DIVISION OF RESEARCH AND INNOVATION
Research Initial Scope of Work
SUBMITTAL FORM - FY 11/12

I. **Project Number: P299**
Project Title: Methods for Identifying High Collision Concentration Locations for Potential Safety Improvements

II. **Task Number: 2317**
Task Title: Development of Safety Performance Functions for California

III. **Project Problem Statement:**

Problem Statement: Development of Safety Performance Functions for California Roadway Types.

IV. **Objective:**

The main objective of the proposed effort is to develop these safety performance functions following the approach that is outlined in Part B of the HSM using data from California. Safety performance functions will be developed for roadway segments, intersections, and ramps. In addition, this project will also develop data sets for input into SafetyAnalyst.

V. **Task Description of Work and Expected Deliverables:**

RESEARCH APPROACH AND TASKS

Task 1: Kick off meeting

A kick off meeting will be held at Caltrans to discuss the research approach, data needs, and other issues. One objective of this meeting will be to determine the crash types (i.e., all crashes, crashes on wet pavement, run-off-road crashes), crash severity (i.e, total, fatal, F+I), and roadway/intersection types that are of interest to Caltrans.

Deliverable: Copy of presentation slides from the meeting and a report of minutes from the meeting.

Task 2: Obtain roadway, crash, and traffic data from TSN for the last five years

The intent is to develop SPFs using data from the last five years. Roadway, crash, and traffic data for the last five years will be extracted from TSN after identifying the variables that are necessary for the development of SPFs. Data will be extracted for roadway segments, intersections, and ramps.

Currently, the TSN files do not have information on the length of ramps. However, Caltrans has rough ramp length data in Microsoft Excel Comma Separated Values (csv) file format.

Deliverable: Roadway, intersection, Ramp, and crash files for the last 5 years.

Task 3: Develop counts of different types and severity levels

Since the SPFs developed in this project may be used with or without SafetyAnalyst, it will be necessary to include the facility types in SafetyAnalyst as well as the facility types (i.e., roadway segment, intersection, and ramp) that are used in Table C. Crash counts of different types and severity levels will be developed for each year for roadway segment, intersection, and ramp.

Deliverable: Roadway, Ramp and intersection based files with counts of different crash types and severities.

Task 4: Develop SPFs for different types of roadway segments

This task will develop SPFs for different types of roadway segments. The intent is to develop two types of SPFs. As discussed in Srinivasan et al. (2011), type 1 SPFs only include AADT, and this is the required format for the current version of SafetyAnalyst. Types 1 SPFs include site characteristics in addition to AADT and will provide a more accurate prediction of the mean crash frequency. Type 2 SPFs can be still be used by Caltrans for network screening purposes, but cannot be used within the current version of SafetyAnalyst. In developing the SPFs, different Caltrans rate group characteristics will be investigated in order to combine the rate groups based on factors such as sample size, collisions within the samples, and other characteristics. New SPFs will be developed for the combined rate groups consistent with the process outlined in Part B of the HSM.

SPFs will be developed for different crash types (i.e., all crashes, crashes on wet pavement, runoff- road crashes) and crash severities (i.e, total, fatal, F+I). Consistent with the state of the art in the highway safety field, SPFs will be developed using negative binomial regression and will follow the log-linear form. Cumulative residual (CURE) plots and other goodness of fit statistics will be provided for each SPF that is developed in this task.

Deliverable: A report or memo documenting the SPFs for roadway segments.

Task 5: Develop SPFs for different types of intersections

Two types of SPFs will be developed. Type 1 SPFs will include only major and minor road AADT, consistent with the requirements for SafetyAnalyst. Type 2

SPFs will include intersection characteristics in addition to AADT. In developing the SPFs, different Caltrans rate group characteristics will be investigated in order to combine the rate groups based on factors such as sample size, collisions within the samples, and other characteristics. New SPFs will be developed for the combined rate groups consistent with the process outlined in Part B of the HSM.

SPFs will be developed for different crash types (i.e., all crashes, crashes on wet pavement, runoff- road crashes) and crash severities (i.e, total, fatal, F+I). Consistent with the state of the art in the highway safety field, SPFs will be developed using negative binomial regression and will follow the log-linear form. Cumulative residual (CURE) plots and other goodness of fit statistics will be provided for each SPF that is developed in this task.

Deliverable: A report or memo documenting the SPFs for intersections.

Task 6: Develop SPFs for different types of ramps

Again, type 1 SPFs will be developed including just AADT. Type 2 SPFs will include AADT along with other ramp characteristics that are available from Caltrans. In developing the SPFs, different Caltrans rate group characteristics will be investigated in order to combine the rate groups based on factors such as sample size, collisions within the samples, and other characteristics. New SPFs will be developed for the combined rate groups consistent with the process outlined in Part B of the HSM.

SPFs will be developed for different crash types (i.e., all crashes, crashes on wet pavement, runoff- road crashes) and crash severities (i.e, total, fatal, F+I). Consistent with the state of the art in the highway safety field, SPFs will be developed using negative binomial regression and will follow the log-linear form. Cumulative residual (CURE) plots and other goodness of fit statistics will be provided for each SPF that is developed in this task.

Deliverable: A report or memo documenting the SPFs for ramps.

Task 7: Milestone Meeting

A progress meeting will be held with/at Caltrans to discuss the work completed and the direction in which the work will proceed. Most likely, this meeting will be held in month 10 of the project. By that time, the type 1 SPFs from Tasks 4, 5, and 6 are expected to be completed.

Deliverable: Copy of presentation slides from the meeting and a report of minutes from the meeting.

Task 8: Develop data sets for input into SafetyAnalyst

Using HSIS data for urban freeways and rural two lane roads from 2003 to 2007, Srinivasan et al. (2011) developed roadway inventory files, crash files, and AADT files for two roadway types for inclusion in SafetyAnalyst. Only the required variables were included in those data sets. The intent of Task 8 of this project is to prepare data sets that include all roadway, intersection, and ramp types. Both required and desirable variables will be included. One of the activities in this task is to recode the variables from TSN to match the levels in SafetyAnlayst. Finally, the data sets will be used to demonstrate the use of SafetyAnalyst for network screening.

Deliverable: Data sets that were developed for input into SafetyAnalyst.

Task 9: Develop the Final Report

The final report will document all the tasks and provide a summary of the SPFs and the programs that were used to prepare the data sets for SafetyAnalyst. It will also discuss options for updating the SPFs in the future and outline possible directions for future research.

Deliverable: Draft final report.

Task 10: Presentation of Final Report

The final report will be presented to Caltrans in a meeting. Following the meeting, the report will be revised based on comments from Caltrans.

Deliverable: Copy of presentation slides and revised final report.

VI. **Background:**

One of the first steps in effectively managing a road network is to identify sites that require safety investigations. It is important that the identification process is efficient, otherwise scarce resources may be wasted on sites that are incorrectly identified as collision concentration sites while roadway locations with a truly high potential for cost-effective safety improvement may not be flagged in this process. Conventional methods that make use of just collision counts or collision rates (per unit of exposure) are now known to have problems because they do not effectively account for the potential bias due to regression-to-the-mean phenomenon in which sites with a randomly high account could be incorrectly identified as having a high potential for improvement, and vice versa. Another problem with conventional methods that makes use of collision rates is the implicit assumption that collision frequency and traffic volume are linearly related. Many recent studies have shown that the relationship between collisions and volume depends on the type of facility but tends to be non-linear. For example, a 20% increase in volume will not necessarily result in a 20% increase in collisions. For most facilities, the relationship implies a smaller increase in collisions than the increase in volume with the result that the lower volume sites will have the highest collision rates and will tend to be flagged by the conventional collision rate method.

One method that has been proposed to overcome the pitfalls of conventional methods is the empirical Bayes (EB) procedure. Srinivasan et al. (2011) compared the performance of the EB procedure, the level of service of safety (LOSS), and the Table C method for network screening, and concluded that the EB procedure can be an effective and efficient approach for network screening. The EB procedure can be implemented using a tool called SafetyAnalyst, initially developed by Federal Highway Administration and being distributed through AASHTO.

One of the steps involved in applying the EB procedure is to develop safety performance functions (SPFs) that relate crash frequency with site characteristics. As discussed in the Highway Safety Manual (HSM), SPFs can be used in different ways. For example, Part B of the HSM discusses the use of SPFs for network screening and for estimating the safety of engineering treatments as part of a before-after evaluation using empirical Bayes methods. On the other hand, the SPFs in Part C of the HSM are intended for project level analysis and prediction.

VII. **Estimate of Duration:** 12- 18 Months

VIII. **Related Research:** This is related to the previous research as followed: Method for Identifying High Collision Concentration Locations (HCCL) for Potential Safety Improvements- Phase II: Evaluation of Alternative Methods of Identifying HCCL.

IX. **Deployment Potential:** This research may be at or near the final stage. When this is completed, it will be deployed with SafetyAnalyst. Traffic Operations is committed to this research.

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