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Final Report

Development of Case Studies, Numerical Exercises, and Instructional Modules for Teaching Roadway Safety Analysis

(Project # 2015-004)

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U.S. DOT DISCLAIMER

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ABSTRACT

This study developed three instructional modules using data from several safety projects conducted at University of Florida. Module 1 is focused on qualitative aspects of rural road safety assessment and countermeasure selection. Module 2 is focused on performing benefit-cost analyses for safety projects. Module 3 is focused on calibration of HSM equations. Each module contains power point presentations and supplemental material in the form of spreadsheets and word documents (available along with this report). This report itself is envisioned as an instructional guide for the use of the material provided in the modules. The availability of such processed real world data will enable students to perform a variety of calculations/analysis to learn the application of safety analysis methods. The products of this study would directly complement the existing textual descriptions of methods already available.

EXECUTIVE SUMMARY

Over the last few years there has been continued increase in the emphasis of data-driven approaches for safety analysis of roadway projects. In this context, it is important to distinguish between urban- and rural- contexts as there are significant differences in the availability of data and other resources. Urban locations can benefit from the application of methods presented in the Highway Safety Manual (HSM) to the data generally available in the form of electronic databases. In contrast, roadway safety audits with quantitative- and qualitative- data collection may be more appropriate for addressing safety issues in rural locations.

As such methods become more widely adopted in practice, there is also a need to train the next-generation of transportation engineers in the effective use of these methods. To be sure, The Federal Highway Administration has developed such training material for HSM (NCHRP Report 715[1], National Highway Institute Course NHI-380106[2], and the Webinar Series[3]) and guidelines for performing roadway safety audits[4]. However, these are largely textual information with selected numerical illustrations. The availability of processed real world data which will enable students to perform a variety of calculations/analysis to learn the application of these methods would be very valuable as it would directly complement the existing textual descriptions of methods already available.

Researchers from University of Florida have undertaken several research projects over the last few years on the safety assessment of roadway projects. In these efforts, they have employed both HSM methods as well as safety audits and Benefit/Cost (B/C) analyses. All these efforts have resulted in the assembly of extensive data (multiple years and spanning the entire state across all facilities) and case studies on performing B/C analysis on rural safety projects.

This study developed three instructional modules. Module 1 is focused on qualitative aspects of rural road safety assessment and countermeasure selection. Module 2 is focused on performing benefit-cost analyses for safety projects. Module 3 is focused on calibration of HSM equations. Each module contains power point presentations and supplemental material in the form of spreadsheets and word documents and these are available along with this report. This report itself is envisioned as an instructional guide for the use of the material provided in the modules.

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[1] http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_715.pdf
[2] http://www.highwaysafetymanual.org/Pages/Training.aspx
[3] http://www.highwaysafetymanual.org/Pages/FHWAResourceCenterHSMWebinarSeries.aspx
[4] http://safety.fhwa.dot.gov/rsa/guidelines/documents/fhwa_sa_06_06.pdf

Chapter 1. INTRODUCTION

Over the last few years there has been continued increase in the emphasis of data-driven approaches for safety analysis of roadway projects. In this context, it is important to distinguish between urban- and rural- contexts as there are significant differences in the availability of data and other resources. Urban locations can benefit from the application of methods presented in the Highway Safety Manual (HSM) to the data generally available in the form of electronic databases. In contrast, roadway safety audits with quantitative- and qualitative- data collection may be more appropriate for addressing safety issues in rural locations.

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In the light of the above discussion, the intent of this technology transfer exercise is to develop case studies, numerical exercises, and instructional modules for teaching roadway safety analysis. The researchers will draw data and case studies form several recently completed projects and package them for instructional purposes.

Chapter 2 provides an overview of module 1 focused on qualitative aspects of rural road safety assessment and countermeasure selection. Chapter 3 provides an overview of module 2 focused on performing benefit-cost analyses for safety projects. Chapter 4 provides an overview of module 3 focused on calibration of HSM equations. Each module contains power point presentations and supplemental material in the form of spreadsheets and word documents and these are available along with this report. This report itself is envisioned as an instructional guide for the use of the material provided in the modules.

[5] http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_715.pdf
[6] http://www.highwaysafetymanual.org/Pages/Training.aspx
[7] http://www.highwaysafetymanual.org/Pages/FHWAResourceCenterHSMWebinarSeries.aspx
[8] http://safety.fhwa.dot.gov/rsa/guidelines/documents/fhwa_sa_06_06.pdf

Chapter 2. Rural Road Safety Assessment and Counter Measure Identification

Module 1 is focused on qualitative aspects of rural road safety assessment and countermeasure identification. The instructor would start with a lecture (1_Rural Traffic Safety & RSA.ppt) to discuss the importance of the rural road safety issue, the types of crashes (or safety problems) in rural areas and the most popular (low cost) countermeasures available as treatments for both roadway segments and intersections. The concept of a "Road Safety Audit" is then introduced and examples are provided from the literature (See also 2_RSA_examples.docx).

Once the students are familiar with the broad concepts, the instructor moves on to the tutorial using the slide deck "3_Site Screening and Countermeasures Discussion". There are two case studies included in this tutorial.

The first case study is the Rogers road curves (from Union County, FL). The slide deck provides broad statistics to establish this location to be a particularly hazardous one in the county. The instructor provides the students the document "4_Rogers Crash Reports.docx" which provides an overview of the characteristics of crashes on this location and also the crash reports (collision diagrams and narratives) for the major crashes on this location. The students are encouraged to discuss and identify the safety issues at this location based on the nature of the crashes from the crash reports and the images provided in the slide deck. Subsequently the students are asked to discuss and identify potential counter measures to address the safety problems identified.

The second case study is the intersection of CR241 and CR 18 (from Union County, FL). The slide deck provides broad statistics to establish this location to be a particularly hazardous one in the county. The instructor provides the students the document "5_CR241 CR18 Crash Reports.docx" which provides an overview of the characteristics of crashes at this intersection and also the crash reports (collision diagrams and narratives) for the major crashes on this location. The students are encouraged to discuss and identify the safety issues at this location based on the nature of the crashes from the crash reports and the images provided in the slide deck. Subsequently the students are asked to discuss and identify potential counter measures to address the safety problems identified.

Chapter 3. Benefit Cost Analysis

Module 2 is focused on quantitative aspects of rural road safety assessment. In particular the focus is on performing a benefit-cost analysis for an improvement project once a potential set of countermeasures have been identified. The instructor would start with a lecture (1_BC Analysis.ppt) to discuss how (1) benefits a project are calculated based on expected reduction in crashes (determined from CMFs or CRFs) and monetized over the length of the project life and (2) the costs of the project are calculated using item unit prices and contingencies. Recognizing that there is much variability in the CMFs/CRFs that can be used for benefits assessment, the students are also introduced to the state (Florida) and federal guidebooks on benefits assessment (see 2_Florida CRF and 3_FHWA CRF). The slide deck also provides rates used in Florida to monetize the benefits of crashes. The instructor steps through a sample calculation provided in the slide deck to reinforce the theoretical concepts.

Once the students are familiar with the broad concepts, the instructor moves on to the tutorial using the document “4_BC Tutorial”. There are two case studies included in this tutorial corresponding to the same two locations used in Module 1. For each case, the site conditions, crash history, the set of countermeasures proposed, and other assumptions to be made are clearly defined. The students use the spreadsheet provided (5_BC Tutorial Empty) for the analysis. This spreadsheet workbook includes the Florida’s unit cost of items for easy look ups. The CMFs are determined from document “2_Florida CRF”. The module also includes a completed spreadsheet with the results of the BC analysis for use by the instructor (6_BC Tutorial Solution)

Chapter 4. HSM Calibration

The third module provides students spreadsheets that can be used to understand the calibration of HSM equations. The instructor would start with a lecture (1_HSM Calibration) that begins with a description of the major components of the equations used in Part C of the HSM. Since there is a vast amount of instructional material on the basic HSM principles, these are not included here. It is expected that the students have an overview of the HSM's objectives and organization prior to taking this module. The instructor is also pointed to other online material[9] (also funded by STRIDE) which provides an interactive way to understand HSM equations for roadway segments and intersections. The lecture slides then describe the need for calibration and provide an overview of the calibration procedure. The slides end by providing the results of the Florida's calibration efforts.

Once the students are familiar with the theory on calibration, the instructor can use the spreadsheet "2_intersection" for numerical exercises. This workbook has two sheets. The first sheet "summary" has the predicted and observed crashes (by year and by severity levels) for several intersections (in addition to the intersection identifiers). The students can quickly calculate the calibration factors for all crashes and KABC crashes and for each year or a combination of years. The second sheet "Raw data" has the details for the calculation of the predicted crashes. The intersections in this sheet are urban 4-leg signalized and so the corresponding equations from the manual are applied here. Other online material[10] also provide these equations in detail and list the step-by-step applications of these equations.

The second spreadsheet "3_segments" provide a second set of data (significantly more than that for intersections) for numerical exercises. This workbook also two sheets. The first sheet "summary" has the predicted and observed KABC crashes (by year and by severity levels) for several segments (in addition to the segment identifiers). The students can quickly calculate the calibration factors for KABC crashes and for each year or a combination of years. Further the segment data are available for all districts in Florida. So the students are encouraged to calculate the calibration factors separately for each district to examine spatial variabilities. The second sheet "Raw data" has the details for the calculation of the predicted crashes. The segments in this sheet are rural 2-lane undivided and so the corresponding equations from the manual are applied here. Other online material[11] also provide these equations in detail and list the step-by-step applications of these equations.

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[9] **https://s4.geoplan.ufl.edu/analytics-stride/**
[10] **https://s4.geoplan.ufl.edu/analytics-stride/Docs/UserManual_V1.pdf (pp 27-38)**
[11] **https://s4.geoplan.ufl.edu/analytics-stride/Docs/UserManual_V1.pdf (pp 12-26)**