Research Product Transfer for Local Calibration Factors of the Highway Safety Manual (HSM) and Integrated Surrogate Safety Assessment Framework

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MID-ATLANTIC UNIVERSITIES TRANSPORTATION CENTER

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Final Report

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16. Abstract

This technology transfer workshop presented transportation planners in the public and private sectors with two successful and closely related studies, conducted respectively by Morgan State University and the University of Virginia. The first module of the workshop is based on the two studies recently completed by a team of researchers at Morgan State University. The Maryland State Highway Administration (SHA) funded the studies. The first study developed local calibration factors for the State of Maryland by adjusting the predicted crash frequencies on state-maintained roadway facilities using the predictive methods of the first edition of the Highway Safety Manual (HSM) (Association of American State Highway Transportation Officials, 2010). While the HSM is the first comprehensive and systematic approach to transportation research, prototype models must be readjusted for each state in order to account for, to name a few, different traffic characteristics, roadway geometrics, socio-economic characteristics, weather, and geology specific to a study region. The factor for adjusting predicted crash frequencies is called the local calibration factor (LCF). The second study assessed the safety conditions of base and future traffic scenarios for an interchange on I-495. This study used the new chapters of the HSM for Interstate highways.

The second module presented the surrogate safety assessment model (SSAM) in assessing safety conducted by researchers at the University of Virginia. The SSAM can be applied to conditions such as when historical crash data are not available or new technology is under consideration.

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DISCLAIMER

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INTRODUCTION: BACKGROUND

Improving safety for road users is one of the most important goals of transportation agencies in the United States. Various safety plans and policies have partly contributed to a reduction in fatalities and injuries from vehicle crashes. More strategies, planning, and policy efforts should be implemented to continue this downward trend. Implementing the latest study findings and procedures in real-world planning would help government agencies systematically assess roadway safety and prescribe appropriate countermeasures.

This technology transfer workshop presented transportation planners in the public and private sectors with two successful and closely related studies, conducted respectively by Morgan State University and the University of Virginia. The first module of the workshop is based on the two studies recently completed by a team of researchers at Morgan State University. The Maryland State Highway Administration (SHA) funded the studies. The first study developed local calibration factors for the State of Maryland by adjusting the predicted crash frequencies on state-maintained roadway facilities using the predictive methods of the first edition of the Highway Safety Manual (HSM) (Association of American State Highway Transportation Officials, 2010). While the HSM is the first comprehensive and systematic approach to transportation research, prototype models must be readjusted for each state in order to account for, to name a few, different traffic characteristics, roadway geometrics, socio-economic characteristics, weather, and geology specific to a study region. The factor for adjusting predicted crash frequencies is called the local calibration factor (LCF). The second study assessed the safety conditions of base and future traffic scenarios for an interchange on I-495. This study used the new chapters of the HSM for Interstate highways.

The second module presented the surrogate safety assessment model (SSAM) in assessing safety conducted by researchers at the University of Virginia. The SSAM can be applied to conditions such as when historical crash data are not available or new technology is under consideration.

Goals and Objectives

While the HSM provides a very detailed guidance and example, a real-world application is more complicated than what is described in the manual. In addition, the surrogate safety assessment model (SSAM) was developed to assess safety in untried conditions, and recent research enhanced the SSAM by integrating a vehicle dynamics model and lane change aggressiveness. The goal of this workshop is to provide the participants with a Local Calibration Factor development process as well as an SSAM application. The objectives of this workshop are to:

- Review the HSM predictive method analysis process;
- Discuss data collection and related issues;
- Provide examples of complementary data collection methods;
- Explain the local calibration factor development process and implications; and,
- Provide the significance of surrogate safety measures;
- Teach how to use the SSAM tool and explain its limitations;
- Discuss the need for the proposed approach and explain how it works;
- Conduct a case study comparing the proposed and traditional approaches;
- Develop a tool implementing the proposed approach for practical use.

MODULE DESCRIPTION

Module 1 - HSM Application for the State of Maryland: LCF and Beyond

The HSM is a culmination of decades-long efforts to provide a technical approach that is based on a system analysis frame. The HSM provides tools to facilitate roadway safety planning, design, operations, and maintenance decisions based on explicit consideration of their safety consequences. Once a data set is prepared for the HSM, it is expected that, ultimately, the HSM approach will help government agencies utilize limited resources more efficiently by quantifying and prioritizing the potential safety effects of government actions.

To apply the HSM predictive methodology to the study area, one more step should be taken: the calibration of local calibration factors (LCFs). The crash prediction models of the HSM were developed using data from a number of similar facilities in the states of Washington and California. Due to multiple factors that may vary across the country, such as climate, population, traffic, crash reporting systems, and others, the estimated crashes from the HSM models cannot be directly applied to local agencies. To be effective, LCFs for roadway segments and intersections with various roadway geometry configurations should be developed. This process involves laborious tasks of data collection, generation, and compilation, which include historical data on crashes, traffic volume, roadway characteristics data, and land use data, as well as necessary procedures such as site selection, model estimation, and calibration.

The HSM and any statistical crash models have been widely used in assessing safety for existing transportation networks. This is because one can develop the relationship between actual crash data and covariates including vehicular volume, speed, speed variance, etc. For example, a statistical approach develops a regression type model estimating crash frequency based on the AADT and speed variables. However, these tools are not applicable for the untried and/or new

strategies (i.e., no historical crashes are available). Surrogate safety measures were proposed to assess safety based on "conflicts" even from microscopic traffic simulation tools.

The module consisted of three lessons: (1) LCF Development of Maryland, (2) Project Prioritization using HSM: A Case Study, and (3) Barriers and Alternatives of HSM Application. The instructors of this module were Dr. Hyeon-Shic Shin, Dr. Young-Jae Lee, and Mr. Seyedehsan Dadvar of Morgan State University. Short bios are available in APPENDIX A. The lecture slides are available in APPENDIX C.

Module Objectives

- To understand the overall objectives and structure of the HSM;
- To learn predictive method and data preparation process;
- To interpret LCFs;
- To understand the application of the HSM for project prioritization; and
- To discuss the challenges of employing the HSM method and suggestions.

Module 2 - Integrated Surrogate Safety Assessment Model

The module discussed an application of a surrogate safety assessment model that can be used in conditions such as when historical crash data are not available or new technology is under consideration. It will cover an overview of the Surrogate Safety Assessment Model (SSAM), a hands-on application of the SSAM and enhanced SSAM framework and applications.

Many studies have used the surrogate safety assessment model (SSAM) in assessing safety as it complements the HSM and statistical models for untried conditions. It should be noted that this approach could be extremely useful if there are so few crashes that the statistical approach cannot provide significant difference in crash frequencies/rates. However, one of limitations in the SSAM approach is that the microscopic traffic simulator model does not

explicitly consider later movements within the lane during the lane change and the aggressiveness in the lane change durations. A recent FHWA-funded Exploratory Advanced Research project developed an enhanced integrated safety assessment framework that overcame such limitations. A validation study with actual crashes showed statistically better performance than that of the traditional approach. This workshop will highlight the general overview of the traditional SSAM model, the enhanced approach and its validation, and a tool implementing the proposed approach.

Three lessons constituted the module: (1) Introduction of the SSAM, (2) Hands-on Application of the SSAM, and (3) Integrated SSAM – Framework and Applications. Dr. Byungkyu "Brian" Park of the University of Virginia gave a lecture for this module. A short bio is available in APPENDIX A. The lecture slides are available in APPENDIX D.

Module Objectives

To understand a need for surrogate safety measures;

To learn how to apply the safety assessment model; and

To understand surrogate measures is valid alternative in assessing safety.

TECHNOLOGY TRANSFER WORKSHOP PLANNING

The first step was to develop an agenda tailored for the target audience. The targeted participants include, but are not limited to, traffic engineers and managers from state DOTs in Virginia and Maryland as well as consulting firms dealing with highway safety. Therefore, the workshop contents should be revised for practitioners. The study processes, findings, and results were gathered into a lecture format consisting of modules and lessons. After a series of discussions and revisions, the final agenda was developed. The final agenda is presented in Table 1.

The University of Virginia helped to secure a workshop location at the National Highway Institute. The advertisement was emailed to the public and private sectors and also posted on the NHI web site (APPENDIX B). Using the advertisement to recruit participants continued for about three months.

Table 1. Technology Transfer Workshop Agenda

9:00 - Noon	***Module 1***	***Highway Safety Manual (HSM) Application for the State of Maryland: Local Calibration Factor (LCF) and Beyond***
9:00 - 10:30 AM	Lesson 1	Introduction of the HSM and LCF Development for Maryland
10:30 - 11:15 AM	Lesson 2	Improvement Prioritization using HSM: A Case Study of Three I-495 Interchanges
11:15 - Noon	Lesson 3	Barriers and Alternatives of Safety Analysis
Noon - 12:30 PM		*Lunch*
12:30 - 4:15 PM	***Module 2***	***Integrated Surrogate Safety Assessment Model***
12:30 - 2:15 PM	Lesson 1	Introduction of the Surrogate Safety Assessment Model (SSAM)
2:15 - 3:15 PM	Lesson 2	Hands-on Application of the SSAM
3:15 - 4:15 PM	Lesson 3	Integrated Surrogate Safety Assessment Model - Framework and Applications

WORKSHOP ASSESSMENT

A total of 18 individuals attended the workshop. Attendees by affiliation type is shown in Table 2. Considering the three-month advertisement efforts, the number of participants was lower than expected. However, the participants came from diverse sectors. The largest came from the state safety engineers, a total of 13 attendees – eight from the Virginia Department of Transportation and five from the Maryland State Highway Administration. Three private-sector practitioners, each from three consulting firms, attended. The City of Falls Church, VA, sent one planner. Finally, a researcher from the University of Maryland-College Park attended the workshop.

The day-long workshop was very well accepted. All participants and instructors engaged in lively questions and answers. Also, many constructive suggestions were provided to the instructors.

Table 2. Attendees by Affiliation

Affiliation	Number of Attendees
Maryland State Highway Administration	5
Virginia Department of Transportation	8
City of Falls Church, VA	1
University of Maryland-College Park	1
Consulting Firms	3
Total	18

SUMMARY

The workshop was a success. The attendees shared their experience, and their concerns boiled down to data availability. While the systematic approach of the HSM would help practitioners conduct safety analyses quickly, some variables collected by states were not compatible to the HSM requirements; therefore, they should be manipulated to make them compatible formats. Another salient concern was that some variables are not collected. While the HSM would lead states to collect variables compatible to the manual, the data integration and collection seem to need more time.

The SSAM also received lots of interests from the attendees. Since the model helps approximate safety effects under the existence of missing historical variables, lots of time and resources would be saved by applying the model. Some participants suggested that integrating the HSM and SSAM would generate an improved safety analysis procedure.

Despite the success, there are several limitations that need to be addressed for similar types of technology transfer workshops. First, since the workshop targeted two states, it was difficult to find out a workshop venue located in the middle to minimize travel distances for participants. Second, although various advertisement methods – emails, personal contacts, and the NHI web site – were used, the number of participants was smaller than we expected. These two limitations suggest that instead of targeting a large geographic area, offering the workshop focusing on a smaller geographic area – one each for Maryland and Virginia – would help increase the number of participants. Another suggestion is conducting workshops online – webinars. However, one of the limitations of webinars is that the level of active discussions at webinars seems to be lower than face-to-face workshops, although webinars can be offered without the limitation of physical distance.

APPENDIX A. SHORT BIOS OF THE INSTRUCTORS

Hyeon-Shic Shin, Ph.D.

Dr. Hyeon-Shic Shin is an assistant professor in the City and Regional Planning Program at Morgan State University. His research interests include safety, transportation economics, and urban freight delivery network management. He has conducted several SHA projects on safety, including *Local Calibration of Highway Safety Manual for the State of Maryland* and *Safety Analysis for Three I-495 Interchanges.* He has extensive knowledge of various aspects of vehicle, bike, and pedestrian safety. He received his Ph.D. in Public Policy Analysis with a specialization in Urban Transportation Planning.

Young-Jae Lee, Ph.D.

Dr. Young-Jae Lee is an associate professor in the Department of Transportation and Urban Infrastructure Studies at Morgan State University. His research interests include urban and public transportation systems and safety. Dr. Lee is considered a transit and urban transportation expert in academia and the transit industry. He has conducted projects for SHA, including the recent *Local Calibration of Highway Safety Manual for the State of Maryland*. Also, he has conducted many ITS and CVI projects. He received his Ph.D. in Transportation Systems from the University of Pennsylvania, and he wrote his dissertation on transit network design and analysis.

Seyedehsan Dadvar, Ph.D. Student

Mr. Seyedehsan Dadvar is a Ph.D. student in the Department of Transportation and Urban Infrastructure Studies at Morgan State University. He has played critical roles in the two HSM-based studies conducted by the Morgan State University team, including data collection,

manipulation, IHSDM analysis, statistical analysis, and report writing. He is also experienced at conducting driver preference research using conjoint analysis.

Byungkyu "Brian" Park, Ph.D.

Dr. Byungkyu "Brian" Park is an Associate Professor of Civil and Environmental Engineering at the University of Virginia. Dr. Park has taught a class on highway safety and conducted workshops on the Highway Safety Manual. In addition, he has conducted research in safety, especially in the surrogate safety assessment and crash trigger factors. Dr. Park served as a member of the TRB Statistical Methods committee, and is a current member of the Vehicle-Highway Automation and Artificial Intelligence and Advanced Computing Applications committees. Dr. Park has published over 100 journal and conference papers in the areas of transportation systems operation and management, transportation safety, and intelligent transportation systems. His research interests include cyber-physical systems for transportation, stochastic optimization, microscopic simulation model applications, and transportation system sustainability.

APPENDIX B. ADVERTISEMENT - A COPY OF THE NHI WEB SITE

Workshop Name

HSM Calibration Factors and Surrogate Safety Assessment

Workshop Start

12/03/2014

Location

FHWA - National Highway Institute
1310 North Courthouse Road Suite 300
Arlington VA 22201

Description

Free for anyone who registers!

Search

9:00 – 10:30 AM Introduction of the HSM and LCF development for Maryland
10:30 – 11:15 AM Improvement Prioritization using HSM: a case study of three I-495 interchanges
11:15 – Noon Barriers and Alternatives of Safety analysis
12:30 – 2:15 pm Introduction of Surrogate Safety Assessment Model (SSAM)
2:15 – 3:15 pm Hands-on application of SSAM
3:15 – 4:15 pm Integrated Surrogate Safety Assessment Model – Framework and Applications

Module 1 – Highway Safety Manual (HSM) Application for the State of Maryland: Local Calibration Factors (LCF) and beyond The first half of the today's workshop will discuss the Morgan State University research team's experience with two studies employing the Highway Safety Manual (HSM). This part of the workshop consists of three sections. First, a brief introduction of HSM, data collection and the development of local calibration factors (LCFs) for Maryland are discussed. Then the safety analysis for identifying priority improvement locations on I-495 interchanges is presented. This part of the analysis was carried out based on the proposed new HSM chapters for Interstate highways. Lastly, the speakers will discuss barriers that practitioners and researchers should overcome to get the most out of HSM and also talk about several alternative directions for safety analysis.

This module will be presented by Dr. Hyeon-Shic Shin, Dr. Young-Jae Lee, and Mr. Seyedehsan Dadvar of Morgan State University

Module 2 – Integrated Surrogate Safety Assessment Model
The second half of this workshop will discuss an application of a surrogate safety assessment model that can be used in such conditions where historical crash data are not available or new technology is under consideration. It will cover an overview of the Surrogate Safety Assessment Model, a hands-on application of SSAM and an enhanced SSAM framework and applications. At the end of the second half of the workshop, participants should understand the value of utilizing SSAM while understanding its

limitations.

This module will be presented by Dr. Brian Park of the University of Virginia.

Expected Outcome
Upon completion of the workshop, the participants will understand the development, limitations, and alternatives for Highway Safety Manual local calibration factors and a real world Surrogate Safety Assessment Model application.

Participants must bring a laptop with Microsoft Excel already installed.

Instructor

Hyeon-Shic Shin, Ph.D.
Dr. Hyeon-Shic Shin is Acting Director of the National Transportation Center and an assistant professor in the City and Regional Planning Program at Morgan State University. His research interests include safety, transportation economics, and urban freight delivery network management. He has conducted several SHA projects on safety, including Local Calibration of Highway Safety Manual for the State of Maryland and Safety Analysis for Three I-495 Interchanges. He has extensive knowledge of various aspects of vehicle, bike and pedestrian safety. He received his Ph.D. in Public Policy Analysis with a specialization in Urban Transportation Planning.

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Dr. Young-Jae Lee is an associate professor in the Department of Transportation and Urban Infrastructure Studies at Morgan State University. His research interests include urban and public transportation systems and safety. Dr. Lee is considered a transit and urban transportation expert in academia and in the transit industry. He has conducted projects for SHA, including the recent Local Calibration of Highway Safety Manual for the State of Maryland. Also, he has conducted many ITS and CVI projects. He received his Ph.D. in Transportation Systems from the University of Pennsylvania, and he wrote his dissertation on transit network design and analysis. He is currently a member of TRB Automated Transit Systems committee and associate editor of Korea Society of Civil Engineering Journal of Transportation Engineering.

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Who Should Attend

The targeted participants include, but are not limited to, traffic engineers and managers from State DOTs in Virginia, Maryland, Pennsylvania and Delaware as well as consulting firms dealing with highway safety.

Registration and Payment

The following registration fees cover the session, all course materials and meals:

Local Government: Free
State/Federal: Free
Private Industry: Free

Click here for UVA TTA's general registration information, cancellation policy, and refund policy. UVA TTA accepts the following credit cards: American Express, VISA, MasterCard, and Discover. Credit card information cannot be taken over the phone. Alternatively, after registering you can print out a voucher to send in with your payment. After you have completed the transaction you will receive an automatically generated email confirming registration and payment if applicable. Final confirmation and instructions will be sent out during the week prior to the class date.

Don't have access to a computer?

Click here

to get a paper registration form (PDF). Print it out, complete it, and email, mail or FAX it to our office following the instructions on the form. Include your check or government purchase order with your registration form. Please note that emailed or faxed-in registration forms will be considered as a "provisional booking" until payment is received. For more information, call our office at (434) 982-2897, fax at (434) 982-2856 or email uva-tta@virginia.edu

Special Registration Instructions for Employees of the Virginia Department of Transportation

VDOT employees must register through the VDOT Virtual Campus. Registration fees and related expenses for all VDOT employees will be paid from the VDOT Learning Services Center budget. Registrants should contact their District Training Coordinator or the VDOT Learning Services Center (Central Office employees) for instructions on how to seek reimbursement for travel expenses.

Due to current travel restrictions, VDOT employees are strongly encouraged to attend U. Va. TTA workshops on a day trip basis. Overnight travel requires permission from your District Administrator or Chief -- and in some cases higher levels of authority. If you require overnight lodging to attend a U. Va. TTA workshop, consult with your supervisor, District Training Coordinator, or VDOT Learning Services Center on travel approval procedures.

APPENDIX C. MODULE 1 LECTURE SLIDES

Note: Double click the slide to open the presentation.

APPLICATION OF HIGHWAY SAFETY MANUAL IN MARYLAND

DECEMBER 3, 2014

APPENDIX D. MODULE 2 LECTURE SLIDES

Note: Double click the slide to open the presentation.

Application of Surrogate Safety Assessment Model

Byungkyu Brian Park, Ph.D.
University of Virginia

CTS TTA Workshop on December 3, 2014