**NCHRP 17-99 Proposal Outline**

**Title: Assessing Safety Effectiveness of Treatments and Technologies at Highway-Rail Grade Crossings**

**Team: OSU; Michigan Tech; NDSU**

# Research Plan

* Need a comprehensive **flowchart**

## Task 1 – Literature Review & State Survey

* Introduction paragraph

### Subtask 1.1 Literature Review

* Review of treatments at HRGC: marking, traffic control devices (automated gate, flashing lights, etc.), operational treatments (a comprehensive list)（identify one key literature）
* **Review of technologies at HRGC: machine vision, not mentioning PTC, CV.**
* Review of factors for the selection of locations (ranking at various SHAs), treatments and technologies
* Overview of data needs and data availability
* Overview of crash frequency and severity models (chenwei) (Dr. Lu Pan)
* Overview of effectiveness assessment methods
* Successful practices and gaps and challenges

### Subtask 1.2 Survey of Select SHA and Industry Representatives

* Survey questions: one question for each of the above. (Sample questions)

## Task 2 - Identify and evaluate the factors required for developing a framework(2 pages)

### Subtask 2.1 Recommend a preliminary list of factors

* Summary based on literature review and state survey: a comprehensive table organized by different categories (a paragraph)

### Subtask 2.2 Evaluate the listed factors

* Data availability – FRA, states
* Data quality – completeness (missing/incomplete), reasonableness (validation check, range), imbalanced data
* Time series comparisons, etc. (**case studies**)
* Correlation analysis to exclude highly correlated variables
* Deliver a refined list that merits further consideration

## Task 3 Draft work plan

* Need a **flowchart**, with multiple levels of assessment to accommodate the various needs at SHAs and different levels of available resources and data sets
* In this task, each step is discussed briefly, while in Phase II Task 5 details will be provided.
* Step 1 Define reference populations (factorial) based on the factors recommended in Task 2
* Step 2 Gathering FRA data (inventory & Crash) for the factors and evaluate the quality and adequacy of sample size (if inadequate, go to steps 4)
* Step 3 Crash prediction based on historical data
  + Estimate average crash frequency
  + Develop crash modification factors (CMF)
  + Develop SPFs for crash frequency prediction
  + Predict crash severity
* Step 4 Machine sensor data for safety at crossings (**pilot studies**)
  + Site selection assisted by SHAs
  + Install automated machine vision sensors: existing video cameras at crossings
  + Apply machine learning algorithms to quantify the change of numbers of potential crashes (software open source)
* Step 5 Estimate the expected crash frequency
  + By combining the observed and predicted crash frequency to consider the regression to the mean (RTM) bias
  + Explore Empirical Bayesian, full Bayesian, moderated methods, and other methods.
* Step 6 Perform effectiveness evaluation
  + Crash cost estimates and adjustments
  + Effectiveness evaluation methods

## Task 4 – Interim report

* Deliverables: report and presentation.

## Task 5 – Execute the work plan

* With technical details & equations
* With examples on how to evaluate the effectiveness using each method, and acknowledge the limitations
* For models (frequency and severity), in the literature section we will list the various available methods with brief discussion of limitations (probably in table), while in Phase II Task 5 their suitability of the models for this project will be evaluated and recommended for implementation. Details of the most promising methods will be provided.

### Subtask 5.1 Define reference populations

* A grouping of sites with similar characteristics) based on the factors recommended in Task 2 (CHAPTER 4 from HSM)

### Subtask 5.2 Gathering data and evaluate the adequacy of sample size

* Data processing: imbalanced data
* Adequate data size: methods??

### Subtask 5.3 Crash prediction based on historical data (page 3-29, app-3A)

* Estimate average crash frequency (page 3-35, Section 3A-4)): definition🡪four levels methods (simple for less data🡪comprehensive for more data) (SPF🡪Crash frequency🡪severity)
* Develop crash modification factors (CMF): reliability and standard error (page 3-19 to 3-22, section 3.5.3; page: d6 and d7, page 3-44, etc.)
* Develop SPFs for predicting crash frequency (chenwei)
* Develop SPFs for predicting crash severity

### Subtask 5.4 Characterizing highway rail crossing safety using machine vision data

* Use existing machine vision data sets (<http://rail.rutgers.edu/files/Detection_Safety_Scien.pdf>)
* Observation studies: similar conditions but different treatments
* Apply machine learning algorithms to quantify the change of numbers of potential crashes (near miss crashes)
* Need assistance from SHAs for site selection

### Subtask 5.5 Estimate the expected crash frequency

* by combining the observed and predicted crash frequency to consider the regression to the mean (RTM) bias
* explore empirical Bayesian, full Bayesian, moderated methods, and other methods. (https://online.stat.psu.edu/stat555/node/40/)

### Subtask 5.6 Perform effectiveness evaluation

* (HSM page 3-26)(Chapter 9 HSM) (page C-19, SECTION C.7) (PAGE 9-8 modify the figure, page 9-34, combine it with the figure)

### Subtask 5.7 develop electronic-based tool

* Will use Spreadsheet VBA, and web tool: SHAs only need to click the drop down menus

## Task 6 – Implement the framework and electronic tool

* Develop a workbook with detailed steps and examples following the HSM approach
* Deliver training webinars
* Work with LifeSaver and develop education flyers and web contents

## Task 7 Final report

* List the chapters