UTSA
The University of Texas at San Antonio

PROJECT SUMMARY

Texas Department of Transportation

# 0-6642: Developing Warrants for Active Warning Devices at Low-Volume Highway-Rail Grade Crossings

## Background

In order to utilize funds from the Highway-Rail Grade Crossing Safety Program, Section 130 of Title 23 U.S.C., states must prioritize public highway-rail crossings for improvements. The Texas Department of Transportation (TxDOT) has been utilizing a Priority Index (TPI) that is the product of the following variables (rescaled by 0.001): annual average daily traffic (AADT), train traffic, train speed, crashes in the last five years, a school bus factor, and a protection factor that depends on the active devices.

AADT must be considered in a prioritization, but it is thousands of times greater in active crossings than in passives. Therefore, the literature still lacks an index capable of simultaneously considering AADT and assigning high priorities to low-volume crossings with other risk factors. As a result, most agencies prioritize active and passive crossings separately. Some developed rules/warrants to select passive crossings for upgrades. The researchers found no formal methodology capable of equally considering passive and active crossings, and developed an innovative approach.

## What the Researchers Did

The researchers organized a database combining the most recent TxRAIL data with other sources, using it to evaluate existing warrants, indices, and prioritization methodologies. TxDOT and the researchers discussed these interim findings during a project workshop where a survey of the relative importance of crossing characteristics was also conducted. The researchers used the survey results, the workshop discussions, and further input from the TxDOT oversight committee in conjunction with additional research to develop the following products:

1. **Warrants to identify crossings that may benefit from upgrades.** The warranting procedure first eliminates passive crossings that do not meet minimum eligibility criteria and then applies 10 warrants to the eligible crossings. An improvement candidate must meet at least one warrant. The warranting procedure uses an innovative concept: cumulative percentile thresholds. The only two types of thresholds found in the literature were qualitative (such as "substantial trucks") and fixed (such as "school buses/day>10"). Qualitative thresholds are challenging to implement. Fixed thresholds always have borderline values that are never considered. Cumulative percentiles update every time the data are updated, automatically adjusting the thresholds to the latest information and giving previous borderline values a chance of being considered.

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2. **Revised Texas Priority Index ($TPI_{rev}$).** After investigating different statistical techniques and the significance of several model variables, a negative binomial regression model with 12 variables gave the best crash risk prediction ($\hat{\mu}$). $TPI_{rev}$ is the rescaled product of $\hat{\mu}$ and the observed crashes in the past five years ($A_5$). A small constant (0.1) is added to consider crossings with no crashes (the vast majority). The equation is:

   $TPI_{rev} = 1000^* (\hat{\mu})^*(A_5+0.1)$.

   $TPI_{rev}$ predicts crashes better than the original index but remains most relevant for prioritizing active crossings because it continues to assign bottom priorities to most of the passive crossings.
3. **The Texas Passive Crossings Index (TPCI).** TPCI is an index derived from utility theory principles. It is the weighted average of the utilities of 13 variables found relevant to the potential crash risk in passive crossings. This index also uses the cumulative percentile concept instead of variable values. Prioritizing the set of warranted passive crossings by number of warrants met and TPCI gives the best results.
4. **An integrated prioritization methodology.** This method combines the passive and active priority ranks determined as explained above to generate a final priority list. The top priorities contain properly sorted active and passive crossings that need inspection. This methodology successfully ranked among the top 3 percent of the nearly 10,000 crossings: all passive crossings meeting the greatest number of warrants, most passive crossings meeting multiple warrants, and all crossings with multiple crashes, including several without a $TPI_{rev}$ value due to some missing data items.

## What They Found

The methodology developed in this project is superior to the methodologies found in the literature for the following principal reasons:

- Methodologies relying only on indices that contain AADT cannot identify crossings with risk factors and a missing variable, and place nearly all low-volume crossings at the bottom of the priority list.
- Methodologies relying on warrants cannot prioritize the crossings.
- The only way to generate a useful priority list is to prioritize actives and passives separately and build the priorities according to this project's methodology.

## What This Means

This project's prioritization methodology uses the warrants and indices to generate a priority list whose top contains a balanced number of passives and actives with greatest potential risk factors, including those with missing values of $TPI_{rev}$. These steps can be easily coded into regular platforms; the researchers coded them into their preferred platforms (SAS, Access, and Excel) without assistance of computer specialists. With nearly 10,000 open public crossings in Texas to prioritize for Section 130 funds, an automated ranking procedure capable of generating a useful priority list can be instrumental for efficient fund allocation.


## For More Information

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