carefully considered (Hauer 1997).

Methods of Safety Analysis

Traditional analysis methods directly compare the crash rate (or frequency) of an entity before treatment with the crash rate (or frequency) directly after the improvement to determine the effectiveness of the treatment (Hauer 1997). Crash rates are generally calculated as the ratio between the average crash frequency during the period and the exposure during the same time period and are based on the assumption that a linear relationship exists between crashes and exposure, a relationship that does not always hold true (Hauer et al. 2002, Qin et al. 2004).

Predictive highway safety analysis utilizes more advanced statistical methods to address RTM and provide more reliable estimates of expected average crash frequencies. Predictive methods include the use of crash modification factors (CMFs), crash prediction models (e.g., safety performance functions (SPFs)), and statistical methods (primarily empirical Bayes (EB) and hierarchical or full Bayesian models). Each of these methods is described in detail in the literature, including specific applications in Utah (AASHTO 2010, Brimley et al. 2012, Olsen et al. 2011, Saito et al. 2011, Schultz et al. 2010, Schultz et al. 2011a, Schultz et al. 2011b).

FRAMEWORK FOR HIGHWAY SAFETY MITIGATION

Many components are involved in highway safety improvement. The HSM outlines a Roadway Safety Management Process that can be used to monitor and reduce crash frequency on existing roadway networks (AASHTO 2010). This process forms the basis of the framework for highway safety mitigation developed for Utah. The framework for highway safety mitigation, summarized in Figure 1, includes six primary steps: 1) network screening; 2) diagnosis; 3) countermeasure selection; 4) economic appraisal; 5) project prioritization; and 6) effectiveness evaluation (Schultz et al. 2011b).

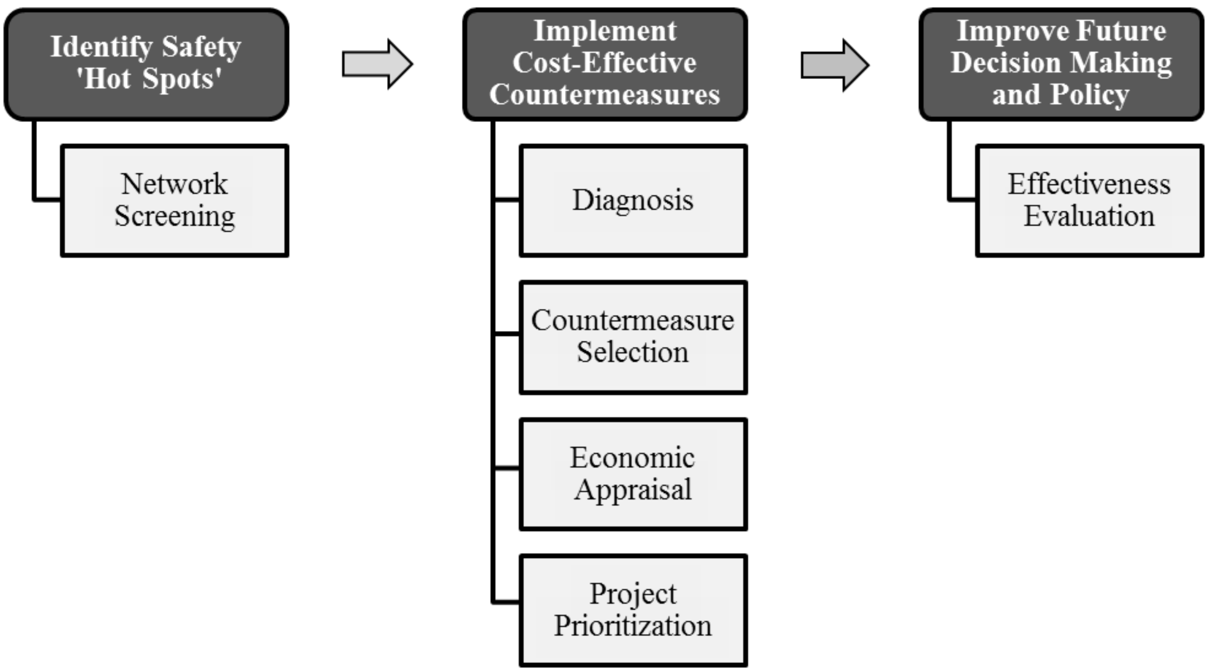

Figure 1. Framework for highway safety mitigation (Schultz et al. 2011b).

The framework for highway safety mitigation provides a logical and comprehensive context within which efforts to improve highway safety can be made. As outlined in the framework, first, safety 'hot spots' in a roadway network may be identified through network screening by comparing actual safety performance with expected performance at a site using statistical methods outlined in the literature (HSM 2010, Schultz et al. 2011b). If the actual safety performance at a site has a significantly higher number of crashes than expected, the site is considered a 'hot spot' or 'black spot' and should be examined more closely to determine the cost-effective countermeasures that could be implemented. To determine the countermeasure to implement, a thorough diagnosis of the site must be conducted and countermeasures selected. The countermeasures can be evaluated for economic viability, and compared and prioritized to find a preferred alternative for implementation. The last objective of the framework is to improve future decision making and policy through a thorough effectiveness evaluation of implemented highway safety improvement projects. Projects found beneficial are recommended to be included in future safety improvement efforts, including consideration for statewide implementation (Schultz et al. 2011b).

CONCLUSIONS

Highway safety continues to be a high priority for transportation officials across the nation, including those at UDOT. Safety is also increasingly being emphasized in transportation policy and must be addressed. Recent change to transportation policy along with the rapid advances in highway safety analysis and the guidelines being provide to state DOTs (e.g., HSM) are enabling more state DOTs to effectively address highway safety needs. The purpose of this paper was to summarize a framework developed in Utah for highway safety mitigation that provides a logical and comprehensive context within which efforts to improve highway safety can be made.

The framework for highway safety mitigation presented in this paper is based on the HSM Roadway Safety Management Process and consists of six steps: 1) network screening, 2) diagnosis, 3) countermeasure selection, 4) economic appraisal, 5) project prioritization, and 6) effectiveness evaluation. Although the framework is based on the methods presented in the HSM, the reader is referred to specific research conducted for UDOT wherein hierarchical Bayesian statistical models are utilized to carry out the framework outlined. The framework outlined is currently aiding UDOT in identifying safety 'hot spots,' implementing cost-effective countermeasures, and improving future decision making and policy development. This framework can help other states take a similar proactive approach to safety.

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