LOUISIANA

Highway Safety Manual Implementation Plan

prepared for

Louisiana Department of Transportation and Development

prepared by

Cambridge Systematics, Inc.

DESTINATION ZERO DEATHS

June 2012

report

Louisiana HSM Implementation Plan

prepared for

Louisiana Department of Transportation and Development

prepared by

Cambridge Systematics, Inc.
9015 Mountain Ridge Drive, Suite 210
Austin, TX 78759

date

November 14, 20112

Table of Contents

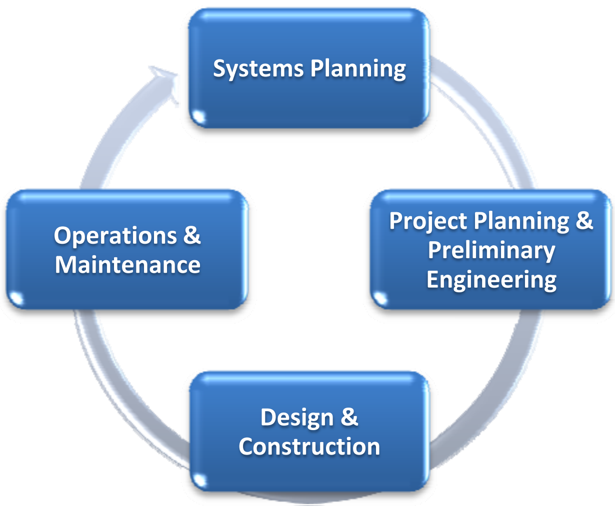
List of Tables

List of Figures

Highway Safety Manual Implementation Overview

1.1 Background and Purpose

In a continued effort to improve safety on Louisiana's roads, the Louisiana Department of Transportation and Development (DOTD) in partnership with the Louisiana State Police (LSP) and the Louisiana Highway Safety Commission (LHSC) recently updated Louisiana's Strategic Highway Safety Plan. The plan identifies infrastructure and operations as one of the four emphasis areas, with implementation of the Highway Safety Manual (HSM) identified as a key strategy.



The HSM was published by the American Association of State Highway Transportation Officials (AASHTO) in the spring of 2010 and provides the best factual information currently available on transportation safety. The HSM provides methods for quantifying crash frequency and severity in all aspects of a typical project development process, including systems planning, project planning, preliminary and final design, construction, operations, and maintenance. The HSM is intended to assist agencies in their effort to integrate safety into their decision-making processes.

The Louisiana Strategic Highway Safety Plan (SHSP) specifically identifies the following objectives to support HSM implementation:

- Develop an Implementation Plan for adopting the HSM as a guideline for DOTD project safety analysis.
- Conduct HSM training courses to ensure practitioners are able to integrate the HSM into daily project planning, programming, and engineering activities.
- Evaluate and compare state crash, roadway, and traffic volume data availability to HSM data needs.

- Implement analytical tools to assist in network screening and project identification.

This plan serves to accomplish the first objective and provides a detailed plan for adopting the HSM as a guideline for DOTD project safety analysis.

1.2 Benefits and Driving Forces of HSM Implementation

While the HSM is only one of many tools that can be used for evaluating safety, there are many benefits associated with its implementation. The HSM provides transportation professionals with knowledge, techniques, and methodologies to quantify the safety impacts of transportation decisions, similar to the way the Highway Capacity Manual provides knowledge and tools for quantifying operational impacts. By enabling transportation professionals to quantify the safety implications of decisions in the transportation project development process, the HSM:

- Allows for the explicit consideration of safety in project development;
- Improves the decision-making process;
- Promotes the use of effective countermeasures;
- Enables decisions based on quantitative evaluations that predict change in crash frequency or severity associated with a planned roadway modification.
- Instills confidence that safety funds are being applied most effectively;
- Reduces time spent justifying a safety decision by conducting a definitive, science-based analysis; and
- Integrates safety elements in the most cost-effective manner in the project development process.

These benefits should be used as driving forces to promote HSM implementation within the DOTD.

Other forces driving the need for HSM implementation include the requirement to include a safety analysis in design exceptions and the ability to quantify safety in the evaluation of alternatives. The HSM can be used to demonstrate a particular alternative's expected safety performance is greater than another and can be used to educate the public on how projects are saving lives. Finally, the HSM provides for a more systematic and efficient process for evaluating and discussing safety performance and an opportunity to improve how the DOTD conducts business.

The DOTD intends to integrate quantitative safety decisions into the state project development process as appropriate. The HSM provides one set of tools for quantitative safety analysis, and this document explains how the HSM fits into the state's process. As other quantitative safety tools become available, they will also be considered for integration into the state's process for quantitative safety decision-making.

1.3 CHALLENGES TO HSM IMPLEMENTATION

While there are many benefits associated with implementing the HSM within the DOTD, the HSM Implementation Team also identified several challenges to consider in the development of this plan. These challenges include:

- Data quality (e.g., crash location) and availability (e.g., data for local roads);
- Interpreting results and establishing standards for use;
- Complexity of manual is intimidating to users;
- Institutional resistance;
- Relaying expectations to consultants;
- Determining the appropriate performance metrics;
- Crossing boundaries between disciplines;
- Getting local agencies up to speed – players frequently change, not the same technical staff;
- Rigidity of DOTD practice;
- Development of calibration factors for the HSM SPFs;
- Project schedules and politics;
- Legal aspect in NEPA documents (not protected under Section 409);
- Getting district buy in on new strategies; and
- Resources to conduct additional analysis.

These challenges were a key consideration in the development of this implementation plan. Many of the strategies included in this plan directly or indirectly focus on addressing these challenges, and it is recommended that these potential barriers be reconsidered and addressed as the strategies are refined.

1.4 PLAN ORGANIZATION

This plan is organized into six sections, including this first section. The second section focuses on organizational support needed for implementation including, champion and leadership team, executive support, district support, and marketing. Section 3 identifies the data improvements necessary for full implementation of the HSM, which were identified through a HSM data readiness evaluation conducted as part of this project. Section 4 discusses the DOTD project delivery process and identifies opportunities for using the HSM in the process. Section 5 identifies specific applications for various departments in the DOTD, including implementation strategies and training needs. Finally, Section 6 provides an implementation schedule for the strategies identified throughout this plan.

Organizational Support

This section focuses on the organizational support necessary to successfully implement the HSM within Louisiana DOTD. Because marketing and training are both key elements to gain support for the HSM throughout the DOTD, marketing and training are also included in this section.

1.5 Champion and Leadership Team

Leadership support is an essential element for successful implementation of the HSM within DOTD business practices. This requires an agency champion committed to driving the HSM implementation effort and promoting use of the HSM throughout all levels of the agency. The champion will also lead the efforts to integrate quantitative safety into all aspects of project, program, and policy decision-making at the DOTD. The Highway Safety Administrator accepted this role and established an HSM Implementation Team comprised of representatives from the Federal Highway Administration (FHWA), the Local Technical Assistance Program (LTAP), and several business units within DOTD, including:

- Highway Safety;
- Transportation Planning;
- Environmental;
- Traffic Engineering;
- Road Design;
- Pavement Preservation; and
- District Traffic.

Each of the HSM Implementation Team members provided input into the development of this plan. These business units are the focus of initial implementation efforts.

1.6 Executive Support

While the agency champion and implementation team will manage the day-to-day activities in implementing the HSM, it is also essential to ensure there is an executive sponsor to promote the importance of the HSM within the DOTD and to gain support at all levels. Members of the HSM Implementation Team unanimously agreed that executive level support is essential for successful implementation of the HSM but did not feel the effort currently has adequate executive support.

While the general consensus is that further executive support is needed, the views on the necessary level of executive support varied between the Deputy Secretary and the Directors of the various Offices within the DOTD (e.g., Office of Multimodal Planning, Office of Engineering, Office of Operations). Team members noted that the executive(s) does not need to actively participate in every aspect of the HSM Implementation Team's efforts but rather be kept in the loop and educated on the team's efforts. The executive can then relate the importance of the effort to other groups in the DOTD, the Secretary and the rest of the legislature.

Strategies

- Develop an executive level committee consisting of the Director of the Office of Multimodal Planning, the Office of Engineering, the Office of Operations and the Office of Management and Finance.
- Hold executive level committee meetings on a quarterly basis to discuss implementation of HSM and the integration of quantitative safety into decision-making in the DOTD.

1.7 HSM Technical Committee

As implementation occurs, it may become necessary to make policy level decisions regarding various HSM applications. An HSM Technical Committee could be convened to evaluate and identify HSM analysis assumptions related to:

- Default data assumptions (i.e., crash distributions, default traffic volume assumptions for particular facility types) for those data and variables which impact safety prediction in Louisiana and may not be available in current databases.
- When "safety" should be in integrated into different projects. Potential "safety" analysis thresholds could be project size, project activity (e.g., design, planning) or project issue (e.g., traffic operations, environmental impacts, safety).
- Acceptable/minimum CMF Clearinghouse star rating for CMF application in Louisiana. The DOTD may want to adopt a policy requiring CMFs to have a minimum star rating (e.g., three-star rating or higher) for use in DOTD projects.
- Appropriate application of standard error and confidence intervals for project analysis. For example, should a 90, 95, or 99 percent confidence interval be used in calculating the confidence interval of the CMF; or what should be done when the upper end of the confidence interval is over 1.0 and the lower end is below 1.0?

- When to revise design standards. As DOTD learns more about the safety impacts and tradeoffs of different design characteristics, DOTD may want consider whether they want to integrate these findings into design standards.
- How to integrate other safety partners. For example, if a project or plan identifies an enforcement issue, what is the protocol for including enforcement and implementing the required enforcement programs or policies?

The DOTD should establish a HSM Technical Committee to develop policy recommendations related to HSM applications. Membership on the committee should include staff from both headquarters and districts (i.e., District Traffic, District Design, Data, Safety, HQ Traffic, Planning, Design).

Strategies

- Establish a HSM technical committee consisting of various sections in the DOTD involved in implementing the HSM.

1.8 District Support

Obtaining district support and participation is another essential element to successful implementation of the HSM within the DOTD. The HSM Implementation Team currently includes one representative from District Traffic. Some team members thought a District Design Engineer or District Administrator should also participate on the team to promote district support, while others thought communication with the districts could be achieved through the District Traffic representative. One member thought that getting the Chief of Operations on board was important to selling the use of the HSM to the districts. Overall, it is evident that the District Engineers need to see the value of the HSM and apply it in their project planning. The team identified several strategies to gain District Engineers' support, including:

- Identify a district liaison to reach out to district traffic and design engineers at the programmatic level.
- Provide example applications or worksheets for district use.
- Provide extensive training, including one-on-one training as needed with District Engineers and teach them how to use the HSM. A similar tactic was used for training on SIDRA software to evaluate roundabouts.
- Establish a local district technical expert on HSM to support other districts and answer questions.

Strategies

- Add one District Design Engineer and one District Administrator to the HSM Implementation Team.

- Establish a HSM users group to provide peer level technical support to promote HSM integration into DOTD practices.
- Establish a District Engineer HSM working group to discuss barriers and opportunities to integrating HSM analysis methodologies into District activities.

1.9 Marketing

Marketing the benefits and uses of the HSM to potential users is also an essential to gaining support throughout the DOTD, especially the support of the districts, and of other transportation stakeholders in the state. Several members discussed need for developing a marketing plan and identified strategies for communicating the benefits and uses of the HSM targeted to potential users. Some of the strategies identified include:

- Develop white papers on effective countermeasures and the predictive method;
- Develop one page summaries:
  - Providing a concise explanation of how to apply various parts of HSM;
  - Identifying DOTD specific HSM applications (e.g., balancing between lane and shoulder width, analysis comparing median access configurations);
- Present summaries of Louisiana specific HSM applications at professional organization meetings (similar to outreach for new access management policy);
- Document Louisiana specific project applications in which the HSM was used in the decision-making process;
- Document applications of the HSM in design exceptions and other decision-making processes; and
- Conduct a PR campaign.

The Office of Communications should be included in HSM marketing efforts and the development of a HSM marketing plan. The marketing and communications efforts should be targeted as appropriate to different user groups (i.e., executives, managers, technicians).

Strategy

- Develop a marketing plan to promote application of methods, demonstrate value, broadcast training opportunities, and emphasize importance of quantitative safety in all project, programs, and policies in the DOTD. Some concepts for a marketing plan may include:

- Identify specific examples of HSM project applications within the DOTD to highlight and develop project summaries documenting how the HSM was applied and benefits of its use in the project development process.
- Prepare presentations of these applications and present at professional organization meetings and related conferences in the state.

1.10 Training Program

To successfully implement the HSM within the DOTD, staff must be properly trained on HSM applications and uses. The DOTD has already conducted several introductory training sessions on the HSM; however staff will require more specialized training on how the HSM can be used in their job function. Staff training needs will vary by DOTD business unit and job responsibility. A training program should be developed that identifies and prioritizes training needs according to business unit and staff level to serve as a guide for staff HSM training.

Strategy

- Develop an overall training program that identifies and prioritizes training needs according to business unit and staff level.
- Include courses in formalized training requirements.

Data Improvements

A HSM data readiness evaluation was conducted as part of this HSM Implementation Plan development effort. The existing DOTD crash, roadway and traffic volume data were compared to the HSM data needs. The findings of the evaluation identify the data necessary for calibration of the predictive method safety performance functions (SPFs), use of the predictive method in project development, use of new network screening software, local road data, and location of systemwide improvements as the critical elements for data improvements. The full evaluation can be found in Appendix A.

1.11 PREDICTIVE METHOD CALIBRATION

The HSM Part C predictive method includes predictive models which consist of SPFs, and crash modification factors (CMFs). These predictive models are regression equations developed from a nationwide database of number of similar sites. They estimate the predicted average crash frequency for a typical site given specific geometric characteristics and traffic volumes. However, because crash frequencies can vary significantly from one jurisdiction to another, it is important to calibrate SPFs for application in each jurisdiction for reliable results. Calibration requires a separate calibration factor for each SPF being used. The HSM currently includes SPFs for rural two-lane roads, rural multilane highways, and urban and suburban arterials. Each facility type includes SPFs for both roadway segments and intersections, which may include multiple SPFs based on facility characteristics as shown in Table 3.1.

Table 0.1 Part C Predictive Method SPFs Available by Facility Type

Facility Type	Segment Type	Intersection Type
Rural two-lane, two-way roads	Two-lane undivided segments	3-leg intersections with minor-road stop control 4-leg intersections with minor-road stop control 4-leg signalized intersections
Rural multilane highways	Undivided segments Divided segments	3-leg intersections with minor-road stop control 4-leg intersections with minor-road stop control 4-leg signalized intersections
Urban and suburban arterials	Two-lane undivided segments Three-lane segments with center two-way left-turn lane Four-lane undivided segments Five-lane undivided segments with center two-way left-turn lane	3-leg intersections with minor-road stop control 3-leg signalized intersections 4-leg intersections with minor-road stop control 4-leg signalized intersections

Calibration requires crash data, traffic volume data, and site characteristic data for 30 to 50 sites for each SPF being calibrated. Crash and traffic volume data are required for the calibration of all SPFs, but the necessary site characteristics data varies by facility type. The HSM categorizes the site characteristics data as required or desired for the calibration of each SPF. However, it should be noted that these distinctions were based on assumptions of which data elements agencies were likely to have available and not based on their impact on the calibration results. As calibration is undertaken, the DOTD should consider conducting a sensitivity analysis on the desired data elements (not currently available in the state's databases) to evaluate their relative impact on the predicted crash frequency.

The predictive method calibration data needs were compared to the DOTD highway inventory assets database to identify data availability. Table 3.2 summarizes the results of the evaluation for roadway segments.

Table 0.2 Roadway Segment SPF Calibration Data Not Available in DOTD Databases

HSM Chapter	Required Data Element	Desired Data Element
Chapter 10 – Rural Two-Lane, Two-Way Roads		Presence of spiral transition for horizontal curves Superelevation variance for horizontal curves Presence of lighting Driveway density Presence of short 4-lane section Presence of centerline rumble strips Roadside hazard rating Use of automated speed enforcement
Chapter 11 – Rural Multilane Highways	Presence of lighting Sideslope (undivided only)	Use of automated speed enforcement
Chapter 12 – Urban and Suburban Arterials	Number of driveways by land-use type Type of on-street parking	Roadside fixed object density Presence of lighting Presence of automated speed enforcement

This evaluation includes the efforts underway to develop the GIS-based highway inventory database. With the exception of four required data elements, the remaining required data elements are available in the DOTD databases for roadway segment calibration. The data elements not included in the DOTD databases (including desired data elements) could be manually estimated for calibration purposes using the Visiweb data or from Google Earth. The state of Oregon successfully developed calibration factors using these types of data sources to obtain missing data elements.

The calibration of intersection SPFs on the other hand, presents more of a challenge. Although efforts are underway to locate intersections, they are currently not included in the DOTD roadway elements database. Additionally, unless the intersections are signalized and in the traffic signal database, the number of approaches and type of traffic control are not available. The traffic signal database is also currently being updated, and while it currently includes information on approach turn lanes, this information will not be included in the updated database. Table 3.3 provides a summary of the intersection evaluation.

Table 0.3 Intersection SPF Calibration Data Not Available in DOTD Databases

HSM Chapter	Required Data Element	Desired Data Element
Chapter 10 – Rural Two-Lane, Two-Way Roads	Number of intersection legs (unsignalized) Type of traffic control (unsignalized) AADT for minor roads (non-state roads) Number of approaches with left turn lanes Number of approaches with right turn lanes Presence of lighting	Intersection skew angle
Chapter 11 – Rural Multilane Highways	Number of intersection legs (unsignalized) Type of traffic control (unsignalized) AADT for minor roads (non-state roads) Number of approaches with left turn lanes Number of approaches with right turn lanes Presence of lighting	Intersection skew angle
Chapter 12 – Urban and Suburban Arterials	Number of intersection legs (unsignalized) Type of traffic control (unsignalized) AADT for minor roads (non-state roads) Number of approaches with left turn lanes Number of approaches with right turn lanes Presence of lighting Use of right turn on red at signal operation (signalized) Use of red-light cameras (signalized)	Pedestrian volume (signalized) Maximum number of lanes crossed by pedestrians on any approach (signalized) Presence of bus stops within 1,000 feet (signalized) Presence of schools within 1.000 feet (signalized) Presence of alcohol sales establishments within 1,000 feet (signalized)

At a minimum, calibration of the intersection SPFs will have to wait until the efforts to locate the intersections in the roadway elements database are complete, so crashes can be linked to the intersection locations.

While much of the data required to calibrate the intersections is not readily available in the databases, many of the roadway characteristics data elements could be manually estimated as described for the roadway segments. Additionally, a method for estimating the minor approach traffic volumes is also needed. The DOTD could potentially use estimates from the travel demand model or develop another methodology for estimating these volumes.

The initial efforts of collecting the data for calibration may be tedious. However, unless there are changes in site conditions, only the crash and volume data would need to be updated in future efforts.

Predictive method results can also be improved by using Louisiana derived crash type and severity distributions. The HSM provides default crash type and severity distribution functions. These default crash distributions are used to convert total crashes to crash type or severity. Local data may show different crash type or crash severity distributions than the default distributions provided in the HSM. Therefore, replacing the default values with local values will improve predictive method results. Table 3.4 identifies the default distributions that can be updated with Louisiana data, including the corresponding HSM table or equation number. When possible, DOTD should replace these default values with Louisiana values based on the state crash database.

Table 0.4 Predictive Method Default Crash Distributions

Chapter	HSM Table or Equation Number	Type of Roadway Element: Roadway Segments	Type of Roadway Element: Intersections	Data Element or Distribution that May be Calibrated
Chapter 10 Rural Two-Lane, Two-Way Roads	Table 10-3	X		Crash severity by facility type for roadway segments
	Table 10-4	X		Collision type by facility type for roadway segments
	Table 10-5		X	Crash severity by facility type for intersections
	Table 10-6		X	Collision type by facility type for intersections
	Eqn 10-18	X		Driveway-related crashes as a proportion of total crashes
	Table 10-12	X		Nighttime crashes as a proportion of total crashes by severity level
	Table 10-15		X	Nighttime crashes as a proportion of total crashes by severity level and by intersection type
Chapter 11 Rural Multilane Highways	Table 11-4	X		Crash severity and collision type for undivided segments
	Table 11-6	X		Crash severity and collision type for divided segments
	Table 11-9		X	Crash severity and collision type by intersection type
	Table 11-15	X		Nighttime crashes as a proportion of total crashes by severity level and by roadway segment type for divided roadway segments
	Table 11-19		X	Nighttime crashes as a proportion of total crashes by severity level and by roadway segment type for divided roadway segments
	Table 11-24		X	Nighttime crashes as a proportion of total crashes by severity level and by intersection type
Chapter 12 Urban and Suburban Arterials	Table 12-4	X		Crash severity and collision type for multiple-vehicle nondriveway collisions by roadway segment type
	Table 12-6	X		Crash severity and collision type for single-vehicle crashes by roadway segment type
	Table 12-7	X		Crash severity for driveway-related collisions by roadway segment type
	Table 12-8	X		Pedestrian crash adjustment factor by roadway segment type
	Table 12-9	X		Bicycle crash adjustment factor by roadway segment type

Chapter	HSM Table or Equation Number	Type of Roadway Element		Data Element or Distribution that May be Calibrated
		Roadway Segments	Intersections	
Chapter 12 Urban and Suburban Arterials (cont.)	Table 12-11		X	Crash severity and collision type for multiple-vehicle crashes by intersection type
	Table 12-13		X	Crash severity and collision type for single-vehicle crashes by intersection type
	Table 12-16		X	Pedestrian crash adjustment factor by intersection type for stop-controlled intersections
	Table 12-17		X	Bicycle crash adjustment factor by intersection type
	Table 12-23	X		Nighttime crashes as a proportion of total crashes by severity level and by roadway segment type
	Table 12-27		X	Nighttime crashes as a proportion of total crashes by severity level and by intersection type

Implementation Strategies

- Identify which roadway segment SPF to calibrate first (e.g., based on data availability, traffic volumes, crash frequency/rates, analysis needs etc.), collect the missing data, and develop the calibration factor.
- Use lessons learned from first calibration effort and develop calibration factors for the remaining roadway segment SPFs.
- Complete the efforts of locating the intersections in the roadway elements database.
- Identify methodology to estimate minor street traffic volumes at intersections.
- Collect missing data and develop calibration factors for the intersection SPFs.
- Update predictive method default crash distributions.

1.12 PREDICTIVE METHOD USE

Calibrating the HSM SPFs provides a certainty in the reliability of the predictive method results. While the predictive method can be used without calibration factors, it should only be used for relative comparisons.

The application of the predictive method not only requires the required data elements, it also requires all of the desired data elements. Although not all of these data elements are available in the DOTD databases, it is feasible to obtain this data to apply the predictive method at the project level for planning or design applications. The necessary data can be obtained by gathering the project site data from various data sources within the DOTD. Developing a reference guide that identifies where and how data can be obtained or who to contact would help DOTD staff in applying the predictive method. Strategies for applying the predictive method for project level applications are identified in Section 5.

Implementation Strategy

- Develop quick reference guide outlining where, how or who to contact to access DOTD traffic volume, roadway and crash data for use in the predictive method and other safety analysis.

1.13 Network Screening

The HSM includes 13 different performance measures for use in network screening. These performance measures vary in data needs and reliability of results. Performance measures that use the HSM predictive method with the Empirical Bayes (EB) method provide the most reliable results.

The DOTD is in the process of acquiring new network screening software called Vision Zero Suite, which is based on the Level of Service of Safety (LOSS) performance metric from the HSM and incorporates the EB method. Implementing the Vision Zero Suite will involve development of SPFs for the various facility types within the state. While the Vision Zero Suite SPFs can provide an estimate of the predicted crash frequency for a particular facility type, these SPFs are developed using a different methodology than those in the HSM and therefore, should not be utilized in the HSM predictive method procedure. With the exception of intersection location and minor street traffic volumes, which are also necessary for calibration of the HSM predictive method, the DOTD databases include all of the data necessary for the implementation of the Vision Zero Suite.

SPFs for rural two-lane roads and rural interstates were previously developed for the Vision Zero Suite; however, these will need to be updated with more recent data. These two facility types should serve as the starting point for Vision Zero Suite implementation. For the development of the SPFs for other facility types, it is recommended that the DOTD prioritize these efforts based on the facility type(s) with the highest crash frequency or crash severity.

In addition to its use for network screening, the Vision Zero Suite also includes Direct Diagnostics and Pattern Recognition techniques. These techniques are valuable to the diagnosis process and can be used to determine the nature of a safety problem identified based on LOSS. The Direct Diagnostics and Pattern Recognition techniques identify crash patterns susceptible to safety improvement and will help in identifying the appropriate countermeasures.

Implementation Strategies

- Prioritize facility types for development of SPFs for Vision Zero Suite implementation.
- Provide training on Vision Zero Suite to the Highway Safety Section, District Traffic Engineers, and other staff as appropriate.

1.14 LOCAL ROAD DATA

The HSM data readiness evaluation conducted for this effort focused on the state road system due to the lack of availability of local road data. To overcome this shortcoming, the DOTD is currently evaluating/validating the local road data they currently have available. Additionally, the DOTD will be collecting video log data of all public roads in the state. Roadway characteristics data will be post-processed from the video logs for all roads classified as collector or above.

Implementation Strategies

- Continue efforts to evaluate/validate availability of local road data.
- Collect video log data on all public roads and post-process the data on roads classified as collector or above.

1.15 LOCATION OF SYSTEMWIDE IMPROVEMENTS

The DOTD has implemented systemwide improvements, such as rumblestrips and cable median barriers; however, the location of the installation of these treatments has not been tracked to date. It would be beneficial for the DOTD to know where these treatments have been implemented to evaluate the effectiveness of these countermeasures and to identify potential future sites for installation. The DOTD should ensure all future installations of systemwide improvements are tracked and document where existing systemwide improvements have been implemented.

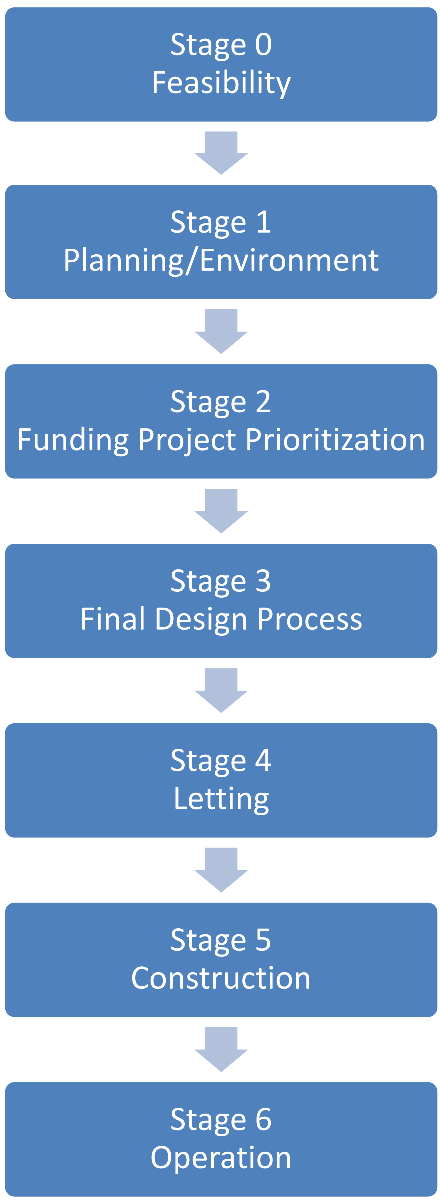
Implementation Strategies

- Document where systemwide improvements have been implemented.
- Track the locations of all future installation of systemwide improvements.

HSM Applications in DOTD Project Delivery

The DOTD project delivery process is comprised of 7 stages as illustrated in Figure 4.1. This section provides an overview of each stage and identifies opportunities for incorporating the HSM into the project delivery process

Figure 0.1 DOTD's Project Delivery Process



1.16 Stage 0: Feasibility

Once a project is proposed for consideration by DOTD, a feasibility analysis must be performed to determine if the project merits further consideration. The outcome of stage 0 is a "go/no-go" decision regarding project advancement. The "go/no-go" decision is based on a series of analysis that include:

1. Preliminary Purpose and Need;
2. Preliminary Alternatives and Initial Feasibility Analysis;
3. Design Criteria and Initial Context Determination;
4. Preliminary Environmental Review;
5. Agency and Public Involvement Plan; and
6. Preliminary Project Estimate and Budget.

During stage 0, the HSM Part B can be used to diagnose crash patterns to determine if safety should be included in the project purpose and need. Additionally, the countermeasure selection guidance, the Part C predictive method and/or Part D crash modification factors (CMFs) can be used to evaluate the safety impacts of various design elements or alternatives. Finally, if it is necessary to estimate the order of magnitude of project safety benefits to compare alternatives, a benefit-cost analysis could be conducted.

1.17 Stage 1: Planning and Environmental Process

Stage 1 identifies the preferred alignment for the project, including a clear description of the project scope, budget, and major design features. During this stage, the Part C predictive method and/or Part D CMFs can be used to quantitatively evaluate the safety impacts of various design alternatives or roadway cross-sections. Similar to Stage 0, an order of magnitude cost-benefit analyses could be conducted at this stage to assist in narrowing down project alternatives to advance into the design stage.

1.18 Stage 2: Funding Project Prioritization

Stage 2 deals with the programming of a project that has completed all of the planning and environmental requirements to proceed into the final design stage. This stage involves three basic activities: updating the cost estimate developed in Stage 1, allocating the funds, and establishing the project delivery date. Depending on the process used by the DOTD for allocating the funds, if a benefit-cost analysis is conducted during this stage, Part B Chapters 7 and 8 could be used to incorporate the safety benefits into the analysis.

1.19 Stage 3: Final Design

Stage 3 is the final design and development stage of a project. During this stage, the Part D CMFs can be used to compare the effect on crash frequency of different design alternatives, and Part C can be used to predict future safety performance. Both Parts C and D enable the designer to quantitatively evaluate the safety impacts of design decisions and provide quantitative documentation on the safety impacts of design exceptions and decisions.

1.20 Stage 4: Letting

Once a project proceeds into stage 4, it will be readied to be let for construction. There are no opportunities for HSM application during this stage.

1.21 Stage 5: Construction

Stage 5 involves the construction process. During the stage, the HSM could be used to evaluate the safety impacts of any changes made to the design or traffic control plans during the construction process. Most likely this would just be small changes using treatments from Part D of the HSM.

1.22 Stage 6: Operation

Stage 6 involves the continuous monitoring of a project once it is placed into operation. Part B procedures (e.g., network screening, diagnosis, countermeasure selection, economic appraisal and evaluation) are used as part of an ongoing overall highway safety management system. The change in crash frequency or severity (i.e., safety effectiveness) that can be associated with projects can be evaluated using one of the safety effectiveness evaluation methods provided in Part B once a project has been in operation long enough to have three to five years of crash data available.

1.23 Summary of HSM Applications in the DOTD Project Development Process

Table 4.1 provides a summary of where the key methods from the HSM can be used in the DOTD project development process.

Table 0.1 HSM Applications in the DOTD Project Development Process

Project Stage	Part B				Part C	Part D
	Network Screening	Diagnosis and Countermeasure Selection	Benefit Cost Analysis	Safety Effectiveness Evaluation	Predictive Method	Crash Modification Factors
Stage 0 – Feasibility		X	X		X	X
Stage 1 – Planning/ Environment		X	X		X	X
Stage 2 – Funding Project Prioritization			X			
Stage 3 – Final Design Process					X	X
Stage 4 – Letting						
Stage 5 – Construction					X	X
Stage 6 – Operation	X	X	X	X	X	X

2.0 HSM Applications in DOTD Business Practices

The previous section identified opportunities to incorporate the HSM into the DOTD project development process. This section focuses on implementation strategies and training needs for the specific groups within the DOTD identified to lead the implementation of the HSM.

2.1 HIGHWAY SAFETY

The Highway Safety Section is responsible for managing the DOTD safety programs and providing safety analysis support to other DOTD sections as needed. The Highway Safety Section administers the Highway Safety Improvement Program (HSIP), which is the primary mechanism used by the DOTD to identify candidate safety projects to include in the Highway Program. The DOTD HSIP process includes components for planning, implementation, and evaluation, which is closely aligned with the roadway safety management process provided in the HSM Part B. The Part B roadway safety management process includes methods for network screening, diagnosis, countermeasure selection, economic appraisal, project prioritization, and safety effectiveness evaluation.

Currently the DOTD uses a number-rate method in network screening, which considers both crash frequency and crash rate, to identify locations with potential for safety improvement to study further. Because network screening is conducted at the network level, the performance measure(s) used in the analysis is ultimately dependent on the capabilities of the DOTD's network screening software. The Highway Safety Section investigated different software options that incorporate some of the more advanced HSM performance metrics into network screening, including SafetyAnalyst and the Vision Zero Suite, which is based on the Level of Service of Safety (LOSS) performance measure. As discussed in Section 3, the DOTD will be acquiring the Vision Zero Suite in the near future.

Safety analysis is a required element in design exceptions and traffic management plans. To assist DOTD staff with performing safety studies, the Highway Safety Section developed draft *Guidelines for Performing a Safety Analysis.* Following discussion with FHWA and HSM Implementation Team members, these guidelines will be adapted into specific guidelines for conducting safety analysis for the different business units involved in the project development process (Planning, Environmental, Road Design, and Traffic Engineering). These guidelines will focus on safety analysis applications and will expand on HSM methodologies applicable to the various business units. One of the specific needs identified by the Traffic Engineering Section was more guidance on conducting a safety benefit-cost analysis. These guidelines are intended to be incorporated into the procedures manuals of the respective business units and to be updated as the HSM is utilized more and standard assumptions are identified. Additionally, the *Project Delivery Manual* should be updated to acknowledge use of the HSM in the project delivery process.

While some of the districts and sections in the DOTD conduct their own project safety analysis, the Highway Safety Section currently conducts the majority of the project safety analysis. In the future, the goal is for the Highway Safety Section to be involved only in the more complex analysis and to have the individual groups conduct the more typical safety analysis on their own. The development of the guidelines for conducting safety analysis will support this goal.

As part of the HSIP, the Highway Safety Section conducts safety effectiveness evaluations of implemented HSIP projects. The effectiveness evaluations of different countermeasures could be used to develop Louisiana specific CMFs. Development of CMFs may prove especially beneficial when there is limited research available on the effectiveness of a particular countermeasure or when the available research does not correlate well with Louisiana conditions.

The Highway Safety Section has also been coordinating HSM training for DOTD staff, local agencies, and consultants. The training sessions offered to date have primarily utilized the NCHRP 17-38 course materials, which serves as an introduction to the HSM. To successfully implement the HSM, DOTD will need to offer audience specific training that focuses more on hands on applications. Specific training needs are identified for each of the focus groups.

Implementation Strategies

- Obtain and implement Vision Zero Suite.
- Develop guidelines for conducting safety analysis for the different business units involved in the project development process (Planning, Environmental, Road Design, and Traffic Engineering).
- Integrate reference to use of the HSM in the *Project Delivery Manual*.
- Develop state specific CMFs from safety effectiveness evaluations as necessary.
- Lead development of predictive method calibration factors.[1]

Training Needs

- Ensure all Highway Safety Section staff is trained on HSM applications.

---

[1] The DOTD should consider research into consistency of the safety predictions with calibrated HSM SPFs and safety predictions from the Vision Zero Suite.

- Provide training on new network screening software when implemented.

2.2 TRANSPORTATION PLANNING

Within the DOTD project development process, the Transportation Planning Section focuses on Stage 0: Feasibility. As discussed in Section 4, the HSM Part B can be used to diagnose crash patterns to determine if safety should be included in the project purpose and need, and the Part C predictive method and/or Part D crash modification factors (CMFs) can be used to evaluate the safety impacts of various design elements or alternatives. Additionally, the Vision Zero Suite includes a diagnosis tool that can be applied in a feasibility study to establish purpose and need.

While the Transportation Planning Section conducts some of the feasibility analysis in-house, many of the feasibility studies are conducted by consultants. DOTD does require engineering consultants that prepare Stage 0 (Feasibility) documents to be trained in the principals and use of the HSM. When advertising for engineering consultant services or a request for qualifications (RFQ) for safety studies, DOTD requires that the consultant has available "One Professional Civil Engineer registered in the State of Louisiana who has been trained in the use of the Highway Safety Manual, or will be trained in the use of the Highway Safety Manual at the time of contract execution. Acceptable courses are the 2 ½ day workshops conducted by the FHWA Resource Center, NCHRP 17-38, or equivalent as approved by LADOTD." Although the DOTD has this requirement, no guidance currently exists on how the HSM should be utilized in these studies. The development of safety analysis guidelines will fill this gap.

Implementation Strategies

- Develop guidelines for conducting safety analysis in Stage 0 feasibility studies and update as necessary.
- Integrate safety analysis guidelines into the *Stage 0 – Manual of Standard Practice*.

Training Needs

- Provide consultants and in-house staff with applications based training on the predictive method.

2.3 ENVIRONMENTAL

The Environmental Section is primarily responsible for Stage 1 of the project development process – planning and environmental. All projects, regardless of classification (preservation, operations, safety, capacity, or other) and funding source, are developed and carried through Stage 1. During this stage, several factors are evaluated to identify the preferred project alignment with a clear description of scope, budget, and major design features. As discussed in Section 4, the HSM Part C predictive method and Part D CMFs can be used to evaluate the safety impacts of various design features to assist in the selection of the preferred alternative.

Since many of the environmental studies are reviewed by FHWA, the Environmental and Safety Sections should meet with FHWA to identify when a safety analysis needs to be included in an environmental study. These requirements can be incorporated into the safety analysis guidelines for the Environmental Section. In projects requiring a safety analysis, language should be incorporated into the advertisement for engineering consultant services or RFQ similar to what is already included in the feasibility stage requiring training on the HSM. Until the safety analysis guidelines are complete, the Environmental Section should confer with the Safety Section on analysis requirements to include in the advertisement.

One potential challenge in incorporating the HSM into the Environmental Section is that not all of the staff have a technical background and may require simplified procedures or tools to apply the predictive method or to review analysis submitted by consultants. One way to get around this challenge is to develop lookup tables illustrating the safety impacts of different variables in the predictive method for typical DOTD cross-sections. Alternatively, a spreadsheet tool could be developed to provide for quick comparisons of various design features. This sort of tool would benefit all staff using the predictive method, not just the Environmental Section.

Implementation Strategies

- Include HSM training requirements in advertisements for engineering consultant services or RFQs for environmental projects requiring a safety analysis.
- Develop spreadsheet tool or lookup tables for DOTD staff to provide a comparison of the safety impacts of typical design cross sections or design features (e.g., safety impacts of changing lane or shoulder width).
- Develop guidelines for conducting safety analysis in Stage 1 environmental studies and update as necessary.
- Integrate safety analysis guidelines into the *Stage 1 – Planning/Environmental Manual of Standard Practice.*

Training Needs

- Provide training to Environmental Section on how to interpret the tables or results of the spreadsheet tool.
- Provide training to Environmental consultants.

2.4 ROAD DESIGN

The Road Design Section of the DOTD is primarily involved in Stage 3 of the project development process – final design plans. The Road Design Section is responsible for preparing plans for roadway construction projects, supervising and directing engineering consulting firms in the preparation of plans, and reviewing plans submitted by the districts.

Applying the HSM in the design process allows for safety performance based design and can support identifying solutions balancing safety performance with operational and other project-specific considerations. The HSM can be applied within the Road Design Section to quantitatively evaluate the safety impact of design parameters under consideration or evaluate the safety impact of design exceptions using the Part C predictive method and/or the Part D CMFs. The Road Design Section has started to apply the predictive method in a small portion of alternatives analysis and more extensively in design exceptions. However, to fully utilize the predictive method to compare the safety impacts of various design alternatives, the DOTD will need to develop calibration factors. The integration of the predictive method in the design process could be phased in as calibration factors are developed for each of the facility types.

Systems preservation is also part of the Road Design Section. All preservation projects are required to have a safety assessment. The Vision Zero Suite and the HSM Part B provide information on diagnosis and countermeasure selection (Chapters 5 and 6, respectively) that can be used in these studies. The Part D CMFs and results of safety effectiveness evaluations can be used to identify effective low cost safety improvements to incorporate into roadway preservation projects. The predictive method can also be applied in transportation systems management to evaluate the safety impacts of various tradeoffs, such as the impact of reducing the shoulder width to add a turn lane. Network screening information and a site's potential for safety improvement can also assist in determining whether or not safety can be attributed as a reason for modifying a particular facility.

Use of software or tools could ease the burden of applying the predictive method and help integrate its use into the design process. The Interactive Highway Safety Design Model (IHSDM) is one tool the Road Design Section might consider for application of the predictive method. Other states have modified the spreadsheets developed as part of the NCHRP 17-38 training program to serve their analysis needs.

Finally, the Road Design Section can potentially use results of safety effectiveness evaluations to revise existing design standards and policies. For example, if a low cost safety countermeasure is found to be highly effective in reducing crash frequency or severity, the existing design standards could be modified to include this countermeasure on all new projects.

Implementation Strategies

- Develop guidelines for conducting safety analysis in the design process, including design exceptions and pavement preservation projects and update as necessary.
- Integrate the predictive method into the roadway design process (including design exceptions and decisions).
- Integrate and update safety analysis guidelines into the *Roadway Design Procedures and Details* and appropriate pavement preservation guidelines.
- Evaluate existing predictive method tools for ease of use and data availability to use in the DOTD design process or develop a DOTD specific tool.

Training Needs

- Provide training to the Road Design Section on how to apply the predictive method in the design process and how to interpret the results. Also provide training on the application of CMFs in the design process. Include hands on exercises in the training.
- Provide training on use of IHSDM or other predictive method tool(s).
- Provide training to staff involved in the safety studies for preservation projects on how to conduct a typical safety analysis based on the Highway Safety Section Guidelines.
- Provide training to staff on documenting design exceptions and decisions using the HSM.

2.5 TRAFFIC ENGINEERING

The Traffic Engineering Section is involved in various aspects of the project development process. The section provides traffic engineering direction and support to districts and other DOTD sections through planning, design, and review of geometric features, traffic control devices, and access management.

While safety is a priority in the Traffic Engineering Section, so is traffic operations, and these two factors are sometimes in conflict. For example, adding a protected left turn signal is known to reduce angle crashes when installed at a warranted location; however, the additional signal phase may cause additional delay to vehicles on the conflicting approach. The Traffic Engineering Section must commonly weigh factors such as mobility, delay, and safety in the decision-making process. The HSM now provides a quantitative measure of safety to be considered alongside other performance measures commonly used in this decision-making process.

The Traffic Engineering Section has already been using the Part D CMFs for countermeasure selection. The Part C predictive method could also be applied in corridor studies to provide a quantitative safety measure to use in the alternatives evaluation. These results can also be used to educate the public when safety is the deciding factor in the decision-making process.

The Traffic Engineering Section expressed concern over use of inappropriate CMFs in traffic studies. One way to address this issue is to include in the safety analysis guidelines a requirement for an assessment of the applicability and quality of the CMF being used in the analysis (e.g., study location and site characteristics compared to the site of interest, study method, standard error, star rating, etc.).

Implementation Strategies

- Incorporate the predictive method into corridor studies when applicable.
- Develop guidelines for conducting safety analysis in Traffic Engineering and update as necessary.
- Incorporate safety analysis guidelines into the appropriate Traffic Engineering Section guidelines.

Training Needs

- Provide training on how to apply and interpret the results of the predictive method that incorporates some typical project examples.
- Provide training on the application of CMFs.
- Provide training on how to conduct a typical safety analysis based on Highway Safety Section's guidelines.

2.6 DISTRICT DESIGN AND TRAFFIC OPERATIONS

There are several opportunities to utilize the HSM at the district level. District Design Engineers can utilize the predictive method to incorporate safety into alternatives evaluation and to provide documentation for design exceptions and decisions. District Traffic Operations Engineers can also use the predictive method when developing conceptual designs. District Traffic Operations Engineers are responsible for conducting a safety engineering evaluation of the top three sites of each roadway classification in their districts identified in the HSIP network screening process. For the evaluation of the sites identified through HSIP and for other site investigations, they can utilize the Part B methods for diagnosis, countermeasure selection, and economic evaluation and the Part D CMFs in countermeasure selection. District Traffic Engineers can also utilize the Vision Zero Suite during the diagnosis process to help identify crash patterns likely to respond to safety improvement.

As discussed in Section 2, implementation at the district level will most likely require additional outreach efforts to establish buy in and train District Engineers on the proper application. It will also require some sort of mechanism to provide technical support for questions related to HSM applications. Analysis tools to simplify the application of the predictive method would also promote its use by the District Engineers.

Implementation Strategies

- Develop summary sheet identifying how the HSM can be used in typical district projects.
- Provide example applications and worksheets/tools for districts to use for HSM applications.

Training Needs

- Provide HSM training tailored to typical district projects and focused on applications for both District Design Engineers and District Traffic Operations Engineers.
- Provide District Traffic Operations Engineers with training on how to perform safety analysis based on the guidelines.

2.7 PUBLIC AGENCIES

One of the biggest obstacles public agencies will come across in trying to use the HSM is the availability of local road data. Roadway characteristics data is very limited on local roads; traffic volume data is often not available; and the crash data on local roads is often unreliable in terms of crash location and inconsistent crash coding. Even when data is available, local agencies may not know it is available or know how to gain access to it.

As discussed in the section on data improvements, efforts are underway on improvements to the local road data. DOTD is currently evaluating/validating the data currently available on the local roads. DOTD will be collecting video log data on all public roadways in the state and will post-process the roadway characteristics data for local roadways classified as collectors or above. In terms of the crash data, there have been efforts to train law enforcement officers on consistent crash report completion, so the reliability of the crash data should continue to improve.

To overcome the challenges with data, safety improvement efforts on local roads have primarily focused on systematic approach. Efforts have been focused on roadway departure and intersection crashes. Louisiana Technical Assistance Program (LTAP) is developing a tool to automate the process of locating horizontal curves to identify potential locations for safety improvements. Additionally, a rural roads intersection evaluation tool is currently under development, which will serve as a repository for completed rural road intersection safety improvement projects. This tool will track the project costs and compare the before and after observed crash frequency, as well as the number of crashes estimated using CMFs.

To improve network screening capabilities on local roads, the DOTD could initiate a research or pilot study to evaluate and develop default values for applying HSM network screening methods on local roads. These efforts could also be expanded to all roads, possibly as a phased approach.

Staffing and funding resources are additional barriers to implementation of the HSM in the local agencies. Not all parishes have an engineer on staff, so there is no one to hold accountable or champion the effort. Additionally, local road projects are usually tight on funding, so it will be difficult to convince the agencies on the need for an additional step in the analysis process.

Based on data availability and staffing resources, the MPOs are the likely candidates for utilizing the HSM at the local agency level. Members of the HSM Implementation Team should collaborate with various local agencies (e.g., parishes, MPOs, and cities) in the state to identify opportunities to incorporate the HSM into agency practices. The HSM marketing and training efforts should also include local agencies and their potential applications.

Implementation Strategies

- Initiate a research or pilot project to develop default values for applying HSM network screening methods on local roads.
- Collaborate with parishes, MPOs, and cities to identify opportunities to incorporate the HSM into their project development processes and business practices.
- Include local applications in the HSM marketing efforts.
- Identify avenues for more focused training for locals as the need arises.

Training Needs

- Continue to provide introductory training on the HSM to market the benefits and applications to potential users in the state.
- Provide local agency specific HSM application-based training.

Plan Implementation

This section focuses on plan implementation. It provides an implementation schedule and conceptual training program by business unit and discusses implementation tracking and evaluation.

2.9 Implementation Schedule

The strategies identified in this plan have been consolidated into six major categories: organizational support, data collection, technical assistance and tools, policies and procedures, marketing, and training. Table 6.1 shows the consolidated list of strategies and identifies the agency lead and proposed timeframe for starting the activities. In this context near term is within the next year, mid-term is 2-3 years from now, and long-term is 4-5 years out. Figure 6.1 provides a visual representation of the implementation schedule.

2.10 Training Program

As discussed in Section 2, development of a training program is one of the most critical strategies for successful HSM implementation. This plan has identified several training needs associated with the implementation strategies. Table 6.2 provides a sample training program categorized by business unit and prioritized based on the order of importance of training to be offered over time. The level of detail provided for the various HSM topic areas may vary by business unit. It is assumed the level of detail in the training courses will provide sufficient knowledge to carry out job responsibilities. Future training efforts may also want to incorporate the realities of liability and risks associated with implementing the HSM.

The training program provided in Table 6.2 serves as a starting point and should be further refined by DOTD. For example, this training program could be further defined by staff level or job responsibilities within each business unit. Consultant staff working on projects for the various business units should also receive the corresponding training. While the Highway Safety Section will oversee developing and refining of the training program, the decision of what staff participates in a particular training course will be based on staff interest and needs and will be at the discretion of the staff managers. The DOTD could also consider including local agency staff in the training program.

Table 0.1 HSM Implementation Schedule

Strategy	Lead	Priority to Start	Anticipated Duration
Organizational Support			
Develop an executive level committee consisting of the Director of the Office of Multimodal Planning, the Office of Engineering, the Office of Operations and the Office of Management and Finance.	Safety	Near-term	1 year
Hold executive level committee meetings on a quarterly basis to discuss implementation of HSM and the integration of quantitative safety into decision-making in the DOTD.	Safety	Near-term	Ongoing
Establish a Technical Committee to lead development of HSM related technical policy and recommendations.	Safety	Mid-term	Ongoing
Add one District Administrator and one District Design Engineer to the HSM Implementation Team.	Safety	Near-term	1 year
Establish a District Engineer Working Group to discuss barriers and opportunities to integrating HSM analysis methodologies into District activities.	District Engineer	Mid-term	Ongoing
Data Collection			
Identify which SPFs to calibrate (e.g., based on data availability, traffic volumes, crash frequency/rates, etc.), collect the missing data, and develop the calibration factor.	Safety	Near-term	Ongoing
Use lessons learned from first calibration effort and develop calibration factors for the remaining roadway segment SPFs.	Safety	Mid-term	3 years
Complete the efforts of locating the intersections in the roadway elements database.	Data	Mid–term	2 years
Identify methodology to estimate minor street traffic volumes at intersections.	Safety/Data/Modeling	Long-term	2 years
Collect missing data and develop calibration factors for the intersection SPFs.	Safety/Data	Long-term	5 years
Update predictive method default crash distributions.	Safety	Mid-term	2 years
Prioritize facility types for development of SPFs for Vision Zero Suite implementation.	Safety	Mid-term	1 year
Continue efforts to evaluate/validate availability of local road data.	Data	Mid-term	2 years
Initiate a research or pilot study to develop default values for applying HSM network screening methods to local roads.	Safety/LTAP	Long-term	3 years
Collect video log data on all public roads and post-process the data on roads classified as collector or above.	Data	Long-term	5 years
Document where systemwide improvements have been implemented.	Data	Long-term	5 years
Track the location of all future installations of systemwide treatments.	All units led by Data	Near-term	Ongoing

Strategy	Lead	Priority to Start	Anticipated Duration
Technical Assistance and Tools			
Establish and maintain a HSM users group to provide peer level technical support to promote HSM integration into DOTD practices.	Committee led by Safety	Mid-term	Ongoing
Develop quick reference guide outlining where, how or who to contact to access DOTD traffic volume, roadway and crash data for use in the predictive method.	Safety/Data	Near-term	1 year
Obtain and implement Vision Zero Suite.	Safety	Near-term	1 year
Develop state specific CMFs from safety effectiveness evaluations as necessary.	Safety	Mid-term	Ongoing
Develop spreadsheet tool or lookup tables for DOTD staff to provide a comparison of the safety impacts of typical design cross sections or design features (e.g., safety impacts of changing lane or shoulder width).	Committee led by Traffic Engineering	Mid-term	Ongoing
Evaluate existing predictive method tools for ease of use and data availability to use in the DOTD design process or develop a DOTD specific tool.	Design	Near-term	1 year
Develop summary sheet identifying how the HSM can be used in typical district projects.	Safety	As needed	Ongoing
Provide example applications and worksheets/tools for districts to use for HSM applications.	Safety	As needed	Ongoing
Policies and Procedures			
Integrate reference to use of the HSM in the *Project Delivery Manual*.	Safety	Near-term	1 year
Develop guidelines for conducting safety analysis in Stage 0 feasibility studies and update as necessary.	Safety/Planning	Mid-term	2 years
Integrate safety analysis guidelines into the *Stage 0 – Manual of Standard Practice*.	Planning	Mid-term	1 year
Include HSM training requirements in advertisements for engineering consultant services or RFQs for environmental projects requiring a safety analysis.	Safety /Environmental	Near-term	1 year
Develop guidelines for conducting safety analysis in Stage 1 environmental studies and update as necessary.	Safety /Environmental	Mid-term	2-years
Integrate safety analysis guidelines into the *Stage 1 – Planning/Environmental Manual of Standard Practice*.	Environmental	Mid-term	1 year
Develop guidelines for conducting safety analysis in the design process, including design exceptions and decisions and update as necessary.	Safety/Design	Mid-term	2 years
Integrate the predictive method into the roadway design process (including design exceptions and decisions).	Design	Mid-term	3 years
Integrate safety analysis guidelines into the *Roadway Design Procedures and Details* and appropriate pavement preservation guidelines.	Design	Mid-term	1 year
Develop guidelines for conducting safety analysis in Traffic Engineering and update as necessary.	Safety/Traffic Engineering	Mid-term	2 years

Strategy	Lead	Priority to Start	Anticipated Duration
Incorporate safety analysis guidelines into the appropriate Traffic Engineering Section guidelines.	Traffic Engineering	Mid-term	1 years
Marketing			
Develop a marketing plan to promote application of methods, demonstrate value, broadcast training opportunities, and emphasize importance of quantitative safety in all project, programs, and policies in the DOTD.	Safety (FHWA)/LTAP/ Office of Communications	Near-term	Ongoing
Collaborate with parishes, MPOs, and cities to identify opportunities to incorporate the HSM into their project development processes and business practices.	Safety (FHWA)/LTAP	Near-term	Ongoing
Include local applications in the HSM marketing efforts.	Safety (FHWA)/LTAP	Near-term	Ongoing
Training			
Develop an overall training program that identifies and prioritizes training needs according to business unit and staff level.	Safety	Near-term	Ongoing
Identify avenues for more focused training for local agencies as the need arises.	LTAP	Near-term	Ongoing

Figure 0.1 Louisiana HSM Implementation

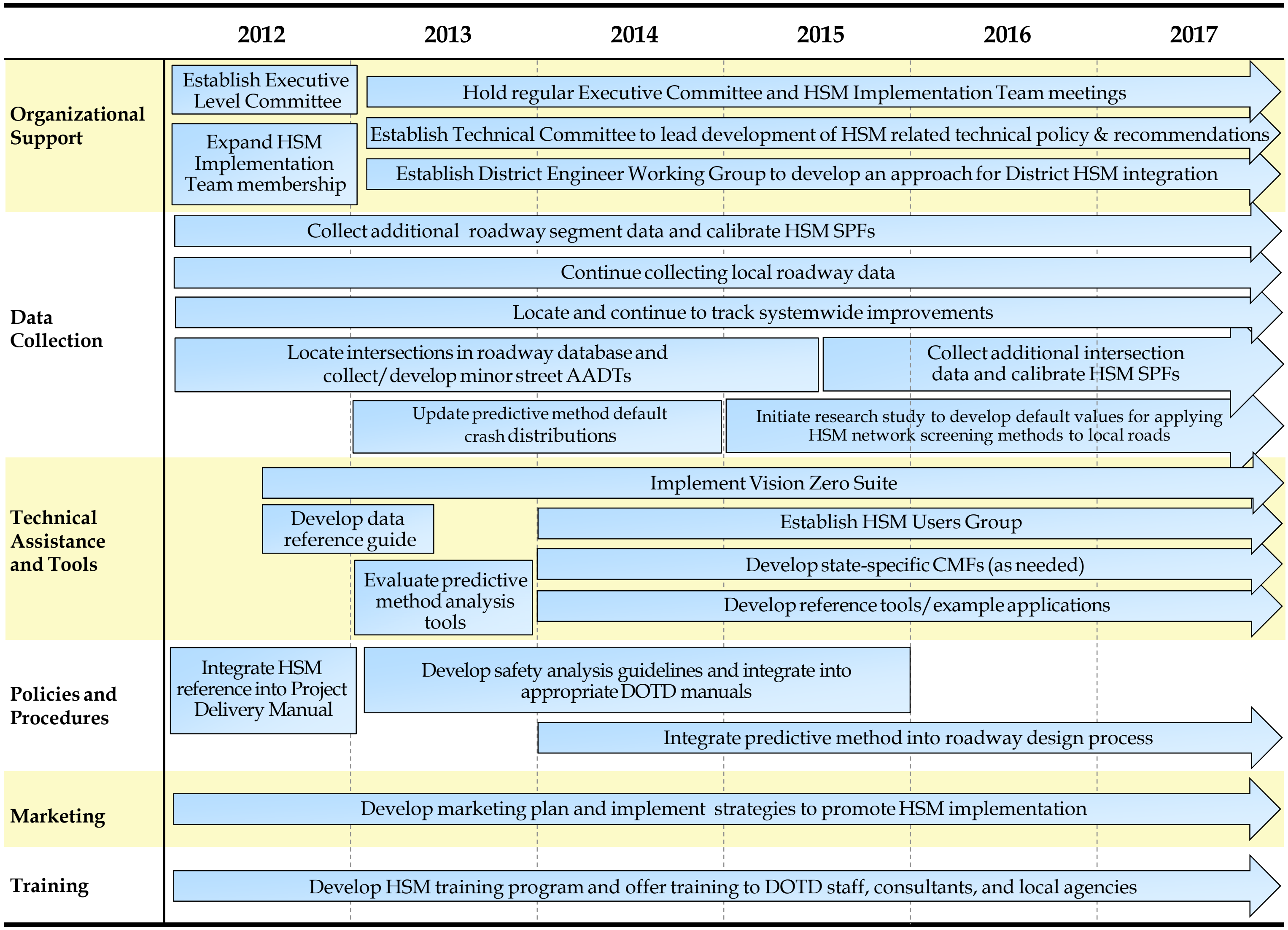


Table 0.2 HSM Training Program

DOTD Office/Section	Skills						
	Part B					Part C	Part D
	Safety Fundamentals[1]	Network Screening Concepts	Diagnosis and Countermeasure Selection	Benefit Cost Analysis	Safety Effectiveness Evaluation	Predictive Method	Crash Modification Factors
Office of Multimodal Planning							
Highway Safety	A	A[2]	A	A	A	A	A
Data Collection Management and Analysis	C	A[2]	N/A	N/A	B	B	B
Transportation Planning	A	A	A	A	N/A	A	A
Office of Engineering							
Environmental	A	N/A	B	A	N/A	A	A
Traffic Engineering	A	B	A	A	B	A	A
Project Development	A	N/A	B	A	N/A	A	A
HQ Construction	B	N/A	B	C	N/A	N/A	B
District Construction	B	C	B	C	N/A	N/A	B
Office of Operations							
ITS	B	N/A	A	B	B	N/A	A
Maintenance	B	N/A	B	N/A	N/A	N/A	B
District Design	A	B	A	A	N/A	A	A
District Traffic Engineering	A	A	A	A	C	A	A
District Area Engineers	A	A	N/A	N/A	N/A	N/A	N/A

Legend: A = high priority, B = medium priority, C = low priority, N/A = not applicable.

[1] Note the exhibit includes Safety Fundamentals for all of the business units. This course would teach fundamental transportation safety concepts to support the goal of integrating safety into all aspects of transportation at the DOTD.

[2] Provide training on both concepts and software.

2.11 IMPLEMENTATION TRACKING AND EVALUATION

Tracking implementation efforts is a key element to successful implementation of the HSM within the DOTD. Tracking implementation efforts helps to identify potential issues with the implementation schedule, monitor progress, and keep the implementation team accountable.

Table 6.1 identifies a lead group from the HSM Implementation Team to oversee each strategy. While other groups may be involved in carrying out the strategy, the lead is responsible for making sure the effort is on track and reporting on progress. Performance metrics such as not started, early progress, underway, substantial progress, and completed could be used for tracking implementation progress in each strategy. DOTD can also track the staff trained in the various HSM skill sets. These performance metrics can be used to update the executive committee on implementation progress.

The HSM Implementation Team should continue to meet on a regular basis to discuss progress. The meetings can also be used as a forum for collaboration on how to address potential issues and for coordination of efforts.

DOTD should continue to update the implementation schedule on a regular basis as strategies are completed or as the schedule changes. Performance metrics should be collected on a regular basis and a formal evaluation of the progress should be conducted annually at a minimum.

Finally, concurrent with HSM implementation efforts, the DOTD should continue to evaluate the effectiveness of the overall safety program in reducing crash related fatalities and serious injuries.

A. HSM Data Readiness Evaluation

Memorandum

TO: Dan Magri, Terri Monaghan

FROM: Beth Wemple, Colleen McGovern

DATE: March 29, 2012

RE: LDOTD HSM Data Readiness Evaluation

Cambridge Systematics (CS) is assisting the Louisiana Department of Transportation and Development (LADOTD) in developing a Highway Safety Manual (HSM) Implementation Plan. As part of this effort, the CS team conducted a HSM data readiness evaluation. The CS team met with key staff in the LADOTD to identify the HSM related data currently available. The CS team evaluated the existing DOTD crash, roadway and traffic volume data as compared to HSM data requirements. As part of this effort, the CS team also evaluated the data necessary for the new network screening software package (Vision Zero Suite) the DOTD is in the process of acquiring. This memorandum summarizes the findings of the evaluation.

Overview of HSM Data Requirements

HSM methods require crash, site characteristics, and traffic volume data.

- **Crash data.** Typically for HSM applications, the crash data elements necessary include date (year), location (milepost/log mile/coordinate), severity level (fatal/injury/property damage only), relationship to intersection (at intersection/intersection-related/not-intersection-related), and distance from intersection.
- **Site characteristics**. Sites can be either roadway segments or intersections.
  - Roadway segments: Generally types of site characteristics used for roadway segments include area type (e.g., urban/suburban, rural), site length, roadway cross section, added lanes, roadway horizontal and vertical alignment, driveway type (e.g., major or minor industrial/institutional, major or minor commercial, major or minor residential) and density, roadside conditions, and lighting.
  - Intersections: General types of site characteristics for intersections include intersection configuration, type of traffic control, turn lanes, intersection angle, sight distance, enforcement devices, terrain, and lighting.
- **Traffic volume data**. The traffic volume data needed are annual average daily traffic volumes (AADT) for the road in question for the analysis of roadway segments or average

daily traffic volumes of intersecting roads (major and minor roads) in the case of intersections.

The available data influences the HSM methods that can be applied. In addition, the more rigorous HSM methods require statistical analysis to develop either local safety performance functions or local calibration factors.

This memorandum identifies the data necessary for the HSM Part B: Roadway Safety Management and Part C: Predictive Method and compares it the DOTD's available data. Since the predictive method is a necessary part of some of the network screening performance metrics in Part B, the Part C data needs are presented first.

Part C: Predictive Method

The HSM Part C predictive method includes predictive models which consist of safety performance functions (SPFs), crash modification factors (CMFs), and calibration factors that have been developed for specific roadway segment and intersection types. These predictive models are used to estimate the predicted average crash frequency for a particular site using a regression model developed from data from a number of similar sites. The SPFs are the basis of the predictive models and were developed in HSM-related research from the most complete and consistent available FHWA Highway Safety Information System (HSIS) crash and roadway characteristics datasets. However, because crash frequencies can vary significantly from one jurisdiction to another, it is important to calibrate SPFs for application in each jurisdiction for reliable results.

Predictive Method Calibration

The Part C predictive method recommends development of calibration factors for all SPFs being used. Table 1 summarizes the SPFs available for the Part C predictive method by facility type.

Table 1: Part C Predictive Method SPFs Available by Facility Type

Facility Type	Segment Type	Intersection Type
Rural two-lane, two-way roads	Two-lane undivided segments	3-leg intersections with minor-road stop control 4-leg intersections with minor-road stop control 4-leg signalized intersections
Rural multilane highways	Undivided segments Divided segments	3-leg intersections with minor-road stop control 4-leg intersections with minor-road stop control 4-leg signalized intersections
Urban and suburban arterials	Two-lane undivided segments Three-lane segments with center two-way left-turn lane Four-lane undivided segments Five-lane undivided segments with center two-way left-turn lane	3-leg intersections with minor-road stop control 3-leg signalized intersections 4-leg intersections with minor-road stop control 4-leg signalized intersections

To calibrate the Part C SPFs, site and crash data must be collected for 30 to 50 sites for each SPF being calibrated. Details of how to estimate calibration factors are provided in Appendix A of Part C of the HSM. The following presents data needs for calibration.

Roadway Segments

Table 2 identifies site characteristic data necessary to apply and calibrate the Part C predictive method for roadway segments. Data for each of the required elements are needed for calibration. For data identified as desirable, it is recommended that actual data be used if available, but the HSM provides assumed default values for the features for situations in which the data is not available. Table 2 also identifies data currently available in LDOTD roadway data inventory and data that will be available following expansion of the highway inventory assets, which is currently underway and expected to be completed in the next two years.

Table 2: Roadway Segment Predictive Method Calibration Data Needs

Chapter	Data Element	Calibration		Current LDOTD Data	Future GIS based Highway Inventory
		Required	Desired		
Chapter 10 – Rural Two-Lane, Two-Way Roads	Segment length	X		X	X
	AADT	X		X	X
	Lengths of horizontal curves and tangents	X		X	X
	Radii of horizontal curves	X		X	X
	Presence of spiral transition for horizontal curves		X		
	Superelevation variance for horizontal curves		X		
	Percent grade		X		X
	Lane width	X		X	X
	Shoulder type	X		X	X
	Shoulder width	X		X	X
	Presence of lighting		X		
	Driveway density		X		
	Presence of passing lanes		X		X
	Presence of short 4-lane section		X		
	Presence of center two-way left-turn lane	X		X	X
	Presence of centerline rumble strips		X		
	Roadside hazard rating		X		
	Use of automated speed enforcement		X		

Chapter	Data Element	Calibration		Current LDOTD Data	Future GIS based Highway Inventory
		Required	Desired		
Chapter 11 – Rural Multilane Highways	Segment length	X		X	X
	AADT	X		X	X
	Lane width	X		X	X
	Shoulder width	X		X	X
	Presence of lighting	X			
	Use of automated speed enforcement		X		
	Shoulder type (undivided only)			X	X
	Sideslope (undivided only)	X			
	Median width (divided only)		X	X	X
Chapter 12 – Urban and Suburban Arterials	Segment length	X		X	X
	Number of through traffic lanes	X		X	X
	Presence of median	X		X	X
	Presence of center two-way left-turn lane	X			X
	AADT	X		X	X
	Number of driveways by land-use type	X			
	Low-speed versus intermediate or high speed	X			X
	Presence of on-street parking	X			X
	Type of on-street parking	X			
	Roadside fixed object density		X		
	Presence of lighting		X		
	Presence of automated speed enforcement		X		

The GIS based highway inventory database currently under development will contain the majority of the required data elements for calibration of roadway segments, with the exception of:

- Presence of lighting (required for rural multilane highways);
- Sideslope (required for rural divided multilane highways);
- Number of driveways by land use type (required for urban and suburban arterials); and
- Type of on-street parking (required for urban and suburban arterials).

The required data elements for the rural two-lane, two-way roads are all available in the current DOTD roadway database and could serve as a starting point for development of segment calibration factors. The required data elements for the rural multilane highways and urban and suburban road segments could be manually estimated using Visiweb data.

Although the desired elements are not required for calibration, a sensitivity test has not been conducted to determine the impact of the presence or absence of these variables in the development of calibration factors. Therefore, when possible, sensitivity to the desired data elements should be tested in the development of calibration factors. This testing would inform the need for the state to add any of this data collection to any of the subsequent data collection efforts.

Intersections

Similarly Table 3 identifies the data elements needed to apply and calibrate the predictive method for intersections, including both required and desired elements. Currently intersections are not located in the DOTD roadway database; however, efforts are currently underway to collect the intersection location data. The DOTD traffic signal database is also in the process of being updated and will include some of the data elements necessary for calibration and use of the predictive method for intersections. Although turn lanes were included in the old traffic signal database, they are not being included in the new database.

Table 3: Intersection Predictive Method Calibration Data Needs

Chapter	Data Element	Calibration		Current LDOTD Data	Future GIS based Highway Inventory
		Required	Desired		
Chapter 10 – Rural Two-Lane, Two-Way Roads	Segment length	X		X	X
	AADT	X		X	X
	Lengths of horizontal curves and tangents	X		X	X
	Radii of horizontal curves	X		X	X
	Presence of spiral transition for horizontal curves		X		
	Superelevation variance for horizontal curves		X		
	Percent grade		X		X
	Lane width	X		X	X
	Shoulder type	X		X	X
	Shoulder width	X		X	X
	Presence of lighting		X		
	Driveway density		X		
	Presence of passing lanes		X		X
	Presence of short 4-lane section		X		
	Presence of center two-way left-turn lane	X		X	X
	Presence of centerline rumble strips		X		
	Roadside hazard rating		X		

Chapter	Data Element	Calibration		Current LDOTD Data	Future GIS based Highway Inventory
		Required	Desired		
	Use of automated speed enforcement		X		
Chapter 11 – Rural Multilane Highways	Segment length	X		X	X
	AADT	X		X	X
	Lane width	X		X	X
	Shoulder width	X		X	X
	Presence of lighting	X			
	Use of automated speed enforcement		X		
	Shoulder type (undivided only)			X	X
	Sideslope (undivided only)	X			
	Median width (divided only)		X	X	X
Chapter 12 – Urban and Suburban Arterials	Segment length	X		X	X
	Number of through traffic lanes	X		X	X
	Presence of median	X		X	X
	Presence of center two-way left-turn lane	X			X
	AADT	X		X	X
	Number of driveways by land-use type	X			
	Low-speed versus intermediate or high speed	X			X
	Presence of on-street parking	X			X
	Type of on-street parking	X			
	Roadside fixed object density		X		
	Presence of lighting		X		
	Presence of automated speed enforcement		X		

SR – minor road AADT available only if it is a state road.
SG – signalized intersections only.

Much of the data necessary for calibration of the predictive method for intersections is not readily available in the DOTD databases and is not planned to be added with the current data expansion efforts. Missing data could be manually determined using a combination of the sign inventory database and Visiweb data but would most likely require a significant effort.

Crash Type and Severity Distributions

Many of the Part C predictive models have default crash distribution percentages for crash type and crash severity. The default crash distributions are used to convert total crashes to crash type or severity. As expected, local data may show different crash type or crash severity distributions than the default distributions provided in the HSM. The DOTD can also improve the reliability of predictive method results by using state derived crash type or severity distributions, instead of the HSM default values. Table 4 identifies the default distributions that can be updated with Louisiana data, including the corresponding HSM table or equation number. When possible, DOTD should replace these default values with Louisiana values based on the state crash database.

Table 4: Predictive Method Default Crash Distributions

Chapter	HSM Table or Equation Number	Type of Roadway Element		Data Element or Distribution that May be Calibrated
		Roadway Segments	Intersections	
Chapter 10 – Rural Two-Lane, Two-Way Roads	Table 10-3	X		Crash severity by facility type for roadway segments
	Table 10-4	X		Collision type by facility type for roadway segments
	Table 10-5		X	Crash severity by facility type for intersections
	Table 10-6		X	Collision type by facility type for intersections
	Equation 10-18	X		Driveway-related crashes as a proportion of total crashes
	Table 10-12	X		Nighttime crashes as a proportion of total crashes by severity level
	Table 10-15		X	Nighttime crashes as a proportion of total crashes by severity level and by intersection type
Chapter 11- Rural Multilane Highways	Table 11-4	X		Crash severity and collision type for undivided segments
	Table 11-6	X		Crash severity and collision type for divided segments
	Table 11-9		X	Crash severity and collision type by intersection type
	Table 11-15	X		Nighttime crashes as a proportion of total crashes by severity level and by roadway segment type for divided roadway segments
	Table 11-19		X	Nighttime crashes as a proportion of total crashes by severity level and by roadway segment type for divided roadway segments
	Table 11-24		X	Nighttime crashes as a proportion of total crashes by severity level and by intersection type
Chapter 12 – Urban and Suburban Arterials	Table 12-4	X		Crash severity and collision type for multiple-vehicle nondriveway collisions by roadway segment type
	Table 12-6	X		Crash severity and collision type for single-vehicle crashes by roadway segment type
	Table 12-7	X		Crash severity for driveway-related collisions by roadway segment type
	Table 12-8	X		Pedestrian crash adjustment factor by roadway segment type
	Table 12-9	X		Bicycle crash adjustment factor by roadway segment type
	Table 12-11		X	Crash severity and collision type for multiple-vehicle crashes by intersection type
	Table 12-13		X	Crash severity and collision type for single-vehicle crashes by intersection type
	Table 12-16		X	Pedestrian crash adjustment factor by intersection type for stop-controlled intersections
	Table 12-17		X	Bicycle crash adjustment factor by intersection type

Chapter	HSM Table or Equation Number	Type of Roadway Element		Data Element or Distribution that May be Calibrated
		Roadway Segments	Intersections	
	Table 12-23	X		Nighttime crashes as a proportion of total crashes by severity level and by roadway segment type
	Table 12-27		X	Nighttime crashes as a proportion of total crashes by severity level and by intersection type

Predictive Method Use

The predictive method can be used without calibration factors, but the results of the analysis are applicable only for conducting a relative analysis of facilities. For example, if the planning section were comparing the performance of two different multi-lane rural highway cross-sections, the safety performance could be calculated without calibration factors. The analysis results could be reported as the percent difference in the number of crashes of one alternative over the other but not the actual difference in the number of crashes. However, without calibration factors, a comparison of the predicted safety of two different facility types, such as comparing a rural two-lane alternative to a rural multilane alternative cannot be made.

Application of the predictive method requires all of the required and desired data elements for the respective facility type under investigation. For site specific applications (e.g., planning, design), this data should be available through one of the DOTD databases or Visiweb data. However, since all of the data elements required to apply the predictive method are not available in the DOTD databases, it is not currently possible to apply the predictive method at the network level in terms of network screening without significantly expanding the datasets.

Part B: Roadway Safety Management Process

Part B of the Highway Safety Manual is the Roadway Safety Management Process. Part B includes chapters on: Network Screening, Diagnosis, Countermeasure Selection, Economic Evaluation, Prioritization and Safety Effectiveness Evaluation.

Network Screening

Network screening is the most data intensive chapter in Part B. The HSM identifies 13 performance measures that can be used for network screening. The data requirements vary depending on the performance measure(s) being utilized for the network screening analysis. Table 5 provides a summary of the data requirements of the 13 performance measures included in the HSM. All 13 methods require crash data and roadway information for categorization. Some of the methods also require traffic volumes or a calibrated safety performance function (SPF) with an overdispersion parameter.

Table 5: Network Screening Performance Measures Data Needs

Performance Measures	Crash Data	Roadway Information for Categorization	Traffic Volume[2]	Calibrated SPF and Overdispersion Parameter
Average Crash Frequency	X	X		
Crash Rate	X	X	X	
Equivalent Property Damage Only (EPDO) Average Crash Frequency	X	X		
Relative Severity Index	X	X		
Critical Crash Rate	X	X	X	
Excess Predicted Average Crash Frequency Using Method of Moments	X	X	X	
Level of Service of Safety	X	X	X	X
Excess Predicted Average Crash Frequency Using Safety Performance Functions (SPFs)	X	X	X	X
Probability of Specific Crash Types Exceeding Threshold Proportion	X	X		
Excess Proportion of Specific Crash Types	X	X		
Expected Average Crash Frequency with Empirical Bayes (EB) Adjustment	X	X	X	X
EPDO Average Crash Frequency with EB Adjustment	X	X	X	X
Excess Expected Average Crash Frequency with EB Adjustment	X	X	X	X

The DOTD is in the process of acquiring a new network screening software package, Vision Zero Suite, which uses the Level of Service of Safety (LOSS) as a performance metric. Implementation of Vision Zero involves statistical modeling to develop SPFs for the various facility types in the state for both total crashes and fatal/injury crashes. However, it should be noted that the SPFs developed for the Vision Zero Suite do not utilize all of the same data elements as the HSM SPFs. While the Vision Zero Suite SPFs can be used to provide an estimate of the predicted crash frequency for a particular facility type, these SPFs should not be utilized in the HSM predictive method procedure. The data elements required for use of the Vision Zero Suite are identified in Table 6 and compared to the data elements available in the DOTD databases. The vast majority of the data elements necessary for the Vision Zero Suite are currently available in the DOTD databases. The DOTD will need to continue efforts to locate intersections and estimate or collect minor road AADT on the non-state roadways to screen intersections.

---

[2] Traffic volumes could be AADT, ADT, or peak hour volumes.

Table 6: Vision Zero Suite Data Needs

Data Element	Required	Desired	Available in DOTD databases
Roadway files			
Highway number	X		X
Control section	X		X
Milepoint	X		X
Length (to next feature)	X		X
Description (of feature at this milepoint)	X		
Rural/urban designation	X		X
Terrain (flat, rolling, mountainous)	X		X
Number of through lanes	X		X
AADT (mainline)	X		X
AADT (cross-street – intersection SPFs)	X		State roads only
Divided/undivided	X		X
Functional classification	X		X
Signalized (intersection feature)	X		X
Number of intersection legs (intersection feature)	X		
County		X	X
City		X	X
Truck percent		X	
Roadway lane width and type		X	X
Shoulder width and type		X	X
Median width and type		X	X
Crash files			
Highway number	X		X
Control section	X		X
Milepoint	X		X
Crash type	X		X
Sequence of harmful events	X		X
Location (on/off roadway)	X		X
Weather conditions	X		X
Road conditions	X		X
Road description (intersection, non-intersection, etc.)	X		X
Date of crash	X		X

Data Element	Required	Desired	Available in DOTD databases
Time of crash	X		X
Unique serial number ID	X		X
Node/link/node (street vehicle was on/distance-direction from reference feature/reference feature – i.e., on Main St, 250 feet north of 1st St)	X		X
Direction of vehicle travel	X		X
Type of vehicle	X		X
Movement of vehicle (i.e., going straight, turning left)	X		X
Injury level counts (KABCO)	X		X
Number of traffic units (vehicles/peds/bikes) involved in crash	X		X
Railroad crossing or construction related		X	X
Lighting condition	X		X
Estimated vehicle travel speed		X	X
Driver action	X		X
Driver condition	X		X
Alcohol and/or drugs suspected	X		X
Age of driver		X	X
Sex of driver		X	X
Restraint type		X	X
Injury level of driver		X	X
Longitude/latitude		X	X
Officer's narrative		X	X
Crash diagram		X	X
Contributing factor		X	X
Wild animal type (if applicable)		X	

The Vision Zero Suite uses quantitative measures to characterize the safety of a site (intersections or road segments) in reference to its expected performance based on the LOSS concept. With the LOSS concept, the number of crashes predicted by the SPF represents the normal or expected crash frequency at a specific level of annual average daily traffic (AADT), and the degree of deviation from the norm is stratified to represent the specific levels of safety. The four LOSS categories include:

- LOSS I – low potential for crash reduction;
- LOSS II – low to moderate potential for crash reduction;

- LOSS III – moderate to high potential for crash reduction; and
- LOSS IV – high potential for crash reduction.

LOSS reflects how the roadway segment is performing in regard to its expected crash frequency and severity at a specific level of AADT in comparison to the expected norm, but it does not provide any information on the nature of the safety problem. However, the Vision Zero Suite also includes Direct Diagnostics and Pattern Recognition techniques to use in diagnosis.

Diagnosis and Countermeasure Selection

The Vision Zero Suite Direct Diagnostics and Pattern Recognition techniques can be used to determine the nature of a safety problem identified based on LOSS. The Direct Diagnostics and Pattern Recognition techniques utilize much of the data identified in Table 6 to identify crash patterns susceptible to safety improvement. Determining crash patterns susceptible to safety improvement will help the DOTD identify the appropriate countermeasures.

As part of the diagnosis process, additional data should also be reviewed on a site specific basis. This may include individual crash reports, recent studies, as-built plans, or any information that may be relevant to reviewing the site. The individual crash reports for some crash records are available for viewing through Crash 1. Crash reports provided by the Louisiana State Police are available in a separate electronic reporting system and can be accessed by requesting permission from the Highway Safety Section.

Economic Appraisal and Project Prioritization

Economic appraisal and prioritization require crash costs and discount rates. These values can be state specific or federally provided values. The DOTD has established crash costs and a discount rate which can be used to conduct an economic appraisal and to prioritize projects based on a benefit-cost analysis.

Effectiveness Evaluation

Safety effectiveness evaluations support future decision-making and policy development. Evaluation results can be used to determine the percentage change in crash frequency, the shift in proportions of crashes by type or severity and the CMF for a treatment or to compare benefits achieved as a function of the cost of a project or treatment.

The data required for safety effectiveness evaluations depends on the method used for the evaluation. Table 5 summarizes the data needs for the four evaluation methods identified in the HSM. The simple before-after study requires crash data for the evaluation sites both before and after the treatment. If an SPF is available, the before-after using SPFs (EB method) can be used for the evaluation. The before-after method with a comparison group requires data for the before and after periods for both treated sites and similar non-treated sites. Finally, the cross-sectional study requires data only for the after period for sites that have been treated and similar sites without the treatment.

Table 5: Safety Effectiveness Evaluation Method Data Needs

Evaluation Method	Treatment Sites		Nontreatment Sites		Calibrated SPF
	Before Data	After Data	Before Data	After Data	
Simple before-after study	X	X			
Before-after using SPFs (EB method)	X	X			X
Before-after using comparison group	X	X	X	X	
Cross-sectional study		X		X	

DOTD can utilize data from the crash database to conduct safety effectiveness evaluations of implemented projects once three to five years of after crash data is available. If calibration factors are developed the DOTD can incorporate the EB method into the evaluations to account for effects of regression-to-the-mean and changes in site conditions.

Conclusion and Recommendations

Calibration is essential for reliable results with the HSM predictive method. The majority of the data elements required for calibration of the roadway segment SPFs, as well as many of the desired data elements, are available in the current DOTD roadway elements database or will be with the expansion efforts currently underway. Because the intersections are not currently located in the DOTD database and many of the required data elements for calibration are not available, it is recommended the DOTD begin calibration efforts with the roadway segment SPFs and develop a plan for enhancing the intersection database.

Although the desired elements are not required for calibration in the HSM, these data elements should be included in the calibration effort when possible. The distinction between required and desired elements in the HSM is strictly based on data elements thought to be available in the state databases, not based on the actual sensitivity of the variable. Calibration efforts in other states can be used as a model for determining some of these values. For example, in Oregon, many data elements used in the calibration procedure not readily available in the DOT's databases were determined using digital video logs and Google Earth. These sources could also be utilized to collect the missing required data elements and much of the data necessary for calibration of the SPFs for intersections. Additionally, Oregon developed a methodology for estimating the AADT of the minor roads at intersections. The DOTD could consider use of a similar methodology or use of the travel demand model to estimate the volumes for the minor roads. The initial efforts to collect the missing data will most likely be tedious; however, unless there are changes to the site conditions, only the traffic volume and crash data will need to be updated in future calibration efforts.

Prioritizing which SPFs to begin the calibration efforts with could be based on a number of factors. One option would be to start with the two-lane, two-way rural roads, since all of the required data elements are available in the DOTD roadway data elements database (although some of the desired elements would require further effort to obtain if desired). Alternatively, the DOTD could prioritize based on the facility types with the highest frequency of severe crashes or on the facility types with the highest volume. As another option, the DOTD could decide to compile the data to calibrate SPFs for which they anticipate the most upcoming state or local design work. As part of the calibration effort, the DOTD should also update the predictive method default crash distributions identified in Table 4.

Calibration of the SPFs would enable the DOTD to apply the predictive method in the planning and design stages of the project develop process and provide certainty of reliable results. While not all of the data elements necessary for calibration are readily available in the DOTD database, use of data sources such as Visiweb data, digital video logs, or Google Earth should provide the DOTD with all of the necessary data.

For implementation of the Vision Zero Suite, DOTD will most likely want to begin by updating the previous models developed for two-lane rural roadways and rural freeways. Future efforts for expanding the development of SPFs for the Vision Zero Suite throughout the state should be prioritized based on facility types with the highest crash frequency or crash severity. Similar to the calibration efforts, the DOTD will need to first finish locating the intersections, collect the appropriate intersection characteristics information, and either estimate or collect AADT on the minor street approaches prior to developing the intersection SPFs.

References

AASHTO. *Highway Safety Manual*. First Edition. American Association of State Highway Transportation Professionals. Washington, D.C., 2010.

Xie, Fei. *Calibrating the Highway Safety Manual Predictive Methods for Oregon Rural State Highways*. Master's Thesis. March 3, 2011.