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Project Title:
Highway Safety Manual Part D: Validation and Application in Wyoming

University:
University of Wyoming

Principal Investigator:
Dr. Mohamed M. Ahmed, Ph.D., P.E., Assistant Professor
Civil & Architectural Engineering
University of Wyoming
1000 E. University Ave., Laramie, WY 82071
Phone: (307) 766-5550
Fax: (307) 766-2221
mahmed@uwyo.edu

Research Needs:
Transportation Engineering is a relatively old branch of engineering whose importance has been stressed by the engineering community for some period of time. Traffic safety, however, is relatively a new field and its emphasis has been growing since epidemic nature of roadway fatalities has been discovered in the last decade. American Association of State Highway and Transportation Officials (AASHTO), after ten years of research have finally published their first edition of Highway Safety Manual (HSM) in 2010.The Highway Safety Manual (HSM) is a result of extensive work spearheaded by the Transportation Research Board (TRB) committee on Highway Safety Performance. This is a well-received development as it bridges the gap between research and practice. The HSM is considered as the sole national resource for quantitative information about traffic accident analysis and evaluation with a main focus of reducing crash frequency and severity. Equally useful is the FHWA Guide to Developing Quality Crash Modification Factors (CMFs). Crash Modification Factors or Functions are defined as a quantitative measure of the safety effectiveness of a particular treatment or design element. The HSM includes CMFs for treatments applied to five different categories; 1) roadway segments (e.g., alignment, roadside elements, rumble strips, etc.) 2) intersections (e.g., geometry, and control), 3) interchanges, 4) special facilities (e.g., highway-rail crossing), and 5) road networks. It is worth mentioning that the CMFs provided in the HSM were calibrated using data from various states with different driver population, traffic laws, crash reporting thresholds, and weather and roadway conditions. Thus, a validation of the applicability of the HSM Part-D in Wyoming is essential. This research proposal is a first step toward the adaptation of the Highway Safety Manual to Wyoming conditions.
The HSM has been a hot research topic since its publication. Researchers are keen to work on the application of the HSM in different states. States like Florida (Ahmed et al., 2015; Ahmed and Abdel-Aty, 2015; Abdel-Aty et al., 2014), Utah (Brimley et al., 2012), Kansas (Howard and Steven, 2012), Oregon (Zhou and Dixon, 2012) and etc., have already worked on calibrations and modifications of the Crash Modification Factors in the HSM on their own roadways.

Although other states have calibrated their own CMFs, it was clearly found that the HSM in its current format will not be suitable to adopt in Wyoming.

Research Objectives:

The future of the HSM – Part D was discussed during the 2015 Transportation Research Board Annual Meeting. The Safety Performance Committee and its subcommittees discussed three options to propose to AASHTO; 1) keep and update Part D in the second edition of the HSM, 2) remove Part D and include a methodology section on how to calibrate state-specific CMFs, 3) remove Part D and maintain an updated CMFs on the CMF Clearing House. From the committee discussion, it is more likely that the second option will be elected. Not having a CMFs chapter in the new HSM edition emphasize the need of calibrating State-Specific Crash Modification Factors/ Functions for Wyoming. Moreover, the unique roadway characteristics and weather conditions in Wyoming urges a full calibration of CMFs for treatments of interest.

The main objectives of this study are 1) to quantify the safety effectiveness of different countermeasures on different roadway types, intersection, crash type, and severity level, and 2) to validate and apply Crash Modification Factors/ Functions to the State of Wyoming.

Research Methods:

HSM Part D provides CMFs for roadway segments (e.g., roadside elements, alignment, signs, rumble strips, etc.), intersections (e.g., control), interchanges, special facilities (e.g., Hwy-rail crossings), and road networks. CMFs could be applied individually if a single treatment is proposed or multiplicative if multiple treatments are implemented. Other possibilities are to divide or interpolate CMFs. In this study, the Empirical Bayes (EB) approach to analysis before-after effects will be utilized. The EB method can overcome the limitations faced by simple before-after evaluation and compare group methods by not only accounting for regression to the mean effects, but also accounting for traffic volume changes when identifying the crash modification factors. This will increase the reliability of the CMF and increase the likelihood of achieving the same change in crash frequency if the treatment is implemented elsewhere.

Crash Modification Factors can therefore play a vital role as an important tool to enable practitioners in WYDOT to estimate the safety effects of various countermeasures (e.g. installing guard-rails, rumble strips, widening shoulders, variable speed limit during inclement weather, etc.), identify the most cost-effective strategies to reduce the number of crashes (or severe crashes) at problematic locations, and check the validity of assumptions in cost-benefit analyses.

First phase of this study (year 1) will identify, collect Wyoming data, and calibrate Crash Modification Factors/ Functions for selected countermeasures in interest for the state, second phase (year 2) will compare the calibrated Wyoming-Specific CMFs to those calibrated in the HSM, provide recommendations for CMFs application in Wyoming, and integrate with results from Parts B and C.

Expected Outcomes:

First phase of this study (year 1) will provide methodologies to calibrate Crash Modification Factors/ Functions for selected countermeasures in Wyoming , second phase (year 2) will extend the methodologies to include additional countermeasures, compare and validate with the HSM CMFs, and integrate the results with HSM Part-B and Part-C.

Relevance to Strategic Goals:
This project fits under the local and rural roadways safety area. The proposed project and its expected outcomes will help in better prioritizing safety countermeasures for different roadway facilities, crash types, and severity. The outcomes will aid in selecting the most cost-effective treatments to reduce crashes and/ or their severities.

Educational Benefits:
One graduate student will be involved in various tasks including; conducting review of literature, data collection, defining modeling framework and estimation methodology, prioritize different roadway facilities and calibrating SPFs for them, participating in documenting the results and writing scientific journal papers.

Work Plan:
In order to validate and apply CMFs to Wyoming, the following tasks are proposed (prioritization of the analysis group (e.g. roadway segments, intersections, interchanges, etc., type of treatment, and crash type(s)) will be defined by WYDOT):

Phase 1 (First Year):

1. Identify and collect Wyoming data for different locations where treatments have been adopted
2. Conduct a critical review of literature related to crash prediction models for the most important treatments in Wyoming.
3. Data Preparation
4. Exploratory Analysis
5. Proof of concept (conduct evaluations and calculate the CMFs for selected countermeasures).
6. Recommendations

Phase 2 (Second Year):

7. Compare the calibrated Wyoming based CMFs to those calculated for the same location type and treatment using the HSM procedure
8. Develop recommendations as to whether we can use the HSM Part D, or some applications/countermeasures need CMF re-calibration and validation and adjustments to use in Wyoming.
9. Provide an extension to the HSM based on WYDOT needs and Wyoming conditions.
10. Adjusted CMFs for additional set of countermeasures in Wyoming.
11. Integrate and coordinate with the results of Parts B and C in Wyoming.

Project Cost:
The first set of tasks described in this project will be performed in one year

Budget for first year:

MPC Funds Requested: $ 54,957
Matching Funds: $55,141 Source of Matching Funds: Wyoming DOT
Total Project Costs: $110,098

TRB Keywords:
Highway Safety Manual, Crash Modification Factors, Rural Roadways Safety, Empirical Bayes.

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