SUMMARY REPORT

Highway Safety Manual
Lead State Third Peer Exchange
Nashville, Tennessee

NCHRP Research Project Statement 17-50
Lead States Initiative for Implementing the Highway Safety Manual

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ch2m

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Disclaimer

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Appendixes

Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
AADT	average annual daily traffic
ARAN	automatic road analyzer
ARTS	all roads transportation safety
BC	Benefit/Cost
Caltrans	California Department of Transportation
CARE	Critical Analysis Reporting Environment
CDIP	Crash Data Improvement Program
CMF	crash modification factor
CRF	crash reduction factor
CURE	cumulative residual
DDSA	data driven safety analysis
DOT	Department of Transportation
EB	Empirical Bayes
EDC3	Every Day Counts – third round
FAQ	Frequently Asked Questions
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
GIS	geographic information system
HCM	*Highway Capacity Manual*
HSIP	Highway Safety Improvement Program
I	Interstate
IDOT	Illinois Department of Transportation
IRI	International roughness index
ISATe	Enhanced Interchange Safety Analysis Tool
IHSDM	Interactive Highway Safety Design Model
KDOT	Kentucky Department of Transportation
LADOTD	Louisiana Department of Transportation and Development
LCF	local calibration factor
LiDAR	light detection and ranging
LRS	linear referencing system

MAP-21	Moving Ahead for Progress in the 21st Century Act
MassDOT	Massachusetts Department of Transportation
MDOT	Michigan Department of Transportation
MIRE	Model Inventory of Roadway Elements
MnDOT	Minnesota Department of Transportation
MoDOT	Missouri Department of Transportation
MPO	metropolitan planning organization
NB	negative binomial
NCHRP	National Cooperative Highway Research Program
NDOT	Nevada Department of Transportation
NHDOT	New Hampshire Department of Transportation
NHI	National Highway Institute
NHS	national highway system
NHTSA	National Highway Traffic Safety Administration
NJDOT	New Jersey Department of Transportation
ODOT	Ohio Department of Transportation
PDO	property damage only
PennDOT	Pennsylvania Department of Transportation
PSI	potential for safety improvement
RHR	roadside hazard rating
RSA	roadway safety audit
RSA	Road Safety Audit
RSDP	Roadway Safety Data Program
SA	Safety Analyst
SHSP	Strategic Highway Safety Plan
SPF	safety performance function
SR	State Road
SRI	Safer Road Index
TB	terabytes
TRB	Transportation Research Board
TRCC	Traffic Record Coordinating Committee
TRIMS	Tennessee Roadway Information System

UDOT	Utah Department of Transportation
usRAP	U.S. Road Assessment Program
VDOT	Virginia Department of Transportation
WSDOT	Washington Department of Transportation

Executive Summary

This report summarizes the presentations and discussions for the *Highway Safety Manual* (HSM) Lead State Third Peer Exchange held through the National Cooperative Highway Research Program (NCHRP) 17-50, *Lead State Initiative for Implementing the Highway Safety Manual* Project. The meeting was held in conjunction with the Transportation Research Board (TRB) Highway Safety Performance Committee, ANB25. Attendees included representatives from the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), state departments of transportation (DOTs), academia, and the private sector. The format of the workshop provided opportunities to share challenges and best practices. Topics generally were introduced by brief presentations and followed by facilitated discussion. The presentations were provided in electronic format at the peer exchange and are posted on the NCHRP 17-50 Project SharePoint Site along with other shared resources.

Objective

The objectives of the NCHRP 17-50 Project are (1) to help with the widespread effective implementation of the HSM across the country through monitoring progress, (2) provide technical assistance, and organize and facilitate two peer exchanges, and (3) develop an HSM User Guide based on the experiences and examples of the lead states. The User Guide will be utilized to assist highway agencies in implementing the HSM.

Introduction

The HSM has the potential to bring about major changes in the accuracy and completeness of safety analyses conducted by highway agencies. However, as with any new analysis tool, the HSM will be effective only if it is implemented by the state agencies. Recent experience has shown that one of the best approaches to encourage states to implement new methods is to share experiences and best practices. Lead state initiatives and peer exchanges are becoming an increasingly common approach to spread new information that is ready for implementation by highway agencies. As such, a Safety Performance Function National Summit was held in Chicago, Illinois, in July 2009 (http://ict.illinois.edu/conferences/spfsummit09/index.htm), and an HSM Lead State Peer Exchange was held in Schaumburg, Illinois, in November 2010 (http://ict.illinois.edu/conferences/hsmworkshop2010/).

As part of the NCHRP 17-50 Project, four peer exchanges were planned to bring together representatives from 13 states that are leading the way on HSM implementation. These states benefit directly from the peer exchange and will provide information and examples to other highway agencies.

The first NCHRP 17-50 peer exchange took place on August 10 and 11, 2011, in Irvine, California. The second peer exchange took place on August 27 through 29, 2012, in Baltimore, Maryland. The third one took place on August 31 through September 01, in Nashville, Tennessee. The agenda for the third peer exchange is provided in Appendix A. These 2-day workshops provided an informal setting in which state representatives and other invited guests shared their HSM implementation experiences, including best practices, successes, and lessons learned. The workshop format supported networking and information sharing between peers. This was accomplished through states' 10- to 15-minute presentations, followed by facilitated discussions. The topics focused on state implementation status, capacity building, HSM calibration, data, HSM implementation best practices, policy, case studies, and resources and support. This report summarizes the proceedings from the NCHRP 17-50 HSM Lead States Third Peer Exchange and the evaluation comments received from the participants. A list of attendees is provided in

Appendix B. A summary of the Lead State Attendee Survey is provided in Appendix C and references are listed in Appendix D.

*The **goal of the HSM Lead State Initiative** is to advance implementation of the HSM.*

*The **goal of this HSM Lead State Peer Exchange** is that each state learns at least one item that it can bring back to its agencies to advance HSM implementation.*

Meeting Proceedings

Day 1: Session 1 – National Efforts

AASHTO Overview: State Implementation Efforts, HSM Second Edition, Strategic Plan for Future Editions – Illinois Department of Transportation (IDOT)

Priscilla Tobias, AASHTO Task Group Chair

The AASHTO overview of HSM implementation status was made by Priscilla Tobias, state safety engineer for Illinois Department of Transportation (IDOT).

The HSM first edition created a major shift in how safety was considered in the management of transportation system. The areas that the HSM addressed include planning, design, operations and evaluation of the transportation system. Since the publication of the HSM, significant collaboration has occurred between AASHTO, TRB, and FHWA to advance the implementation of the HSM. It was a team effort, and all parties have been working to identify gaps and needs related to the HSM. Through all those efforts, a series of guidebooks, analysis tools, and procedures have been produced, and many research projects are ongoing.

A list of HSM-related research projects since the publication of the HSM, some of which have been completed already while the others are still ongoing, was provided. These research projects addressed technical issues with HSM Part A, Part C, Part D, human factors, crash predictive models, Crash Modification Factors (CMFs), etc. The history of the HSM implementation pooled-fund study as well as the purpose of the study were also mentioned in the AASHTO overview.

Several aspects of the HSM implementation at state level were discussed. Many states are now using the HSM. Since the publication of the HSM, most states have already had some type of HSM training for their users. Regarding safety performance function (SPF) development, different states are at varying stages. Many states have calibrated the HSM SPFs based on their jurisdiction-specific data. The CMFs in HSM Part D are also widely used. For example, IDOT has used the CMFs in Part D for the benefit/cost analysis. High quality data are critical for both the SPF development and SPF calibration; therefore, the state DOTs should identify the appropriate sources to obtain the needed data, or to collect it when such data are not available. Some states, for example, Illinois, have also developed the HSM User Guide to illustrate the step-by-step procedures for applying the HSM methodology in engineering practices. For policy, many states have required that consultants use the HSM for design exception analysis.

The second edition of the HSM was also discussed. The research project will be completed within 4 years. With the contract being executed in 2015, the HSM second edition is expected to be published in 2019. To ensure the high quality of the HSM second edition, a Steering Group, comprised of safety management representatives, roadway design engineers, and traffic engineers from AASHTO, was created to provide input for the HSM second edition and ensure that research work is proceeding in the right direction. The Steering Group acts as liaison between the project technical advisory panel and their various subcommittees, and it will be part of the AASHTO Task Group as well. New materials will be introduced in the HSM second edition, without creating any inconsistencies with the existing material.

FHWA Overview: Roadway Safety Data Program, HSM Implementation Pooled Fund, Every Day Counts (EDC3) Data Driven Safety Analysis Initiative – Federal Highway Administration

Ray Krammes and Jerry Roche

The FHWA overview covered the Roadway Safety Data Program (RSDP), the HSM implementation pooled-fund study, and the data driven safety analysis (DDSA) initiative.

The motivation for the RSDP is that improving safety data systems and analysis capabilities could help decision makers to achieve more informed decisions, which leads to better targeted safety investment and greater reductions in fatalities and serious injuries. Improving data and analysis capabilities is one of the strategies for FHWA to reach a new lower plateau in terms of fatalities and serious injuries.

FHWA implemented the RSDP through developing guidance, providing a variety of resources and tools, providing technical assistance, and helping develop and deliver training. In terms of guidance development, FHWA issued the Highway Safety Improvement Program (HSIP) guidance suite several years ago and the notice of proposed rulemaking for the Moving Ahead for Progress in the 21st Century Act (MAP-21) guidance on state safety data systems last year. Specifically, the subset of the model inventory roadway elements (MIRE) that FHWA proposed was based on the requirements for applying the SPFs and the HSM on all public roads. FHWA also has developed a list of resources, informational guides, and tools, both to improve the data systems for the HSM application and to directly support the implementation of the HSM. FHWA has created some targeted technical assistance programs as well as a variety of fairly general technical assistance programs. FHWA also has tried to assemble a suite of resources to be responsive to small or large requests from state DOTs. FHWA provides a wide suite of safety analysis, HSM and interactive highway safety design module (IHSDM) courses, either in person or web-based, through National Highway Institute (NHI) or the FHWA Resource Center. Based on feedback received over the years, the FHWA is planning to develop more basic courses to complement the courses that have been developed already.

The HSM implementation pooled-fund study is funded by the 16 participating states that pooled their assets together for the study, and the FHWA's role is to manage the funding and facilitate the studies to help these 16 states achieve their study goals. The objective of the study is to advance the implementation of the HSM, not in the leading states or the participating states only, but in all states. To tackle the early big issues for HSM implementation, a number of SPF-related projects have been funded and completed, and a nearly complete suite of resources on whether SPF should be calibrated or developed is available. In addition, several other projects are underway for the HSM implementation pooled-fund study.

The vision of the DDSA is to incorporate safety performance into all highway investment decisions. The benefits for DDSA include informed decision-making, optimizing investment, and improving safety. By quantifying the safety impacts associated with roadway planning and design, more informed decisions can be made by weighing safety with other project goals. By applying the most current analytical methods, agencies have powerful tools to optimize investments and the safety of all users. State, local, and tribal agencies can proactively apply safety countermeasures at roadway locations identified as having the highest potential for improvement, thereby effectively reducing fatalities and serious injuries. There are many opportunities for DDSA initiative, both for safety management and for project development. Solid progress has been made on safety management, but there is much to accomplish for project development. A variety of activities are underway, including a DDSA "How To" webinar series, videos, and training. FHWA is tracking the states' progress on HSM implementation through the EDC program. For both safety management and project development, six states have advanced to a higher implementation stage since the beginning of EDC this January. For project development, 28 states have requested DDSA assistance through the FHWA EDC program, resulting in 47 requests.

TRB Overview: Highway Safety Performance Committee (ANB25) – Washington Department of Transportation (Washington DOT)

Ida Van Schalkwyk

The TRB overview included the historical overview of the TRB ANB25 committee; its current structure; the importance of partnerships among TRB ANB25 committee, AASHTO and FHWA; current NCHRP problem statements; and how to get involved with TRB ANB25 committee.

The TRB ANB25 Committee deals with the advancement, integration, and institutionalization of quantitative highway safety information to support transportation decision-making at all levels. The function of the committee is to foster the continual development, validation, and increased knowledge of science-based methods, procedures, and measures that will increase the safety of the nation's highways and roadways. The committee is comprised of multiple subcommittees that serve different roles as a whole.

The history of the TRB ANB25 committee began in 1999, the year in which the idea of HSM originated. In 2001, the TRB Joint Subcommittee for the Development of a Highway Safety Manual was formed, followed by the formation of the TRB Task Force for the Development of a Highway Safety Manual in 2003. With the publication of the HSM first edition in 2010, the TRB Task Force became the Highway Safety Performance Committee (ANB25) in the same year.

The HSM first edition was the result of strong collaborative partnership among TRB ANB25 committee, AASHTO, and FHWA. Within this partnership, each partner has a specific role and respects the role of the other. Specifically, AASHTO oversees the policy-related fields and is the owner of the HSM, and the TRB ANB25 committee is in charge of all technical issues. FHWA's efforts are focused on providing support for the implementation of the HSM.

With the goal of having sound research in the HSM, the TRB ANB25 committee works very closely with AASHTO to identify high priority research needs to fill in gaps and move the HSM forward. Recent research problem statements identified and developed by the TRB ANB25 committee include estimating CMFs from surrogate safety measures, evaluation of severity SPF approaches, implementation and training materials for the HSM second edition, incorporating safety planning in the HSM, and pedestrian and bicycle SPFs for the HSM.

The TRB ANB25 committee encourages involvement in committee activities through different means. The focus of the committee is to move the science of safety forward, and the committee will continue its strong interaction with the user community.

Day 1: Session 2 – Data: Innovative Approaches for Obtaining and Managing Data for the HSM

Enterprise Data Collection and Management – Utah Department of Transportation (UDOT)

Scott Jones

Multiple groups within UDOT collected the data separately to support their own functions, which caused inconsistency among data from different sources. The UDOT's goal is to develop a database to allow all business systems to work together seamlessly. There should be no duplication or manipulating data in the database, and all data should be accessible through one portal. All the data should be updated as projects are completed.

To obtain the data for use in making safety, pavement, and roadway asset management decisions, the UDOT started the Utah Roadway Imaging/Inventory project. Data for 6,000 miles of roadway segments and 300 miles of ramps and collectors on state-maintained roads were collected. The data collection cost is being shared across multiple UDOT divisions, including the System Planning and Programming, Central Maintenance, and Central Traffic and Safety. The initial cost was $2 million to $2.5 million for each cycle, and the cost for ongoing data collection will be shared across multiple UDOT divisions.

Mobile light detection and ranging (LiDAR) was used for the data collection efforts because the device offered the level of precision required. Data were collected for roadway features including shoulder width, median width, horizontal and vertical geometric characteristics, and signs and traffic signals. Each cycle of collected data is 15 terabytes (TB) in size. UDOT created a data portal for disseminating the collected data both internally and to the public.

Several lessons were learned from the UDOT roadway inventory projects. First, the agency should ensure that it has the ability to store, distribute, analyze, and utilize the collected data before any real data collection efforts. Second, to ensure the success of the project, it is critical to build support from senior leadership. Third, the agency should prepare to work extensively with the vendor on activities such as selecting data items to delivering the data. Lastly, the agency should be prepared to address the fact that additional data users might be identified after the data collection is completed.

For data management, the UDOT is working on integrating all business systems using an Oracle platform. Oracle arranged a week-long session with each business unit to identify all data available from them. With this database, UDOT is able to understand the inventory for different assets. UDOT can also combine the roadway and roadside data with the crash data for safety analysis. For this reason, the project was funded through the HSIP funding.

The UDOT has used the collected data for multiple projects. One example is the U.S. Road Assessment Program (usRAP) Safer Roads Investment Plan project, which is based on data for approximate 40 safety-related roadway design and traffic control attributes. Outputs from the project include specific countermeasures to be implemented, specific implementation locations, quantitative cost estimates, quantitative safety benefits, cost-effectiveness measures, and benefit-cost ratio, which could be in the form of either tables, maps, or spreadsheets.

Advances in Comprehensive, Real-Time Crash Data – Tennessee Department of Transportation and Development (Tennessee DOT)

Brian Hurst

In 2007, the Tennessee Roadway Information System (TRIMS) housed all roadway inventory data. The Tennessee Department of Transportation (TDOT) created a 5-year, $12 million contract to inventory all roadways in Tennessee. Data including stopping sight distance, passing sight distance, and horizontal and vertical curve were collected.

The Tennessee's Project Safety Office was created in 2010. High quality data are needed for data-driven decision-making to save lives. However, the crash data were so outdated that TDOT was not able to determine the latest crash types or crash trends, such as distracted driving, lane-departure crashes, and fatal or serious injury crashes.

In 2011, TDOT hired a consultant to store local crash data. There were some challenges on obtaining current data, mainly because of delays in getting crash data reported and uploaded into the system.

TDOT made major improvements on data collection in 2012. The TRIMS contract was completed and all data, including the data for local roadway systems, were collected completely. TDOT partnered with the Tennessee Department of Safety and worked with the Kentucky Transportation Cabinet to learn their process on mandating of electronic reporting and real time data.

TDOT contracted a new consultant to store and maintain crash data in 2013. Based on the data, the Project Safety Office was able to identify data driven concerned areas on local routes. TDOT also partnered with the Tennessee Department of Safety through Tennessee Traffic Record Coordinating Committee (TRCC) and the Strategic Highway Safety Plan (SHSP) to draft a legislative bill mandating that "all crash report shall be completed and submitted electronically."

In 2014, the Project Safety Office conducted Roadway Safety Audits (RSA) on local routes based on the crash data. Under its partnership with the Tennessee Department of Safety, an official legislation bill was passed in 2014 that requires all crash data shall be submitted electronically after January 1, 2015.

With all these efforts, TDOT now owns real time crash data for all roads to support real time decision making. TDOT also created a new version of TRIMS (E-TRIMS, Enhanced) that enables users to access data anytime and anyplace.

Tennessee has made contact with the HSM lead states. Meanwhile, a HSM task force between TDOT and FHWA Tennessee Division has been created. TDOT also is working with two local universities on SPF calibration and development.

Non-Signalized Intersection Inventory for SPF Development, SPF Development and Tool Integration – Alabama Department of Transportation

Tim Barnett

The presentation began with some statistics on intersection crashes. According to the National Highway Traffic Safety Administration (NHTSA), of the 9,412,000 crashes in the U.S. in 2011, 47.6 percent were intersection or intersection-related crashes. Therefore, to improve the overall roadway safety, it is critical to achieve a deeper understanding of intersection characteristics by analyzing intersection inventory data. To identify the contributing factors for intersection crashes and further develop appropriate countermeasures, the correlation between intersection inventory parameters and the existing crash data needs to be investigated.

The intersection inventory was nonexistent in Alabama. The goal of the project is to collect geo-referenced roadway data associated with non-signalized intersections along state routes in Alabama. In this project, a data collection methodology and an online geographic information system (GIS) tool were developed, and a pilot study was conducted to obtain a statistical representation of the intersections. The level of effort for statewide implementation was also evaluated.

There are approximately 300,000 intersections in Alabama, with roughly 30,000 of these listed in the state system. This project will be focused on non-signalized intersections along state routes in Alabama; the signalized intersections are being handled in a separate project. Meanwhile, the study will be limited to three-leg and four-leg intersections. The GIS link-node linear reference system and remote sensing from existing aerial and street view imagery will be utilized.

Nine types of non-signalized intersections, both in rural and urban, were included in this study. For each category of intersection, 30 sites were randomly selected across the state for the data collection. Intersection inventory data were collected for 270 intersections. The definition of "rural" and "urban" areas is based on FHWA guidelines, which classify "urban" areas as place inside urban boundaries where the population is greater than 5,000 persons. The 270 intersections are evenly distributed for rural and urban, 135 intersections for rural and 135 intersections for urban.

A data collection methodology was developed for intersections. The intersection inventory data are classified into two levels, that is, the intersection-level and the leg-level. Meanwhile, a standardized leg numbering method was developed in this study. With this method, major roads will be numbered first, followed by numbering of the minor roads.

Many intersections are poorly aligned in the state of Alabama. In order to develop the SPF, for each intersection type, the intersection inventory data were collected for at least 30 intersections. Generally, it took about 20 minutes to collect all the information for one intersection. For the statewide data collection, the Alabama DOT is looking for a way to collect the intersection inventory data automatically so that the data collection efforts could be shortened.

Crash data from the critical analysis reporting environment (CARE) were used. Of the approximately 290,000 crashes that occurred from 2009 to 2013 in Alabama, 60 percent happened at intersections or were intersection-related. For the investigated intersections, 2,127 crashes were captured when a 600-foot buffer was used. The number of crashes at each intersection was normalized with the average annual daily traffic (AADT). The effect of intersection inventory, such as skew angle and turn lane, on crash frequency was analyzed based on the intersection inventory and crash data. Alabama will utilize the intersection inventory data as a resource to develop the SPFs for intersections.

Data Round Table Discussion

The following information on data maintenance was shared in the state round table discussion session:

- The Alabama DOT runs the roadway inventory database using the Lidar data collection system every year. The Lidar system allows that once the data are collected and a complete roadway inventory is created, the Lidar screen will show only the changes to the roadways next time the Lidar is run.
- In Utah, lots of roadway assets are going into an asset management system. The Utah DOT had some difficulties in fitting the new data collection into the system and identifying the differences between the new and existing data collection devices. The Utah DOT's short-term strategy is to keep collecting the roadway inventory data using the Lidar system.
- Four or five states are moving toward collecting and maintaining roadway inventory data using the Lidar data collection system.
- An ongoing NCHRP project by University of Wisconsin at Madison was introduced during the discussion. The project is aimed at developing new methods to extract horizontal and vertical alignment data with the purpose of fixing the gaps in the existing data collection methods.
- FHWA is working on developing a data collection method for large intersections.
- FDOT is contracting a third-party vendor to collect data for non-motorized roadway users. These data can be packaged up in GIS format and sold to the state DOTs. The data will be used for analyzing safety issues with bicyclists and pedestrians.
- The Virginia Department of Transportation (VDOT) collected continuous pavement friction data for all the routes on national highway system (NHS) roads as well as 20 percent of county roads. An SPF was developed based on the friction reading, curvature, and AADT. VDOT obtained a new data collection truck through the FHWA pavement group, which will be used in four states for a pilot study. The new device can map routing and collect international roughness index (IRI) and all pavement friction related data.

Day 1: Session 3 – HSM Case Studies (Part B): Programming Planning and Network Screening

Pairing the Strategic Highway Safety Plan and Safety Analyst: How Michigan Moved to Implement Safety Analyst and the Michigan SHSP, Michigan Department of Transportation (MDOT)

Tracie Leix

The presentation was about how to use the Safety Analyst (SA) to implement the SHSP in Michigan. Michigan has been using the SA since the beginning of its data collection efforts. However, it took a couple of years for the SA to function properly. Many data owners were not aware that they owned. However, the iterative process helped MDOT build relationships with these data owners.

The first step for MDOT on SA application was to generate the High Crash based on the crash and roadway features data. With that, they continue to do the Five Percent Report and Transparency Report. Previously, the roadway segments were limited to either 0.2 or 1 mile for the High Crash Report. The SA made it possible to implement the sliding window analysis, which could cover intersections and freeway ramps as well as roadways.

MDOT previously had a mainframe system that did a peer group analysis based on volume and facility type but that system no longer works. Several events pushed MDOT to further incorporate the SA into their engineering practices. MDOT had some issues with the continued push of raising speed limits. Also, MDOT is monitoring some specific crashes. Meanwhile, they must respond to specific inquiries from the regions and transportation service centers.

MDOT has used the SA for a few years now. Output for various divisions is gaining understanding by users. They started to look at crashes that involved commercial vehicles, vulnerable users, and pedestrian and bicyclists, which are all Michigan SHSP emphasis areas.

For the purpose of mapping crashes statewide, MDOT started the development of a linear reference system (LRS) in the mid-1990s. Their crash data have improved since 2002, including the accuracy of crash location and other crash attributes. For the 2013 SHSP update, the SA was used for four emphasis areas, lane departure, work zone, lighting condition, and surface condition.

Eleven action teams were created to support the MDOT SHSP. Each action team is required to flag the crashes that are applicable to their respective emphasis area. The benefit for flagging the crashes is that the SA software will only work on these flagged crashes instead of the whole crash database. The action teams use a 150-foot buffer to capture intersection related crashes. To deal with the difficulties with the lane departure crashes, those crashes were broken into three categories, multiple-vehicle crashes, single-vehicle parking related crashes, and single-vehicle other crashes.

MDOT mapped the SA analysis results and provided it to its regions and transportation service centers. The locations are prioritized based on certain criteria and coded with different colors. Two examples, one for high proportion of pedestrian crashes and the other for high proportion of impaired crashes, were shared in the presentation.

Deriving Contributing Factors Using Safety Analyst – Washington Department of Transportation (WSDOT)

Ida Van Schalkwyk

The WSDOT presentation was comprised of three parts. The way that WSDOT currently uses the SA was discussed first, and an example of contributing factor analysis using the SA was provided then. The presentation was concluded after some discussion on the organizational structure of WSDOT, some of their ongoing efforts, and the importance of the contributing factor analysis and the SA for WSDOT.

Currently, WSDOT is using the SA more for network screening and the development of priority array. WSDOT's process of utilizing the SA, beginning with the network screening and ending with development of prioritized list of projects, was reviewed first. WSDOT passed 70 percent of the HSIP funding to the local highway system, which is under the jurisdiction of the local program office. This process, however, is for the state highway system.

A rural two-lane segment was discussed as an example in the presentation. Five years of crash data were collected for the roadway segment, resulting in 117 crashes in total. The AADTs for the segment are relatively low, ranging from 15,000 to 17,000. The SA analysis results indicated that driveway-related crashes, crashes for vehicles stopped in traffic, and left-turn crashes were over-represented.

The contributing factor is the core to finding countermeasures and mitigation that targets the actual need, and focus on the contributing factors increases the chances for success. Meanwhile, the contributing factor analysis is becoming a core part of WSDOT's practical solutions. The basis of design documentation specifically calls out contributing factor analysis.

WSDOT shifts focus on highway safety from a vehicle perspective to a multimodal approach. WSDOT does not have a safety office and safety is a shared responsibility across offices. Traditionally, it was led by the Multimodal Safety Executive Committee, which was comprised of division heads. The director of Quality Assurance and Transportation System Safety now is overseeing the SHSP, safety program, and policies related to safety performance and implementation at WSDOT.

WSDOT will roll out its practical solutions in October 2015 to shift toward a performance-based approach. Regardless of whether it is a safety project, safety is always a baseline need for the project.

It is critical that the planners and engineers have the latest knowledge to allow them make sound decisions. WSDOT funded a research project to develop four different sets of SPFs, from SA macro level screening models to the most robust approach, including random parameter models and severity distribution models. WSDOT currently is working on an implementation plan for making these SPFs part of its toolbox. WSDOT is also working on developing training materials for staff.

Integrating HSM Performance Metrics into the Transportation Management Process – Illinois Department of Transportation (IDOT)

Priscilla Tobias

The HSM Part B discusses safety in the transportation management process, which begins with planning and programming, and ends with evaluation and performance measurement. The HSIP is merely the funding mechanism; the goal is to direct all funds (not only the HSIP) to all the projects. IDOT has incorporated safety into the overall transportation management process in their engineering practices.

IDOT developed the SPF for fatal (K), incapacitating (A) and non-incapacitating (B) crashes on state routes based on the roadway inventory and 5-year crash data. The negative binomial (NB) distribution was adopted to model the crash frequency using AADT and segment length. The peer groups defined by the SA were adopted. SPFs were developed for 20 peer groups, 12 for roadway segments and 8 for intersections.

IDOT developed the SPFs for network screening purposes. The performance metric used for network screening is the weighted potential for safety improvement (PSI), which indicates how much a site's performance exceeds expectation from the perspective of safety. The weights assigned to fatal (K), incapacitating injury (A), and non-incapacitating injury (B) crashes are 25, 10, and 1, respectively. The weights are selected with the purpose of pulling out roadway sites with most of the fatal (K) and incapacitating injury (A) crashes. The PSI is equivalent to the excess expected average crash frequency in HSM part B. The regression-to-the-mean bias is addressed using the Empirical Bayesian (EB) method. IDOT applied the most robust data-driven approach for network screening.

IDOT applied the developed SPFs and the PSI safety performance metrics to generate the 5 percent locations for the FHWA Five Percent Report. The FHWA Five Percent Report becomes the fundamental basis for the whole IDOT safety program. IDOT established a "Safer Road Index" (SRI) rating system and created safety tiers and levels of service for safety. The SRI can assist with incorporating safety into planning, project selection, and programming process. It can also bring safety to the same level as pavements and bridges condition assessments in IDOT.

The IDOT state system safety tiers were developed based on PSI as well as fatal and A-injury crashes, and can be used as a performance metric for programming process and project selection. The safety tiers were first provided in the 2015 Five Percent Report and go beyond the simple "Yes/No" answer of being a Five Percent location. Instead of using "Pass/Fail", the Five Percent Report classified the roadway locations into the safety tiers of 5 percent, high, medium, low, or minimal. The safety tier is similar to a grading scale and the advantage is that it is able to determine what is and is not working. Two examples, one for intersection and the other for roadway segment, were provided in the presentation to illustrate how to classify roadway locations of one peer group into different safety tiers and how the safety tier method can help DOT engineers better manage their safety programs.

IDOT is considering evaluating pavements and safety together to prioritize projects. IDOT is using condition rating system (CRS) to evaluate the loss of load carrying capacity (or structural breakdown) and IRI to evaluate the excessive roughness that impacts functional usability and causes drive discomfort. IDOT will select SRI as a performance metric on safety to establish safety risk based on historical severe crashes and exposure. The SRI values will be utilized with the CRS and IRI values for allocating program funding.

Similar to the state system tier approach, a comparable process was used to rank the local roadways into different tiers. Since no SPFs are available for the local roadways yet, an interim method was developed to identify the 5 percent roadway sites for the local system. The local roadway Five Percent analysis covered 132,000 miles of roadway segments and 100,000 intersections, and 5-year KAB crashes (85,000 total) were used for the analysis.

The Five Percent safety tiers were developed for local roadway segments and intersections separately. The local system roadway segment safety tiers were developed based on frequency of KA and KAB crashes, and the entire local system was divided into three tiers. The local system intersections safety tiers were developed based on KAB weighted and KA crash rates. That is, all intersections of the same peer group were ranked from high to low, first by KAB weighted crash rate, and then by KA crash rate. The analysis results for the entire local system will be provided to the local agencies for their safety analysis.

In conclusion, the Five Percent process has been instrumental in assisting districts and other local agencies to prioritize projects. The tier approach has received positive feedback from districts and others. Network screening tools can be used for project prioritization in both the state and local systems.

HSM Case Studies (Part B) Round Table Discussion

Several states shared their experiences on the network screening process in the state round table discussion.

For the question of crash severity weighting in network screening process, several states described their own ways of practicing. In Virginia, the potential for safety improvement (PSI) was calculated for both fatal plus all injury crashes and total crashes. The Virginia DOT is in the process of moving from using 3-year PSIs to using 5-year PSIs. In Oregon, a weight of 100 for KA, 10 for BC, and 1 for property damage only (PDO) crashes was applied for the network screening process.

For the HSIP funds splitting between state and local systems, Oregon DOT created an all roads transportation safety (ARTS) program in which the state and local programs are competing equally for the HSIP funds. Likewise in North Carolina, all projects must compete for funds under the same rules. The Virginia DOT has always done the HSIP project solicitation statewide. To help local agencies apply for the funds, the Virginia DOT has developed some inclusion rules for the cities. In Massachusetts, the state DOT only owns 10 percent of the roadways. The Massachusetts DOT used the systemic approach for the network screening process, and the majority of the HSIP funds were allocated to regionally developed projects.

Several state DOTs also discussed the support they got from their agency leadership on the network screening process. The Nevada DOT used SA for the network screening process, which was supported by their leadership. In Louisiana, the central office developed a project list and distributed the list to the districts and local agencies. The Tennessee DOT conducted the network screening process for multiple purposes. Instead of using the SA, the Tennessee DOT used a self-developed HSIP software. For Tennessee DOT, support from their upper leadership is readily accessible.

The detailed network screening process was also discussed. The Oregon DOT used the sliding window analysis for the network screening process that traversed the entire roadway system. The Michigan DOT is planning to install SA in computers for all regions so that they can do the network screening process themselves. In Alabama, CARE includes detailed roadway and traffic data elements and is used for the network screening purpose. Over-represented roadway sites could be identified easily based on the CARE analysis results.

Day 1: Session 4 – HSM Case Studies (Part C and D): Corridor and Site Specific Crash Prediction and Decision Making

Design Decision Making for Shoulder Width– IHSDM Application – Arizona Department of Transportation (AZDOT)

Kohinoor Kar

AZDOT has purchased multiple copies of the HSM since it was published. Meanwhile, they have provided various levels of training, including the HSM overview training, the IHSDM training, and the safety management system workshop, to their staff in the past several years. AZDOT has also funded a series of ongoing or completed research projects on HSM implementation.

This presentation focused on how to apply the IHSDM to compare the safety performance of different design alternatives. The State Route (SR) 264 project in northeast Arizona was selected for the discussion. The SR 264 is a rural two-lane two-way undivided road in Navajo County, Arizona. The travel lanes are 12-foot width, and the shoulders are 0 to 1 foot width. The crash data for different calendar years, as well as the observed and projected AADTs for different segments, were provided. The HSM crash predictive models have not been calibrated with the Arizona data yet. However, because the alternative is to compare the relative number of crashes for different design alternatives, calibrating the models was unnecessary.

Different design alternatives were proposed for the corridor. Major design elements include widening the shoulders from 0 to 1 foot to 5 feet or 8 feet, and improving super-elevation to bring the corridor into compliance with AASHTO recommendations. Additional design elements, including centerline and shoulder rumble strips, flattening of side slopes, and installing guardrail, were also proposed.

The corridor was split into two separate segments to be constructed independently, and each segment was evaluated separately for prioritization purposes. The potential reduction in total number of expected crashes over the 20-year analysis period was calculated. The expected crashes were calculated for three conditions, existing conditions, roadway segments with 5-foot shoulders (Alternative A), and roadway segments with 8-foot shoulders (Alternative B).

The analysis results indicate that, as compared with existing conditions and Alternative A, Alternative B will experience the least number of crashes in the 20-year analysis time period. However, the benefit/cost (B/C) ratio for Alternative A will be higher than that for either existing conditions or Alternative B.

Conclusively, results show that Alternative A was the most cost-effective alternative for the corridor. IHSDM provides a user-friendly interface for implementing the HSM predictive method to real world project applications. IHSDM can be used to quantify the safety benefits for a wide variety of proposed improvements; however, improvements that can be evaluated using IHSDM are restricted to those identified in Part C of the HSM.

Safety Decision Making: Roundabouts – Nevada Department of Transportation (NDOT)

Ken Mammen

This presentation briefly discussed how NDOT used the HSM to analyze the safety performance of roundabouts. The presentation covered three parts, beginning with an introduction of the locations of the roundabouts in Nevada. In the second part, it discussed the process of how to apply the HSM analysis worksheet to evaluate the safety performance of the roundabouts and the B/C ratio analysis. Finally, conclusions and recommendations on roundabouts were discussed.

Two roundabout projects in Nevada were discussed in the presentation. The first project is the intersection between SR 227 and the Spring Creek Parkway at Spring Creek, Elko County, Nevada. The second project is the intersection between SR 431 and SR 28 on Mount Rose Highway in Washoe County, Nevada. It was mentioned that the first project did not meet signal warrants.

The safety performance of three scenarios, which are existing conditions, roundabout (Alternative 1) and traffic signal (Alternative 2), were evaluated separately. The NCHRP 17-38 spreadsheet was used to calculate the expected number of crashes for different scenarios. For each scenario, the predicted and expected crash frequencies, for both fatal and injury crashes and property damage only crashes, were calculated. A CMF from the FHWA CMF Clearinghouse was selected to account for the safety benefits for converting a stop-controlled intersection into a single-lane roundabout. The CMF is 0.28 with an adjusted standard error of 0.11.

The analysis results indicate that for both projects, Alternative 1 will have better safety performance than Alternative 2. For both projects, the total expected crashes will decrease 72 percent after the installation of the roundabout. Meanwhile, for both projects, the total expected crashes will decrease only 49.8 percent after the stop-controlled intersections are converted into signalized intersections.

The B/C ratio for the two projects were also calculated. The B/C ratio is 9.69 for the first project and 10.75 for the second project. NDOT is moving forward with educating its division offices. NDOT is gathering information from other sites where roundabouts are being implemented.

Intersection and Freeway Analysis – Maryland Department of Transportation

Ruihua Tao

The Maryland DOT shared its experiences on HSM implementation. The process of developing the Maryland SPF local calibration factors (LCF) was introduced first. Two case studies, one for intersection and the other for freeway, were discussed in the second part.

The Maryland DOT developed LCFs through a two-phase study. In phase I, all SPFs included in the HSM first edition were calibrated with roadway inventory and crash data from Maryland. To calibrate the SPFs for roadway segments, 1,324 roadway segments, including 430 roadway segments in rural and 891 roadway segments in urban, were selected across the state of Maryland. Meanwhile, 1,068 intersections, including 555 stop-controlled intersections and 513 signalized intersections, were randomly selected to calibrate the SPFs for intersections. The LCFs for roadway segments ranged from 0.58 to 2.26. For intersections, the LCFs ranged from 0.12 to 0.46.

The phase II study is ongoing and the project is focused on calibrating the SPFs for freeway segments and interchanges. Data collection efforts have been completed, and separate databases have been created for freeway segments, speed change lanes, and ramps. The entire project is anticipated to be completed by the end of 2015.

The Maryland DOT has completed six case studies on HSM implementation, including four for intersections, one for freeways, and one for roadway corridors. The case studies for the intersection between MD 23 and Grafton Shop Road, and the I-495 freeway were discussed in the presentation.

The intersection case study was discussed first. Two alternatives were developed for the intersection between MD 23 and Grafton Road. Alternative 1 is to re-strip the intersection to add a left-turn and a bike lane on the major road. Alternative 2 is to widen the intersection to add a left-turn and right-turn lane on the major road. The predicted crash frequency for the base condition was found to be very close to the observed crash frequency. However, crash reduction from neither Alternative 1 nor Alternative 2 was very significant.

The freeway case study was for I-495, a major freeway around Washington DC metropolitan area. It was mentioned that congestion was observed all seasons on I-495. The scope of this study includes three interchanges, I-495 at MD 185, I-495 at US 1, and I-495 at MD 295. The purpose of this study was to evaluate the safety performance of these three interchanges to identify the priority of safety improvements for the interchanges. The case study found that for no-build conditions, the total crashes are expected to increase 8 percent because of the increase on AADT. For safety improvements, high priority should be given to freeway segments and speed change lanes at all three interchanges.

HSM Applications for Larger Projects and Alternative Evaluation – Minnesota Department of Transportation (MnDOT)

Derek Leuer

MnDOT shared its experiences on HSM applications for larger projects and alternative evaluation in the presentation. Two projects, the Minnesota Trunk Highway 371 and the US Trunk Highway 53, were discussed as examples in the presentation.

The “ability of influence” chart was discussed first. Usually at the planning stage of a project, the agencies can exert great influence on the project, and any changes during this stage will cause little (if any) increase in expenditures. However, when the project moves to the stage of facility operation, the agencies will have limited influence on the project, and any change will greatly increase expenditures. Therefore, the ability to influence at the beginning of a project is preferred.

Background of the Minnesota Trunk Highway 371 was introduced. This is a four-lane expansion project from Nisswa to Pine River and the road serves as the major north/south arterial for that region. The roadway is located within a tourism destination area with heavy traffic during the weekend. The current AADTs for different segments along the corridor range between 8,000 and 12,000, and are projected to increase to 11,000 to 22,000 in the future. Phase 1 of the project is a 10-mile segment between Nisswa and Jenkins, with a total construction cost of approximate $58 million. Phase 2 of the project, which is from Jenkins to Pine River, is a 5-mile segment and the project has not been funded yet.

There were some arguments as to whether the Minnesota Trunk Highway 371 should travel through the City of Pequot Lakes or go around it, or whether the intersections should be converted into signalized intersections or even interchanges. The same issues exist for the City of Jenkins as well as the City of Pine River.

An HSM analysis was conducted for the various alternatives for the 15-mile corridor. It was observed that some of the alternatives will experience even more severe crashes than the no-build scenario. The selected alternative was a four-lane on the existing alignment with the Pequot lakes bypass with interchange.

The benefits of the HSM analysis are multiple. First, the HSM analysis can provide an objective answer about which alternative is the safest and helps explaining why. Second, the HSM analysis can give quantifiable numbers to justify costs and decisions. Meanwhile, the cost for the HSM analysis is lower, which is only about $40,000 for a $58 million project. Using the HSM analysis is preferable to using only the statewide averages, and better decisions can be made for intersections. More importantly, the HSM analysis results can be used to either justify a project or to cut unneeded portions of a project.

Conversely, the HSM analysis is not good for unusual circumstances, such as non-traditional intersections and interchanges. Also, alternative intersections are not fully vetted yet. Finally, the public is not comfortable with numbers of reported crashes from the HSM analysis.

The background of the U.S. Trunk Highway 53 was introduced. The AADT is 23,000 for the US Trunk Highway 53, and MnDOT needs to relocate the roadway within a short timeline. Several design alternatives were developed for the project, and MnDOT applied the HSM to evaluate the safety performance of different cross section design alternatives, and used the analysis results to support its decision making.

HSM Case Studies (Part C and D) State Round Table Discussion

The crash costs used by the state DOTs for safety analysis was discussed. It was recognized that there is a variety of crash costs used across different states. To facilitate the regulatory impact analysis within the agency, the U.S. DOT Office of the Secretary published a cost for fatal crashes and the procedure for estimating the cost for crashes at other severity levels. However, FHWA hasn't published any guidance, or set up any requirements on where and how the crash costs should be used yet.

The Illinois DOT has used the crash costs developed by the National Highway Transportation Safety Administration (NHTSA) for the safety analysis for many years. In Michigan, a value developed by the National Safety Council for fatal and incapacitating injury crashes was used. However, instead of using the B/C ratio, the Michigan DOT conducted the time return analysis for projects. The Oklahoma DOT developed a logistic regression model to calculate the number of fatal and incapacitating injury crashes based on the predicted total crash frequency.

In engineering practices, it is often found that some alternatives will actually increase the crash frequency. The example for cable median barrier was shared in the discussion. Even though severe injury crashes will be reduced after the cable median barrier is installed, the total crashes are expected to increase for the treatment. In Illinois, as long as a design process exists and the process is appropriately followed, it is acceptable that the design alternative will increase the crash frequency. However, the design process should be well documented and the reason for selecting the design should be articulated. The challenge that Ohio DOT is facing now is that the most expensive projects always tend to be selected if based only on the experimental B/C ratio analysis results.

The appropriate method to apply the HSM Part D CMF was also discussed. In Minnesota, local agencies typically will select the countermeasures that provide the highest B/C ratios when applying for HSIP funds. The cases in Arizona are similar with those in Minnesota. To solve the problem, AZDOT developed a database to list those high-quality CMFs (usually 4-star and 5-star), and local agencies are allowed to select CMF from this list only when applying for HSIP funds. The Illinois DOT also noticed that the local agencies used many CMFs for the HSIP funds application. Meanwhile, the selected treatments cannot appropriately address the targeted crashes. Therefore, the Illinois DOT required that a maximum of four CMFs be selected for the HSIP funds application. They also checked whether the selected countermeasures can address the type of crashes during the HSIP review process.

Day 1: Session 5 – Increasing HSM Implementation and Communicating to the Various Users

States Round Table Discussion

This round table discussion focused on how to communicate to the various users to increase HSM implementation.

The Oregon DOT is in the process of moving to the ARTS program, under which the state and local agencies will compete for HSIP funding under the same rules; and they realize the importance of communicating effectively with local agencies. In Michigan, the HSM analysis is still a volunteer activity for local agencies but the Michigan DOT is encouraging local agencies to conduct proactive safety analyses using the HSM.

In Minnesota, local agencies lack the experience and resources to do a project with either systemic or proactive approaches. The case is the same for Michigan; however, the Michigan DOT realized the importance of separating the programs for state and local agencies because a combined program will deter the local agencies from applying the funds. It was later clarified that the Oregon DOT provided technical support for the local agencies to apply for HSIP funds when needed. The Illinois DOT is considering creating a safety center where universities will provide safety analysis services to local agencies.

For the communication to the local agencies in Arizona, AZDOT believed that the time spent to review and provide comments regarding the HSM application by local agencies is typically longer than the time it takes to complete the analysis themselves. The Illinois DOT is the process of developing a HSIP review document to guide the local agencies on how to do the safety analysis using HSM methods.

Illinois DOT Presentation

Day 2 Session 1 – Calibration and SPF Development (Part 1)

Decision to Develop SPFs, SPF Development – Massachusetts Department of Transportation (MassDOT)

Bonnie Polin

MassDOT developed its SHSP with a data-driven process. As one of the 15 emphasis areas developed for the SHSP, Intersection is a major concern for MassDOT, with 30 percent of all fatalities and 44 percent of all serious injuries occurring at intersections.

The statistical characteristics of the intersection crashes were introduced. In Massachusetts, 87 percent of the lane miles are within urban areas. In the past 5 years, 96 percent of all fatal and serious injury intersection crashes were within the urban/suburban areas. The majority (82 percent) of fatal and serious injury intersection crashes occurred at three-leg or four-leg intersections, with 65 percent occurring at stop-controlled or signalized intersections.

MassDOT retained the University of Massachusetts at Lowell to calibrate the HSM SPF. The scope of the study was to calibrate the SPFs for all urban and rural intersections, including both signalized and stop-controlled intersections, for both three-leg and four-leg intersections. The total budget for the SPF calibration project was $187,000, with over 60 percent of the total budget used for collecting the data for 245 intersections.

All the narratives and diagrams in crash reports were reviewed manually to confirm whether the crashes were intersection-related. Meanwhile, site visits were conducted to collect intersection data and GIS layers were used to collect data for alcohol sale establishments, schools, and bus stops. Procedures were also developed to estimate daily pedestrian and bicycle volumes from peak-hour volumes when such data were not available.

The HSM SPF calibration study showed that the SPF local calibration factors were significantly greater than 1.00 for three-leg and four-leg signalized intersections. For 87 percent of all sampled locations, the observed crashes are greater than the predicted crashes over a 3-year time period. Based on these results, MassDOT decided to develop the SPFs for three-leg and four-leg signalized intersections.

Various models were tested for the SPF development. Results indicated that for multiple-vehicle crashes, the coefficients are statistically significant when using the NB model. However, the coefficients are not statistically significant for single-vehicle, pedestrian, and bicycle crashes. Therefore, instead of developing separate models for those crash types, a crash adjustment factor was used to calculate the single-vehicle, pedestrian, and bicycle crashes based on the predicted multiple-vehicle crashes. The crash adjustment factors were developed based on historical crash data. It was mentioned that no Massachusetts-specific CMFs were developed under this project, and the local calibration factors are close to 1.00 for the SPFs developed using the NB model.

Lessons learned from the SPF development efforts were shared. First, the data collection process could be simplified. For example, the AADT data, when not available, could be estimated based on that for the expanded roadways. Instead of simply relying on site visits, aerial or roadway images could be used to collect the intersection data. The numbers of alcohol sale establishments, schools, and bus stops also could be approximated with appropriate methods. Also, it is critical to generate practical and usable deliverables from the SPF development efforts. A detailed user guide should be prepared to explain how to apply the models in the real world, what crashes should be included in the analysis, what traffic volume should be used, and how to use the data available. An Excel spreadsheet should be developed to simplify the predicted crash calculation process.

SPF Calibration Lessons Learned – Maine Department of Transportation

Darryl Belz and Kara Aguilar

Maine DOT set the goal to reduce 50 percent of traffic-related fatalities by the year 2030 in its 2014 SHSP. The objective for Maine DOT on HSM implementation is to calibrate all the safety SPFs for rural two-lane roads, and urban and suburban arterials included in the HSM first edition.

The SPF calibration and spreadsheet adjustment work was done by a team of five engineers from Maine DOT who decided to calibrate the HSM SPFs since local conditions in Maine are quite different from other states. For example, many crashes were animal-related in Maine, and weather conditions are more extreme in Maine than in other states.

The project started in 2013 and ended in the summer of 2015. The HSM SPFs were calibrated with the following procedures. First, the facility types for which the SPFs were to be calibrated were identified, and for each facility type, the sample locations were randomly selected across the state. Second, the roadway attributes and recent crash data for the selected locations were collected, and the predicted crash frequency for each location was calculated based on the roadway inventory and traffic volume data. The local calibration factors were finally determined by comparing the total predicted crash frequency with the total observed crash frequency.

Data from different sources were used for the HSM SPF calibration, including data collected with automatic road analyzer (ARAN), Google overhead imagery, Google street view, and data from the Maine DOT database. The roadway's vertical and horizontal attributes were calculated based on data collected with ARAN. The IHSDM was used to calibrate the SPFs for rural two-lane, two-way roads. Maine DOT is working on automating portions of the data collected, such as cross slope and edge of pavement drop-off, by using ARAN.

Generally speaking, the SPF local calibration factors for intersections are most below or around 1.00, while the SPF local calibration factors for roadway segments are all greater than 1.00.

A Maine-specific HSM spreadsheet was generated based on the spreadsheet developed by NCHRP 17-38. In the Maine-specific HSM spreadsheet, the Maine-based SPF local calibration factors for total crashes were included, and the default crash severity and collision type distributions were replaced with Maine-based values. Meanwhile, the Maine-specific HSM spreadsheet allows for up to three additional CMFs to be included. The total cost for the Maine HSM SPF calibration project was $70,000.

A case study on application of the HSM SPF calibration results was provided. In the case study, the safety performance of five design alternatives for the intersection was evaluated and compared with the "no-build" option. For comparison, the HSM crash predictive models with local calibration factors being 1.00 were also used to calculate the predicted crash frequency. The results for these models are significantly different, and the case study proved the value of having HSM SPF local calibration factors. For its next step, Maine DOT is considering whether to calibrate the HSM SPFs by county, by geography, or by region.

All Models are wrong, but Some are Useful – Louisiana Department of Transportation and Development (LADOTD)

April Renard

The LADOTD presentation focused on SPF calibration and development.

LADOTD is still using the number-rate method for network screening process. The crash rates for all locations under each peer group are calculated, and roadway sites with twice of or higher than the statewide average crash rates are listed as the high risk locations. The data are distributed to the districts for identifying projects for HSIP funding.

LADOTD contracted the consultants to calibrate the HSM SPFs. Many data elements are required for the HSM SPF calibration. Some variables were available from the Louisiana roadway database directly, while others were gathered in additional data collection efforts. The roadway lighting, roadside hazard rating, and driveway density data as well as other data elements were collected.

Calibration of SPFs for intersections was a challenge for LADOTD because of difficulties in identifying the intersection-related crashes with buffers. Different buffers, including 50-foot, 150-foot, and 250-foot, were tested to capture the intersection crashes. Refinements on the HSM SPF calibration were made later when improved data were available.

The HSM calibration guide developed by Dr. Geni Bahar under NCHRP 20-07 was used as a reference for the LADOTD SPF calibration effort. The HSM calibration guide suggested that instead of developing unique SPF local calibration factor for one facility type, multiple SPF local calibration factors could be developed for different AADT ranges. The SPFs were actually calibrated based on AADT ranges for some roadway types; however, it was found that more roadway sites needed to be added to reach adequate sample size for some AADT ranges when the SPFs were calibrated based on different AADT ranges. Finally, when the roadway sites under different AADT ranges were combined to calculate the SPF local calibration factors for all AADT ranges, the local calibration factor results are biased because segments under certain AADT ranges are over-represented.

LADOTD's HSM SPF calibration effort focused on roadway segments. Multiple SPF local calibration factors have been developed for different roadway types. Specifically, the LADOTD SPF local calibration factors were developed for both total crashes, and crashes under specific crash severity levels and collision types. All SPF local calibration factors have been incorporated into the crash predictive model calculation spreadsheet developed under NCHRP 17-38 by Dr. Karen Dixon and published online.

In Louisiana, the cumulative residual (CURE) plot was applied to evaluate the goodness-of-fit of the crash predictive models. The raw HSM models are not acceptable because even though the CURE plot is generally within the boundary of two times standard errors, it does not iterate around zero. The problem, however, is largely solved by the calibrated HSM crash predictive models. In Louisiana, the calibrated model will be used for project-level analysis, such as the design alternatives comparison.

LADOTD concluded that it is not realistic to apply the calibrated HSM SPF for network screening. Therefore, SPF with only AADT and segment length as independent variables was developed for rural two-lane undivided roads. CURE plots were generated for both the calibration samples and all sites. Results indicated that the developed SPFs correlate with the data fairly well. The developed SPF is practicable for network screening purpose because the model is not data intensive.

Calibration and SPF Development Roundtable Discussion

During the roundtable discussion, the states highlighted the need to have an intersection data workshop with the intent of helping some states deal with this critical information.

AZDOT has been working on a corridor project in the Phoenix area that involved analyzing the safety performance of a tunnel, and requested information related to similar experiences from other states. VDOT has done some work with tunnels, and will provide information to AZDOT and other states that are interested.

Some of the recommendations and experiences from states regarding resources to start the process of calibration include:

- VDOT has a research center at the University of Virginia that helps with various tasks. Staff at the center work with VDOT staff to gain familiarity with VDOT systems such as LRS data, traffic volumes, and crash databases.
- IDOT uses their Center for Transportation, which is funded through State Planning & Research (SPR) funds and also some HSIP funds, for this type of work, and they also use a consultant. Two percent of HSIP funds are allocated for research.
- Michigan uses in-house staff for calibration-related tasks.

One lesson learned that is important is to become familiar with the process of developing SPFs or calibration; otherwise, making decisions or discerning problem areas can be difficult.

Florida DOT presentation

Day 2 Session 2 – Calibration and SPF Development (Part 2)

Calibration Process and Results Evaluation – Ohio Department of Transportation (ODOT)

Derek Troyer

ODOT's presentation summarized the major steps for its HSM SPF calibration efforts as well as experiences and lessons learned from the process. To calibrate the HSM SPFs for the specific facility type, it is critical to identify the data required to calculate the predicted crash frequency. The data required for calibrating the SPFs for rural two-lane, two-way roads were discussed as an example.

Because not all variables are available for the SPF calibration, it is important to document appropriately the assumptions made on data collection. The assumption made on roadside hazard rating (RHR) was used as an example in the presentation.

In order to be able to repeat the HSM SPF calibration process in the future, it is important to create a repeatable process. It was mentioned that because of the change on crash report threshold in 2012, 30,000 less crashes were reported in 2013 in Ohio. ODOT realized that while it is ideally best to calibrate the HSM SPFs every year, because of the limits on time and budget, calibrating the HSM SPFs every 3 years is more feasible. ODOT recommended that the HSM SPF calibration process be transparent so that appropriate changes can be made when data are made revised, or when errors and limitations on the calibration process are noticed. The crash predictive model calculation spreadsheet developed under NCHRP 17-38 was used for the ODOT HSM SPF calibration effort.

The CURE plot was used to evaluate the goodness-of-fit of the calibrated HSM SPFs. For the SPFs for rural two-lane, two-way roads, the CURE plot illustrated that the calibrated crash predictive models can represent the observed crashes well, possibly because of the high quality data; however, slightly more noise was observed on the CURE plot for certain facility types. ODOT has published the research paper on the HSM SPF calibration efforts and a link to access the paper online was provided. An introduction to the FHWA HSM SPF calibration tool was included in the presentation as well.

Using Custom Safety Performance Functions – Oklahoma Department of Transportation

Matt Warren

The presentation began with a discussion on advantages and disadvantages of the custom SPFs. The advantage of using custom SPFs is that any crash types may be targeted and any facility types may be isolated. The custom SPFs can be adapted to all available data with improved accuracy. The presenter stated that the custom SPF can be designed to fit the purpose at hand, and there are more options for dealing with over-dispersion. The disadvantages of custom SPFs are that SPFs will be based on less reference data and it will take some time to collect the data and create an SPF. Also, to create custom SPFs requires a higher level of user skill than to calibrate the SPFs. In addition, distribution of rare crash types may not correlate well with the negative binomial model.

Issues with the network screening process were discussed. When using the SPFs, the network screening process generally is based on excess crashes (or some other measures) that are relative to the crash frequency predicted by the SPFs. Therefore, any factors that have been accounted for in the SPF will automatically become normal. To resolve this problem, a SPF for network screening should only include variables for which no treatments will be considered.

For modeling over-dispersion, the number of years of reference data affects the estimated over-dispersion. Using a function for over-dispersion is a useful empirical tool for dealing with these problems.

The SPF for crossover was provided as an example to illustrate how Oklahoma DOT developed custom SPFs and used them in its engineering practices. The target for the crossover SPF was median crossover crashes on multilane divided highways with open medians. Limitations on data were observed; no speed data were available. For medians wider than 99 feet, the width was not recorded. SPFs were developed for rural and urban facilities separately using the variables of segment length, median width, and AADT. The developed crossover SPF has been used for estimating the CMF, systemic site selection, and policy determination for Oklahoma DOT.

Lastly, special considerations for the crossover SPF were discussed. Based on modeling results, the peak risk will be achieved for the median width of 35 feet. The critical variable of speed was not available for this study, which probably affected the modeling results. The number of years of crash data was included as one variable in the over-dispersion formula; however, the coefficient was not statistically significant.

Florida SPF Development and Calibration – Florida Department of Transportation (FDOT)

Joe Santos

FDOT's presentation covered both SPF development and SPF calibration. FDOT has funded a series of research projects to support the implementation of the HSM in Florida.

In 2012, FDOT calibrated the SPFs for selected facility types included in the HSM first edition. For roadway segments, the SPF local calibration factors varied from 0.68 to 1.63. The SPF local calibration factors for intersections are currently being the developed. Only KABC crashes are captured in the FDOT crash database; PDO crashes were not included in the system. For FDOT, distinguishing between urban and rural facilities is a challenge.

To test whether the CMFs included in HSM Part D are applicable to Florida, FDOT funded the research project Validation and Application of Highway Safety Manual (Part D) in Florida. For 17 treatments, 13 for roadway segments, 3 for intersections and 1 for special facility, CMFs were developed based on data from Florida with either the before-after or the cross-sectional studies. The Florida-specific CMFs were validated with using the HSM, and only Florida-specific CMFs with lower standard errors were selected.

FDOT also funded the project Improved Process for Meeting the Data Requirements for Implementing the Highway Safety Manual and Safety Analyst in Florida to identify influential variables and determine the minimum sample size for SPF calibration. The project used the random forest technique to rank both the required and desired variables based on the importance of each. The variable priority lists were generated for both roadway segments and intersections. For roadway segments, the segment length and AADT are the top two variables; while for intersections, the top two variables are major road AADT and minor road AADT. The benefits of using this process are that the priority list can be checked before developing the jurisdiction-specific SPFs to see which variables are more important, and more priorities can be given to specific variables with higher importance.

Furthermore, the research project also investigated whether different sampling procedures will affect the SPF calibration results. Two types of sampling procedures, the simple random sampling and stratified sampling, were used to select roadway sites. The results indicated that differences from the two sampling procedures are not statistically significant. It was also found that the minimum sample size of 30 to 50 sites with at least 100 crashes recommended by HSM is insufficient to achieve the desired accuracy for nearly all facility types. The sample size for achieving reliable SPF calibration factors was recommended for different facility types. The recommended sample size does not follow the minimum requirements recommended by the HSM.

FDOT offered to share with other states results from the research projects, and links to the technical reports were provided.

Calibration and SPF Development (Part 2) Roundtable Discussion - Continuation

IDOT reported that a national research project found that A-injury crashes are typically over-reported by 30 to 35 percent, whereas B and C injury crashes are under-reported. As data quality improves, opportunities to address B-injury crashes will increase.

For some states, regional calibration made more sense than developing statewide calibration factors. Michigan DOT has conducted regional calibration and development of distribution tables for use in its predictive spreadsheets.

Some states evaluated the possibility of developing regional calibration factors, but found that there was not enough difference between regions to have separate factors. VDOT did not do regionalization for network screening because of the complications associated with deployment Rather, they choose to calibrate their statewide model annually.

Day 2 Session 3 – Policy, Guidance, Training: Building Blocks of Institutionalization

Integrating the HSM into Virginia's Multimodal Construction Program Prioritization – Virginia Department of Transportation (VDOT)

Stephen Read

This presentation discussed how VDOT integrated the HSM into its multimodal construction program prioritization process. The VDOT project planning and funding process was overviewed first, and the factors VDOT used for the project evaluation process were introduced. The method VDOT used for developing planning level CMFs was discussed, and House Bill Two (HB2) planning-level CMFs for different types of projects were summarized. The presentation was ended with examples of how to use the HB2 planning-level CMFs.

VDOT projects are filtered through VTrans2040, the technical document for long-range statewide multimodal transportation planning and needs assessment. For fiscal year 2017, $500 million has been allocated for high priority projects, which are locally or regionally submitted projects that compete funding statewide. Meanwhile, $500 million has been allocated for construction district grants, which are formula driven and distributed to nine construction districts. VDOT developed SPFs for network screening purpose for 26 arterial and freeway site sub-types. The projects' safety needs are assessed based on 3-year PSI values. All sites that have positive PSI values for 2 years or more are identified to the list.

In VDOT, the project needs are assessed based on safety, congestion mitigation, accessibility, environmental quality, economic development, and land use and transportation coordination (for area with over 200,000 people). It was mentioned that the factors are weighted differently across the commonwealth. For the safety needs assessment, 50 percent of the score is assigned to expected reduction in total fatalities and severe injuries, and 50 percent of the score is assigned to expected reduction in the rate of fatalities and severe injuries per 100 million vehicle miles travelled.

A method for developing planning-level CMFs was introduced in the presentation. For this purpose, high quality CMFs from the FHWA CMF clearinghouse were compiled together. To select applicable planning-level CMFs, the CMF range for various conditions was defined. The list of HB2 planning-level CMFs for intersection, interchange, segment, bridge, bike, and pedestrian were included in the presentation.

Several case studies on how to apply the HB2 planning-level CMFs to assess the safety needs of the projects were discussed. These case studies are also posted online.

Design Exception Policy – Missouri Department of Transportation (MoDOT)

Drew Williford

MoDOT's presentation discussed how the HSM was used for developing their design exception policy. The design exception is a documented decision to design a highway element or segment to design criteria that do not meet minimum established values or ranges. Roadway elements, such as horizontal alignment, vertical alignment, lane and shoulder width, stopping sight distance, grade and super-elevations, may require a design exception.

Although it is preferable to design all highway elements to meet design standards, there are many cases where this is not practical. The terrain, environmental, social, and cultural concerns are some examples under which design exceptions must be made.

Design exceptions and safety analysis should go hand by hand. For example, a reduction in curve radius may not meet the standard, and the curve radius reduction may cause an increase in run-off road and cross centerline crashes.

MoDOT's design exceptions policy is that a MoDOT-approved design exception is required for all deviations from standard design policy. If the design exception request involves any features that are safety related, crash data should be attached to the request to support the reasons for justification, and documentation of the exception should include a safety analysis when the analysis process is adequately addressed in the HSM. MoDOT's design exception policy is that any design exceptions, as well as any additional safety features above and beyond the standard design, should be taken into account.

A design exception example was provided in the presentation. The project is to restripe a four-lane section to a four-lane section and the project location was introduced. The design exceptions include the use of 11-foot lanes at narrowing section, use of 2-foot shoulders at narrowing section, and use of 300-foot acceleration lanes. The standards for those roadway elements are 12-foot lane, 12-foot inside shoulders and 6-foot outside shoulders, and 550-foot acceleration lanes, respectively. The reasons for requesting the design exceptions are that the viaduct width is insufficient for a five-lane section, and the design exceptions could help eliminate the need to widen structure and replace one segment of retaining wall.

Five-year crash data were used for the safety analysis to support this design exception request. Specifically, approximately half of the crashes in this section were rear end crashes, with more than 50 percent being either fatal or injury crashes. Traffic congestion was cited in the crash reports as a contributing factor for the crashes. Three geometric options that considered different lane width and shoulder width combinations were analyzed with the Enhance Interchange Safety Analysis Tools (ISATe). After review, it was determined that the benefit of increased traffic flow would have a greater impact to safety than the geometric alterations required for this project.

Lessons learned were shared with the attendees. Personnel turnover is a problem for MoDOT. The HSM users need training and experience to properly understand its methodologies, benefits, and limitations. A yearly cycle of HSM trainings can help alleviate some of these issues. MoDOT also realized that having a person or group that specializes in the HSM can help maintain expertise and provide a means of technical support. MoDOT is also interested in maintaining a national presence because national groups offer a means of comparing state processes and lessons learned.

HSM Analysis in Policy – New Jersey Department of Transportation (NJDOT)

Virgilio Tan

NJDOT's presentation overviewed its NJDOT policy on HSM analysis for requesting funding for safety projects.

NJDOT developed and adopted its HSIP in 2013. The budget for HSIP was $57 million dollars for all public roads. The main goal of the HSIP is to achieve significant reduction in traffic related fatalities and serious injuries; therefore, resources should be focused on areas with the highest rate of return on investment.

Quantitative and comparative information, which can help assist in decision-making process, help select the best alternative designs, and help select the best countermeasures, is needed to achieve the goal. The HSM was chosen as the common resource for methodologies and was used for the safety analysis for both state and local routes.

The NJDOT Bureau of Transportation Data and Safety is in charge of the statewide crash data collection and the maintenance of the safety management system. In New Jersey, the priority locations are continuously updated and implemented through five safety improvement programs. It was stated that in these programs, HSM analysis is required for comparing the design alternatives in a project's concept development phase.

Local HSIP projects are first submitted to their respective metropolitan planning organizations (MPO) for review. In New Jersey, the three MPOs are the North Jersey Transportation Planning Authority, the South Jersey Transportation Planning Organization, and the Delaware Valley Regional Planning Commission. The basic requirements for HSIP funding are that the project location should be identified in the SMS priority list for each MPO, that the infrastructure improvement is consistent with New Jersey's SHSP, that the project should be compliant with Title 23 code of Federal Regulations, and that the HSM analysis with economic appraisal should have a B/C ratio of greater than 1.00. In 2014, NJDOT supported over $26 million in obligated HSIP funds to projects under local jurisdiction. In New Jersey, the state system accounts for only 6 percent of total roads. Funds are distributed evenly between the local and state systems.

To qualify for HSIP funding, the required HSM analysis must be applied to each of the alternative proposals and comparisons made. The preferred alternative will be selected based on the analysis results. Each HSM analysis consists of predicted crash frequency for the existing conditions, expected crash frequency for the build condition, the societal benefits in the reduction of crashes and/or severity, construction cost in implementing the countermeasures, and the B/C ratio.

HSM lists four methods for safety performance evaluation. NJDOT requires the same order of choice of application that HSM recommends.

The overall safety trends in New Jersey over the past 5 years were demonstrated. Results show that numbers of crashes are decreasing for both fatalities and serious injuries.

In New Jersey, local agencies are not ready for safety performance analysis with HSM, and the local agencies also do not have budget to hire consultants for the work. NJDOT provided training to local agencies to help resolve this gap so that local agencies can do the analyses themselves. NJDOT is also facing some challenges on implementing the HSM analysis, some of which stem from the limitations in HSM methodologies. For example, no method of handling the five-leg intersections has been developed.

Policy, Guidance, Training: Building Blocks of Institutionalization Roundtable Discussion

Engaging upper management and getting their support to make safety into policy has been challenging for some states. IDOT is facing a different challenge, which involves convincing the heads of other divisions to implement the HSM. They are currently working on HSM policy for Access Justification Reports (AJRs), and value engineering.

Some states provided examples of how they are attempting to implement the HSM into policy. The California Department of Transportation (Caltrans) has incorporated the HSM with its data-driven safety analysis efforts, and is considering incorporating it with other divisions. Caltrans is also researching how the HSM can be integrated into all public roads planning and design, for other systems as well as the state system. Typically, they implement policy first and they deploy and outreach application. MoDOT has worked on implementing the HSM into its design exceptions. MassDOT experienced some issues with implementing the HSM into design exceptions mainly because most of its design exceptions are related to pedestrian and bike improvements, which are not fully addressed in the HSM. Several states have design exceptions policy in place, but none that cover the local road system.

Regarding selection of consultants and their competency for implementing the HSM, Michigan DOT stated that they use consultants for facilitating RSAs. Personnel facilitating the RSA are required to have NHI training. LADOTD requires that its consultants take a training course to meet minimum personnel requirements.

In terms of policy language specifically related to the use of “shall” versus “should” when referring to the HSM, VDOT stated that for HSIP projects they use “shall.” VDOT also has been working with the traffic operations group to incorporate HSM language into its operations manual. They added HSM references using “should” to accommodate operations staff who could potentially perform safety analyses.

MoDOT uses “should” in its safety policy documents. Their guidance requires that an analysis be performed unless there is a good reason not to do it. After the policy was released, MoDOT staff completed significant training in order to use the guidance effectively.

FHWA is planning to host an HSM and project development workshop next year, which will potentially involve about 4 state representatives from up to 10 states. Representatives potentially will include the safety engineer, chief engineer, and project development engineer.

The discussion then moved into training and lessons learned. FDOT conducted extensive training using the FHWA materials. They are planning to do follow-up on how this information has been correctly used. Currently, more training material is available at highwaysafetymanual.org.

Clemson University is developing an online Highway Safety 101 course, which provides generic safety principles and the 4E’s approach. VDOT has found that hands-on training using the predictive spreadsheets is more effective. They are planning a train-the-trainer session for the freeway and interchange chapter.

NCDOT is using NHI and FHWA training materials to teach the HSM to its staff in different regions. They have a consultant helping with the classes. In Illinois, universities are incorporating the HSM into their curriculum. Most universities have a limited number of hours that an undergraduate student is required in order to get a degree. Teaching a class exclusively focused on safety is challenging, especially when some elective classes require at least 20 students. For this reason, some transportation programs are transitioning to becoming a safety program. The University of Alabama offers a class that is completely dedicated to safety. The key is to have a training program that is similar to a college degree. The best way to make sure the HSM is implemented at a college level is to include it as part of the Professional Engineer evaluation.

There were several miscellaneous closing comments. MassDOT highlighted the importance of having statisticians in house. AZDOT has gone through many reorganization changes in the past few years and is having difficulty deciding who will be doing what.

Day 2 Session 4 – HSM Implementation Strategies and Resources

More than Design to a Budget – Kansas Department of Transportation (KDOT)

Kelly Farlow

KDOT's presentation covered the agency overview, their experiences applying the HSM for roadway design, and an example project illustrating how the HSM was used in roadway design.

Three divisions, Planning and Programming, Engineering and Design, and Operations, are included in KDOT. KDOT developed a practical design guide in 2009; however, the design guide does not include any references to the HSM. KDOT also developed multiple roadway design guidelines, which contain a few paragraphs that suggest using HSM calibration factors. Currently, KDOT is contracting with a university for most of the HSM SPF calibration efforts and will do the SPF calibration for freeways in the future.

KDOT offered several NHI courses and IHSDM courses, including the Highway Safety Manual Practitioners Guide for Horizontal Curves, the Highway Safety Manual Practitioners Guide for Geometric Design Features, and the Enhanced Interchange Safety Analysis Tool. Target audiences for these courses typically include roadway designers and traffic engineers.

KDOT has used the HSM to provide quantitative safety analysis in various project types, including lane modification and capacity analysis, passing lane study, typical selection alternatives, and corridors. The Empirical Bayesian method was used for some of these studies. KDOT has used HSM in the design of six rural two-lane, two-way road projects, one rural multilane road project, and two freeway projects.

The challenges for KDOT on HSM implementation mainly relate to two aspects. First, some of the design alternatives that KDOT considered are not available in the HSM crash predictive models. Second, KDOT has calibrated the SPF for only one facility type, the rural two-lane, two-way roads.

A case study was provided to illustrate how KDOT applied the HSM in roadway design. The purpose of the project is to enhance the traffic safety for I-135 from K-96 to I-235, and I-235 near the Broadway ramp. The safety analysis results confirmed that safety was an issue for this location. Different design alternatives, including a number of directional ramps and a new interchange, were proposed. Analysis results indicated that the design alternative can reduce the predicted total crashes by 16 percent.

Approaches for supporting HSM use for Local Agencies – Oregon Department of Transportation (Oregon DOT)

Kevin Haas

The presentation started with some statistics on the annual fatalities and serious injuries in Oregon. Between the 5-year time period from 2009 to 2013, Oregon experienced an average of 1,800 fatalities and serious injuries per year. Approximately 50 percent of the fatalities and serious injuries occurred on the state highways; 26 percent and 24 percent of the fatalities and serious injuries occurred on the city streets and county roads, respectively.

The Oregon DOT developed a new ARTS program to share the HSIP funds with local agencies in accordance with Map-21. The ARTS program is comprised of two programs, the hot spot program and the systemic program. The HSIP funds were split evenly between the hot spot program and the systemic program. The systemic program is focused on roadway departure, intersection, and bicyclist and pedestrian, and implementation plans have been developed for each of these focus areas. The hot spot projects are typically high cost projects that have limited effect in reducing overall fatalities and serious injuries but are politically popular. For the systemic program, low cost countermeasures are widely implemented to reduce overall fatalities and serious injuries.

For the systemic program, the Oregon DOT and local agencies within a region competed against each other for HSIP funding. The systemic projects is selected through an application-based process for which countermeasures can be chosen from an approved ODOT crash reduction factor (CRF) list. The projects for roadway departure and intersection crashes are prioritized based on the B/C ratio. The projects for pedestrians and bicyclists, however, are difficult to prioritize based on B/C ratios.

Bicyclists are a large part of commuters in Portland, Oregon, and account for 5.9 percent of all commuters, the highest percentage in the nation. In 2014, Oregon ODOT developed a pedestrian and bicycle safety implementation plan that uses measures such as traffic volume, proximity to a signal, and posted speed limit to develop a risk-based network screening tool. The tool works well for network screening purposes; however, it is difficult to prioritize the pedestrians and bicyclists projects using this tool.

The cost effectiveness index, which is the ratio of expected crash reduction to total project cost, was used to prioritize the pedestrian and bicyclist projects. The lower the CEI for the project, the higher the ranking of the project. The expected crash reduction was calculated using the HSM Part C crash predictive models. For this purpose, the Oregon DOT modified the NCHRP 17-38 crash predictive model calculation spreadsheet and included the CRFs of countermeasures for pedestrian and bicyclist crashes. Proposed countermeasures for pedestrian and bicyclist crashes include pedestrian countdown signal, intersection illumination, bicycle box at conflict points, and buffered bicycle lane.

The presentation was ended with a summary of HSM implementation at the local agency level in Oregon. Except for those larger local agencies, most local agencies have little exposure to the HSM. For the local system, the roadway data are not readily available for applying the HSM. The local agencies do not have adequate resources to implement the HSM.

HSM Implementation Strategies and Resources Roundtable Discussion

The roundtable discussion began with learning how states prioritize bike and pedestrian improvements. VDOT uses a risk based purpose and need approach. They have implemented safer roads to schools, and bikes and pedestrian safety programs. They document the purpose and need, identify the risks, assign scores based on various criteria, and anything that has a score more than 50 gets funded. Nevada DOT received $10 million from the Transportation Board of Directors to spend in pedestrian and bikes, which is going mainly to Las Vegas. They developed a trip generation and land use model that looks at variables such as bus stop location, senior centers, pedestrian ODs, high-density, low-income housing, and shopping centers, along with crash information. This model helps them identify locations for potential improvements.

IDOT conducted a system-wide RSA in the Chicago medical district and also in Urbana Champaign. They looked at cars, pedestrian, and bikes issues. They found that signal timing was a major concern. IDOT evaluated contributing factors and assigned risk levels. They also conducted a system-wide pedestrian and bicycle screening where they examined specific countermeasures to become standards, such as piano bar crosswalks. The City of Chicago is using pedestrian refugees, among several other safety strategies.

The following are lessons learned about communicating results to the public and making decisions.

WSDOT is challenged with people understanding the differences between different terminologies, such as expected vs. predicted and calibrated vs. uncalibrated. A Michigan DOT safety engineer has been presenting TZD information to local elected officials, road commissioners, and engineers that covers science-based methodologies. This has been proven effective in keeping information at a very high level without going into the details of the predictive methods. One KDOT project had a very extensive public involvement component, which they will make available to all attendees.

Based on ODOT's experience, the term "peer group" is easily understood for conveying comparisons between sites. It is simpler to explain that a location has a crash frequency lower than the peer group average.

LADOTD had its consultants work on a 16.1-mile access management corridor project with a strong safety component. The corridor study was well received by the public. LADOTD recommended not including too much detail; the public does not care about details such as predicted vs. expected. They recommended reporting round numbers, and making good use of visuals. Their project had minor comments from the public.

The roundtable discussion covered information about resources. The Pennsylvania Department of Transportation (PennDOT) has a CMF guide that helps to identify which CMF should be used for project evaluation. FDOT recently developed an HSM User Guide that is posted online. The target audience is primarily safety analysts. The guide supports spreading a consistent message about the application of the HSM.

IDOT has developed a user guide for calibration that is used by districts. There are two sets of calibration factors, one for the Chicago area and one for the remainder of the state. There was also a change in the reporting threshold in 2009, therefore they have two sets of calibration factors for two time periods. This analysis resulted in four sets of calibration factors that are incorporated into their HSM spreadsheet, which automatically selects the calibration factors to be used based on user input.

Several states have developed implementation plans. Some of the elements included in the ODOT implementation plan are developing SPFs, calibration, project development process elements, design exception, and practical design considerations. AZDOT developed an outline plan that includes needs, priorities, training, highway applications, and policy. LADOTD had its implementation plan prepared by a consultant. It includes a data needs assessment and a training matrix detailing who needs to be trained, among other elements. IDOT's consultant also developed an implementation plan. The main components include policy, training, data, tools, SPF development, and research. Alabama DOT has an implementation plan that contains specific objectives and goals in a 3- to 5-year timeframe.

Day 2 Session 5 – Needs for Sustained HSM Implementation Progress

HSM User Needs Survey – Louisiana Department of Transportation (LADOTD)

April Renard

The presentation on HSM user needs survey was presented by April Renard from LADOTD.

The presenter was tasked to be the clearinghouse for the HSM user needs survey. The survey results will be feed into the HSM second edition. Many questions have been collected from the TRB User Liaison group. This survey should be an information gathering pool for all safety performance issues. To ensure the success of the survey, all questions should be simple and easily answered. Attendees were asked to provide any questions that should be added to the list.

The following sample questions for the survey received by the presenter were discussed in the presentation:

- How has your state institutionalized the use of the HSM within your DOT and your local agencies?
- How should the Human Factors Guidelines (HFG) be integrated with the HSM?
- How do you think guidance and standards for traffic control devices are selected for inclusions in the MUTCD?
- Do you used the HSM? If so, what do you mean by using it?
- For changing the publication format of the HSM from hardcopy to a smart document, what will be your preferred publication format?
- Because the FHWA CMF Clearinghouse also provides information on CMF, how should the HSM Part D be updated? Should the HSM Part D be eliminated?
- What issues do you have with the HSM implementation?
- Which section of the HSM should be expanded?
- How does your agency conduct network screening?

The presenter interacted with the attendees on how to revise the survey questions so that useful information could be collected. Recommendations on changes and revisions to the survey questions were provided by the attendees during the presentation.

AASHTOWare Safety Analyst Update – Ohio Department of Transportation (ODOT)

Derek Troyer

The AASHTOWare SA was updated during the peer exchange. This included the update for systemic tool, the SA webinar, the GIS integration, the SPF Function Builder, future enhancements for SA, and licensing and service unit issues.

The update for systemic tool was introduced first. The procedures for using the systemic tool can be divided into five steps, site type selection, countermeasure selection, screening for potential sites, economic analysis, and priority ranking. It was stated that SA is limited to peak searching and sliding window for network screening. The sites are ranked from high to low based on the B/C ratio.

The SA webinar was held in March and the services were provided by SA contractors. The link to the webinar to download materials is provided in the presentation.

The GIS integration, which is the interface with the list of roadway site, was also introduced. The GIS integration allows the roadway sites to be selected spatially, and roadways also can be labeled under the GIS integration.

With the SPF Function Builder, an alternative safety performance functional form will be allowed in the SA, which will increase flexibility of the software. Specifically, the SPF Function Builder will allow a constant form, an exponential term with constant exponent, an exponential term with a variable exponent, and a power term, both singly and in any combination. The intent for developing the SPF Function Builder is to allow users to easily develop SPFs.

Future enhancements that are under consideration include the performance measure reports and enhancements on crash diagram. AASHTO is also soliciting inputs from the state DOTs about what revisions should be made to SA. The group that works on this task meets once per year to discuss future enhancements.

The costs for SA were included in the presentation. Services provided by the contractors include identifying data gaps or needs for agencies and preparing an implementation plan; preparing and importing the required roadway inventory, crash report, and traffic volume data; specialized training in the use of AASHTOWare SA for either engineering or software production; assisting with software deployment, agency specific modifications, or customized reports and data exporting; and agency specific enhancements to AASHTOWare SA modules. University licenses are also available; however, the capabilities will be limited. The use of the tool is limited to agencies that use federal dollars.

2015 Peer Exchange Participants

Survey Feedback

At the end of the peer exchange, attendees were asked to complete a survey that provided valuable feedback to the organizers. A total of 26 responses were received and summarized. Appendix C contains the attendee summary survey.

Attendees were asked about their satisfaction with key aspects of the peer exchange. Table 1 shows that most attendees were very satisfied with the registration process, speakers and presenters, and the venue.

TABLE 1
Attendee Overall Satisfaction

Overall Satisfaction	Very Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatisfied	Very Dissatisfied	Total
Registration Process	23	3	0	0	0	26
Materials and Handouts	15	7	4	0	0	26
Speakers and Presenters	21	4	1	0	0	26
Venue/Facility	20	6	0	0	0	26

Appendix A: Peer Exchange Agenda

Highway Safety Manual National Peer Exchange

August 31 - September 01, 2015. Nashville, Tennessee

	Monday, August 31st	Tuesday, September 1st
7:00 AM		Continental Breakfast
7:15 AM		
7:30 AM		
7:45 AM		
8:00 AM	Continental Breakfast	Welcome and Opening Remarks; Calibration and SPF Development
8:15 AM		
8:30 AM	Welcome and Opening Remarks/Introduction	
8:45 AM		
9:00 AM	National Efforts	Break
9:15 AM		Calibration and SPF Development – Part 2
9:30 AM		
9:45 AM		
10:00 AM	Break	Break
10:15 AM	Data: Innovative Approaches for Obtaining and Managing Data for the HSM	Policy, Guidance, Training: Building Blocks of Institutionalization
10:30 AM		
10:45 AM		
11:00 AM		
11:15 AM		
11:30 AM		
11:45 AM		Lunch
12:00 PM	Lunch	
12:15 PM		
12:30 PM		
12:45 PM		HSM Implementation Strategies and Resources
1:00 PM	HSM Case Studies (Part B): Programming Planning and Network Screening	
1:15 PM		
1:30 PM		
1:45 PM		
2:00 PM		Break
2:15 PM		Needs for Sustained HSM Implementation Progress; Research, User Needs, Guides
2:30 PM	Break	
2:45 PM	HSM Case Studies (Part C and D): Corridor and Site Specific Crash Prediction and Decision Making	
3:00 PM		
3:15 PM		
3:30 PM		
3:45 PM		Wrap-Up and Closing
4:00 PM		
4:15 PM	Increasing HSM Implementation	HSM Pooled Fund Meeting (Open to All State Agency Participants)
4:30 PM		
4:45 PM	Wrap-Up	

Monday, 8:30 am – 9:00 am

Welcome and Opening Remarks:
Mark Bush and Ray Krammes
Introductions:
Priscilla Tobias and Kim Kolody

Monday, 9:00 am – 10:00 am

National Efforts

AASHTO Overview: State Implementation Efforts, HSM 2nd Edition, Strategic Plan for Future Editions (15 min)
Priscilla Tobias, AASHTO Task Group Chair, Illinois DOT

FHWA Overview: Roadway Safety Data Program, HSM Implementation Pooled Fund, EDC3 Data Driven Safety Analysis Initiative (15 min)
Ray Krammes and Jerry Roche, FHWA

TRB Overview: Highway Safety Performance Committee (ANB25) (15 min)
Ida Van Schalkwyk, TRB ANB 25, Washington DOT

Monday, 10:15 am - 12:00 pm

Data: Innovative Approaches for Obtaining and Managing Data for the HSM

Enterprise Data Collection and Management (15 min)
Scott Jones, Utah DOT

Advances in Comprehensive, Real-Time Crash Data (15 min)
Brian Hurst, Tennessee DOT

Non-Signalized Intersection Inventory for SPF Development, SPF Development and Tool Integration (15 min)
Tim Barnett, Alabama DOT

States round table discussion (60 min)
Potential items to include:

- Data challenges
- Lack of data and how do you move forward
- Methods to overcome the challenges
- Data maintenance, who and how often
- Approaches for sharing data with others
- Data Collection
  - Non-motorized
  - Driveway Density
  - Surface Type
  - Surface Condition
  - ADT frequency, accuracy and estimating

Monday, 1:00 pm - 2:30 pm

HSM Case Studies (Part B): Programming Planning and Network Screening

Pairing SHSP with *Safety Analyst* Network Screening (15 min)
Tracie Leix, Michigan DOT

Deriving Contributing Factors using *Safety Analyst* (15 min)
Ida Van Schalkwyk, Washington DOT

Integrating HSM Performance Metrics into the Transportation Management Process (15 min)
Priscilla Tobias, Illinois DOT

States round table discussion (45 min)
Potential items to include:

- HSM Part B challenges
- HSM Part B most useful applications
- Who conducts network screening for the agency?
- How to expand network screening capabilities and encourage agencies to conduct network screening?
- Prioritization approaches for identifying locations of improvement
- Benefits of investment in network screening tools
- Investment comparison of customized network screening tools
- Obtaining leadership buy-in to change processes

Monday, 2:45 pm - 4:15 pm

HSM Case Studies (Part C and D): Corridor and Site Specific Crash Prediction and Decision Making

Design Decision Making for Shoulder Width–IHSDM Application (15 min)
Kohinoor Kar, Arizona DOT

Safety Decision Making: Roundabouts (15 min)
Ken Mammen, Nevada DOT

Intersection and Freeway Analysis (15 min)
Ruihua Tao, Maryland DOT

HSM Applications for Larger Projects and Alternative Evaluation (15 min)
Derek Leuer, Minnesota DOT

States round table discussion (30 min)
Potential items to include:

- HSM Part C challenges
- Pilot Programs
- Measuring and communicated predictability of models

- Communicating results to obtain design decisions
- Most useful applications – design exceptions, value engineering
- Is the HSM Part C being used to support the right decision or used inappropriately to support the wrong decision?
- HSM Part D challenges
- Methods for supporting proper selection of Part D CMFs
- Misuse of HSM Part D CMFs
- Is the standard error in HSM Part D being communicated? How should it be communicated?
- HSM Part D most useful applications
- Integration of HSM Part C and D into state's processes
- Making decisions using the HSM and Human Factors Guide
- Practical design and the HSM
- Alternatives Analysis: How to select the preferred safety option, Incremental B/C

Monday, 4:15 pm - 4:45 pm

Increasing HSM Implementation—Communicating to the Various Users

States round table discussion (30 min)

Potential items to include:

- How do you communicate the value of the HSM to the user's needs and job functions?
- Obtaining buy-in from:
  - Leadership
  - Standard/policy engineers within the agency
  - Planning/programming to include HSM metrics
  - Users
  - Local agencies
- Common obstacles in HSM implementation and effective strategies to overcome them?
- Case studies and examples to demonstrate the power of the HSM
- Regional peer-exchange or periodic web-conference?
- Partnerships in the expansion of the wide spread use the of HSM (professional societies, universities)

Tuesday, 8:00 am – 9:00 am

Welcome and Opening Remarks

Calibration and SPF Development

State Progress on Calibration and SPF Development (Handout) (5 min)

Decision to Develop SPFs, SPF Development (10 min)

Bonnie Polin, Massachusetts DOT

SPF Calibration Lessons Learned (10 min)

Darryl Belz and Kara Aguilar, Maine DOT

All Models are wrong, but some are useful (10 min)

April Renard, Louisiana DOTD

States round table discussion (25 min)

Potential items to include:

- Methods for prioritizing models for calibration
- Calibration challenges
- Sample size
- Minimal data needed
- Data collection needs
- Maintenance of factors
- Guidance resources

Tuesday, 9:15 am – 10:00 am

Calibration and SPF Development – Part 2

Calibration Process and Results Evaluation (10 min)

Derek Troyer, Ohio DOT

Using Custom Safety Performance Functions (10 min)

Matt Warren, Oklahoma DOT

Florida SPF Development and Calibration (10 min)

Joe Santos, Florida DOT

States round table discussion (15 min)

Potential items to include:

- Methods for prioritizing models for SPF development
- Types of SPFs developed (bridge, roundabout, non-motorized)
- Severity models
- Crash type models
- Minimal data needed
- Data collection needs
- Maintenance frequency
- Guidance resources

Tuesday, 10:15 am – 11:45 am

Policy, Guidance, Training: Building Blocks of Institutionalization

Integrating the HSM into Virginia's Multimodal Construction Program Prioritization (15 min)
Stephen Read, Virginia DOT

Design Exception Policy (15 min)
Drew Williford, Missouri DOT

HSM Analysis in Policy (15 min)
Virgilio Tan, New Jersey DOT

States round table discussion (45 min)
Potential items to include:

- Policies versus manuals/guides – which are more effective
- Methods for overcoming the challenge of change
- Was training delivered before or after policy and manual updates?
- Which users received training? (leadership, designers, managers)
- Additional resources
- NCHRP 15-50 Guidelines for Integrating Safety and Cost Effectiveness into Resurfacing, Restoration, and Resurfacing

Tuesday, 12:45 pm – 2:00 pm

HSM Implementation Strategies and Resources

More than Design to a Budget (15 min)
Kelly Farlow, Kansas DOT

Approaches for supporting HSM use for Local Agencies (15 min)
Kevin Haas, Oregon DOT

HSM Implementation for the Emerging Leader (15 min)
Daniel Helms, Mississippi DOT

States round table discussion (30 min)
Potential items to include:

- Resources available, created based on user needs
- Local agency challenges
- Methods and approaches for supporting HSM at various levels within an agency
- HSM implementation steps
- HSM implementation plans

Tuesday, 2:15 pm – 3:30 pm

Needs for Sustained HSM Implementation Progress

Research, User Needs, Guides

Moderator: Priscilla Tobias

HSM User Needs Survey (15 minutes)
April Renard, Louisiana DOTD

AASHTOWare Safety Analyst Update (10 minutes)
Derek Troyer, Ohio DOT

Appendix B: List of Participants

NCHRP 17-50 Peer Exchange 3. List of Participants

No.	Full Name	Last Name	First Name	Email	Organization
1	Kara Aguliar	Aguliar	Kara	Kara.A.Aguilar@maine.gov	Maine DOT
2	Chris Armstrong	Armstrong	Chris	Christopher.Armstrong@tn.gov	Tennessee DOT
3	Ron Baker	Baker	Ron	Ron.Baker@tn.gov	Tennessee DOT
4	Tim E. Barnett	Barnett	Tim E.	barnettt@dot.state.al.us	Alabama DOT
5	Darryl Belz	Belz	Darryl	darryl.belz@maine.gov	Maine DOT
6	Mark Bush	Bush	Mark	MBush@nas.edu	TRB
7	Clayton Chen	Chen	Clayton	clayton.chen@dot.gov	FHWA
8	Mike Colety	Colety	Mike	Mike.Colety@kimley-horn.com	Kimley-Horn
9	Mike Curtit	Curtit	Mike	Michael.Curtit@ch2m.com	CH2M
10	Brandon Darks	Darks	Brandon	Brandon.Darks@tn.gov	Tennessee DOT
11	David Duncan	Duncan	David	David.A.Duncan@tn.gov	Tennessee DOT
12	Greg Dyer	Dyer	Greg	Gregory.Dyer@tn.gov	Tennessee DOT
13	Kelly Farlow	Farlow	Kelly	kellyf@ksdot.org	Kansas DOT
14	Mike Gilbert	Gilbert	Mike	Michael.Gilbert@tn.gov	Tennessee DOT
15	Kevin Haas	Haas	Kevin	kevin.j.haas@odot.state.or.us	Oregon DOT
16	Kelly Hardy	Hardy	Kelly	khardy@aashto.org	AASHTO
17	Brian Hurst	Hurst	Brian	Brian.hurst@tn.gov	Tennessee DOT
18	Scott Jones	Jones	Scott	wsjones@utah.gov	Utah DOT
19	Kohinoor Kar	Kar	Kohinoor	KKar@azdot.gov	Arizona DOT
20	Kim Kolody	Kolody	Kim	kkolody@ch2m.com	CH2M
21	Ray Krammes	Krammes	Ray	Ray.Krammes@dot.gov	FHWA
22	Tracie Leix	Leix	Tracie	leixt@michigan.gov	Michigan DOT
23	Derek Leuer	Leuer	Derek	derek.leuer@state.mn.us	Minnesota DOT
24	Tracy Lovell	Lovell	Tracy	tlovell@aashto.org	AASHTO
25	Ken Mammen	Mammen	Ken	kmammen@dot.state.nv.us	Nevada DOT
26	Brian Mayhew	Mayhew	Brian	bmayhew@ncdot.gov	North Carolina DOT
27	Tommy Myszka	Myszka	Tommy	Tommy.myszka@CH2M.com	CH2M
28	Dante Perez-Bravo	Perez-Bravo	Dante	Dante.Perez-Bravo@CH2M.com	CH2M
29	Bonnie Polin	Polin	Bonnie	Bonnie.Polin@state.ma.us	Massachusetts DOT
30	Brian Porter	Porter	Brian	brian.porter@dot.wi.gov	Wisconsin DOT
31	Stephen W. Read	Read	Stephen W.	Stephen.Read@VDOT.Virginia.gov	Virginia DOT
32	April Renard	Renard	April	april.renard@la.gov	Louisiana DOTD
33	Jessica Rich	Rich	Jessica	Jessica.Rich@dot.gov	FHWA
34	Jerry Roche	Roche	Jerry	jerry.roche@dot.gov	FHWA
35	Glenn Rowe	Rowe	Glenn	GLROWE@pa.gov	Pennsylvania DOT
36	Joseph B. Santos	Santos	Joseph B.	joseph.santos@dot.state.fl.us	Florida DOT
37	Thomas Schriber	Schriber	Thomas	thomas_schriber@dot.ca.gov	California DOT
38	Zahidul Siddique	Siddique	Zahidul	Zahidul.Q.Siddique@odot.state.or.us	Oregon DOT
39	Jason Siwula	Siwula	Jason	jason.siwula@ky.gov	Kentucky Transportation Cabinet
40	Virgilio Tan	Tan	Virgilio	Virgilio.Tan@dot.nj.gov	New Jersey DOT
41	Ruihua Tao	Tao	Ruihua	rtao@sha.state.md.us	Maryland SHA
42	Priscilla Tobias	Tobias	Priscilla	Priscilla.Tobias@illinois.gov	Illinois DOT
43	Joe Toole	Toole	Joe	jtoole@kittelson.com	Kittelson & Associates, Inc.
44	Derek Troyer	Troyer	Derek	Derek.Troyer@dot.state.oh.us	Ohio DOT
45	Ida van Schalkwyk	van Schalkwyk	Ida	vanschi@wsdot.wa.gov	Washington DOT
46	Matt Warren	Warren	Matt	mwarren@odot.org	Oklahoma DOT
47	Andrew Williford	Williford	Andrew	Andrew.Williford@modot.mo.gov	Missouri DOT
48	Jiguang Zhao	Zhao	Jiguang	Jiguang.Zhao@ch2m.com	CH2M

Appendix C: Lead State Attendee Survey Summary

Highway Safety Manual Lead State Peer Exchange
Attendee Survey

Item	Overall Satisfaction				Additional details for "Not Satisfied", if any	What did you like most and what is your most important gain from it?	Interested in learning more about any specific topic discussed at the Peer Exchange													In a scale from 1% to 100%, where do you think you are with HSM implementation efforts in your state?	While developing and implementing HSM in your organization, what kinds of resources and support would you like to have within our state, regionally, and nationally to continue to support your efforts?	Overall Satisfaction			Additional comments or feedback on this workshop
	Registration Process	Materials/ Handouts	Speakers/ Presenters	Venue/ Facility			SPF Development	HSM Calibration	Future Research	Safety Analyst	HSM Spreadsheets	Data Needs	Implementation Plans	Use of Part D CMFs	IHSDM	Part C Examples	Part B Examples	HSM Resources	Other			Completely	Somewhat	Not at All	
1	VS	VS	SS	VS		I learned about several resource documents from FHWA and other states that will be helpful for our future HSM implementation.	X	X	X	X			X				X			10% - we have support from upper management but lack staff resources to move forward in a timely manner. Getting others involved in our agency to assist with our implementation will be key to our success.	Training on parts B & C, model policy language/documents, guidance on statistical issues with developing/calibrating CMFs/SPFs.	X			Perhaps an HSM status of implementation summary from each state could be developed and sent out to everyone who attended the peer exchange. Having a consistent format or general themes might help to give a framework. Great job on coordinating the peer exchange!
2	VS	VS	VS	VS		Hearing from peer states - success stories, issues. Recommendations to overcome some challenges, etc.	X	X	X	X			X						How to obtain upper management support	25% - No policy yet.	All the above	X			Need peer exchange periodically (on-site) and webinar/conference calls in between to keep the momentum.
3	VS	N	VS	VS	Materials still coming, right?	Connections with colleagues.			X	X	X	X			X	X	X	X		30% - Still some hanging on to crash rates.	Spreadsheet tools that states can tweak.	X			Thank you

Highway Safety Manual Lead State Peer Exchange
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4	VS	VS	VS	VS		All great info	X		X	X	X				X	X	X	X		40% There is a ton more we can do. Chipping away at things.		X			Fantastic
5	VS	VS	VS	VS		Excellent discussion! Great Presentations! Will work on a design exception process using HSM.													I feel well informed at this point.	60%	Training; tutorials.	X			Thanks
6	VS	SS	VS	SS		Finding out ways to expand prediction of crashes. Proportional tables by region. Best time to influence project design.			X																

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7	SS	SS	N	SS		Hearing what other state DOT's are doing. How the SPF & CMF are being developed. Getting started with developing SPF - CMF. Regional based models for SPF development	X	X					X					X		10% - Very early stages of development.	Any type of education and involvement pertaining to HSM due to early development & implementation.		X		Overall, very good peer exchange.
8	VS	VS	SS	VS		Good information and reassurance that HSM implementation is a process. Tennessee is in the early stages but hoping to gain more progress soon.	X	X			X									50% - We have developed an HSM committee, will participate in a peer exchange, and getting training	More examples of how to use it, using our info.		X		

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9	VS	VS	VS	VS	Tennessee is just moving into the HSM, so all information was an eye opening experience for us.	Group discussion	X	X	X	X	X	X	X	X	X	X	X	X	All material will be beneficial	5%	All. We have an outreach plan with FHWA	X			Thank you.
10	SS	VS	VS	SS		Seeing what other states are doing, and getting idea on how to move forward.			X		X		X							15% - project examples and analysis, not much more. Some training.	Training of districts, Implementation plans.	X			Learned a lot. Have a long way to go.
11	SS	SS	SS	SS	Very good overall. Less presentations and more time to talk in small groups	Opportunity to learn best practices from each state.	X	X	X	X	X	X	X	X	X	X	X	X		75%	Region Workshop development and facilitation	X			Good Work!

Highway Safety Manual Lead State Peer Exchange
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12	VS	VS	VS	SS		Networking and sharing of best practices and methods to overcome obstacles	X						X							20% - Primarily targeted to HSIP. Currently working to incorporate Div. of Planning before involving Div. of Highway Design.	Training & Tutorials	X			
13	VS	VS	VS	VS		I enjoyed hearing experiences from a variety of states. It was good to make contacts with states advancing in different areas of the HSM implementation	X	X	X				X	X	X	X		X		It depends on which area. I would say 40% overall. We've used on many projects in Road Design, but not extensively in Traffic Engineering (Intersections/RSA;s) , Network Screening or with local safety projects	State specific training & tutorials. Continued involvement at the region and national level is helpful	X			

Highway Safety Manual Lead State Peer Exchange
Attendee Survey

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14	VS	VS	VS	VS		The different examples that were given by the speakers. I gained ideas of various approaches that can be used to utilize HSM. The presentations were good.					X	X	X							45% - Got a good start but have a long ways to go.	Training - Lots of it.	X			Thank you for setting this up and for scheduling in conjunction with the AASHTO highway safety meeting.

Highway Safety Manual Lead State Peer Exchange
Attendee Survey

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15	VS	VS	VS	VS		Since this was my first true HSM Peer Exchange, I really enjoyed hearing other states discuss their perspective/concerns. I gained several "take home" ideas from this conference: Implement HSM in design alternatives, VE, and AJR with respect to an order of gently introducing the analysis. Look into using TRCC/HSIP funds for safety/data analysis/collection. Cure Plots.			X	X			X		X	X	X	X		40% - I say that because we have made significant strides, but still have a long way to go. I set it below 50% due to the fact that we don't necessarily have strong program yet.	The FHWA training geared towards upper management is a great idea. We need a way to simplify/clarify some of the HSM results (visualization, maps, etc.). Need help with locals	X			This was very informative and well done. A special ""thank you" should go out to all those who handled the logistics of this conference! I have about 20 ideas I want to implement in Missouri (It might be closer to 50).

Highway Safety Manual Lead State Peer Exchange
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16	VS	SS	VS	VS	Waiting for on-line slides to make "materials" very satisfied	Short presentations from many states w/ Q/A. Broad range of topics		X					X		X	X				40% - Have Part B fully implemented. 60% to be done with project development use of Part C/D	Shoe states how to use in different program steps. Case studies/Project documentation. Training 1 and 2 day classes, online. Best Practices for reporting results. Types of tables/comparisons for alternatives.	X			
17	VS	SS	SS	SS			X		X		X	X		X	X	X	X	X		Maybe 50%. Completed training. Usage of HSM is on voluntary basis. Lack of policy & guidelines in institutionalizing. Completed local calibration of HSM.		X			

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18	VS	SS	VS	VS			X	X	X	X	X	X						X		5% - we are just in early stages of developing & researching information needed to create factors unique to our state.					
19	Vs	SS	SS	VS		Learning how other states have implemented the HSM for alternatives evaluation and prioritization.	X	X			X		X			X	X			30% - Our state has just commissioned a consultant to develop statewide SPFs. Our crash data is relatively robust and up to date.		X			
20	VS	N	VS	VS		Wide variety of topics and good roundtable discussions. I can take some of the lessons learned here and try to implement those in my agency.	X	X									X			10%	More outreach to upper management. More push from FHWA/AASHTO	X			

Highway Safety Manual Lead State Peer Exchange
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21	VS	VS	VS	VS		Very interested in short-term heat map for sections developed by TN for law enforcement. Glad we have avoided some of the data gathering and calibration costs paid by some states. Learned that LIDAR data collection has data maintenance issues.	X		X			X			X			X		40% - We have the ability to develop and use SPFs but have not institutionalized this ability or established the use of HSM methods in non-HSIP projects.	Training prepared for and delivered directly to design engineers and senior staff to promote the value of predictive methods.	X			Didn't know if this would work with so many speakers and no breakouts but I preferred it to other conferences that used the breakout format.
22	VS	VS	VS	VS		Networking with colleagues. Q & A sessions/exchange of ideas following presentations	X		X		X	X		X				X		50% - still lacking in roadway design/design exceptions. Still lacking in understanding/support from upper management	Regional conferences/calls, tutorials, meetings with neighboring states	X			Great job and agenda well executed. Good participation.

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23	VS	VS	VS	VS		Al experiences, lessons learned, case studies, pilot projects, and future/next steps planned shared by the group.			X	X	X	X	X		X	X						X			Perhaps 2-year cycle of this peer exchange events in the future will be helpful.
24	VS	N	VS	VS		Learning HSM experiences from other DOT's is great.	X	X		X	X					X				20%	Training and tutorials	X			More time for topics one needs to focus on.
25	VS	VS	VS	VS		Enjoy finding out where the other states are on implementation. Also, what new programs/projects they have underway.							X					X		40%	step by step webinar for all of the HSM and any new material/training	X			
26	VS	N	VS	VS				X			X							X		50% - We have it and are using but not department wide.	Official support from FHWA for state DOT's (at least adopt HSM as a guide).	X			

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27	VS	VS	VS	VS		It was an actual peer exchange and not a lot of talking heads. That was great. A lot of opportunity to talk amongst ourselves	X	X		X	X	X	X	X	X	X	X	X	Any and all info on applied use and real life practical uses.	25% - We are raising awareness, developing SPF's and trying to put in place policy.	Training & Tutorials		X		Having lunch in the same room with an opportunity to walk around and talk gave extra time to have conversations. Want to expand to bring others from MA (Chief Engineer, Design Exceptions Committee, etc.)

VS = Very Satisfied
SS=Somewhat Satisfied
N=Neutral

Appendix D: References

- *Highway Safety Manual* website: www.highwaysafetymanual.org
- IHSDM website: http://www.tfhrc.gov/safety/ihsdm/ihsdm.htm
- SafetyAnalyst website: http://www.safetyanalyst.org
- Crash Modification Factors Clearinghouse: http://www.cmfclearinghouse.org
- NCHRP Research Results Digest 329: www.trb.org/Publications/Blurbs/Highway_Safety_Manual_Data_Needs_Guide_159984.aspx
- Training courses available at http://nhi.fhwa.dot.gov