Transportation Systems Engineering

Southeastern Transportation Center

SAFETY ANALYSIS ON RAIL HIGHWAY AT-GRADE CROSSING IN ALABAMA

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Safety Research at The University of Alabama

University Transportation Center for Alabama (UTCA)

Center for Advanced Public Safety (CAPS)

Safety performance function (SPF) development

- ✓ In line with the Highway Safety Manual (HSM)
- ✓ SPFs for two-lane rural roads, four-lane divided highways, urban/suburban arterials, highway bridges, and rail highway at-grade crossings, based on Alabama data.

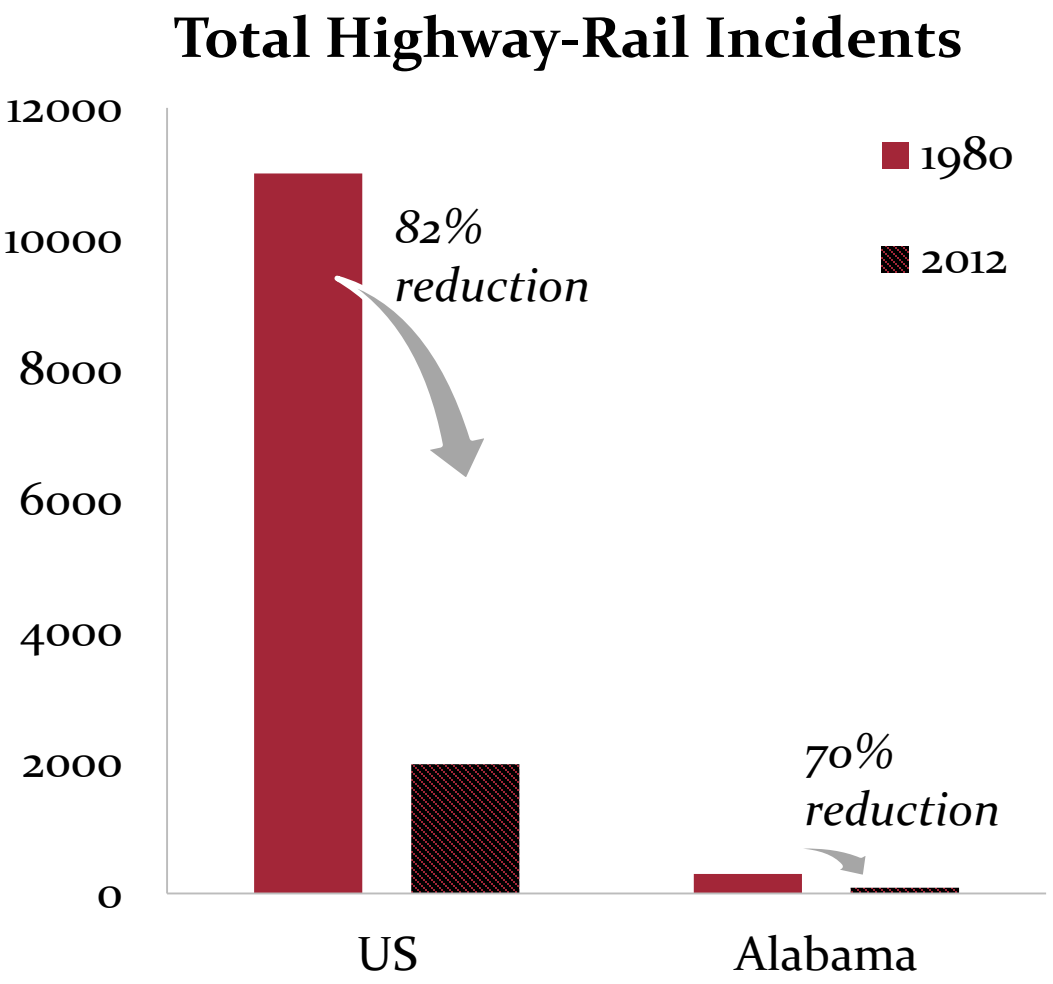
Highway safety plan development

- ✓ Comprehensive Highway Safety Plan
- ✓ Strategic Highway Safety Plan

Outline

- Background of Study
- Objective of Study
- Data Description
- Modeling Methodology
- Modeling Results
- Conclusion
- Future Research

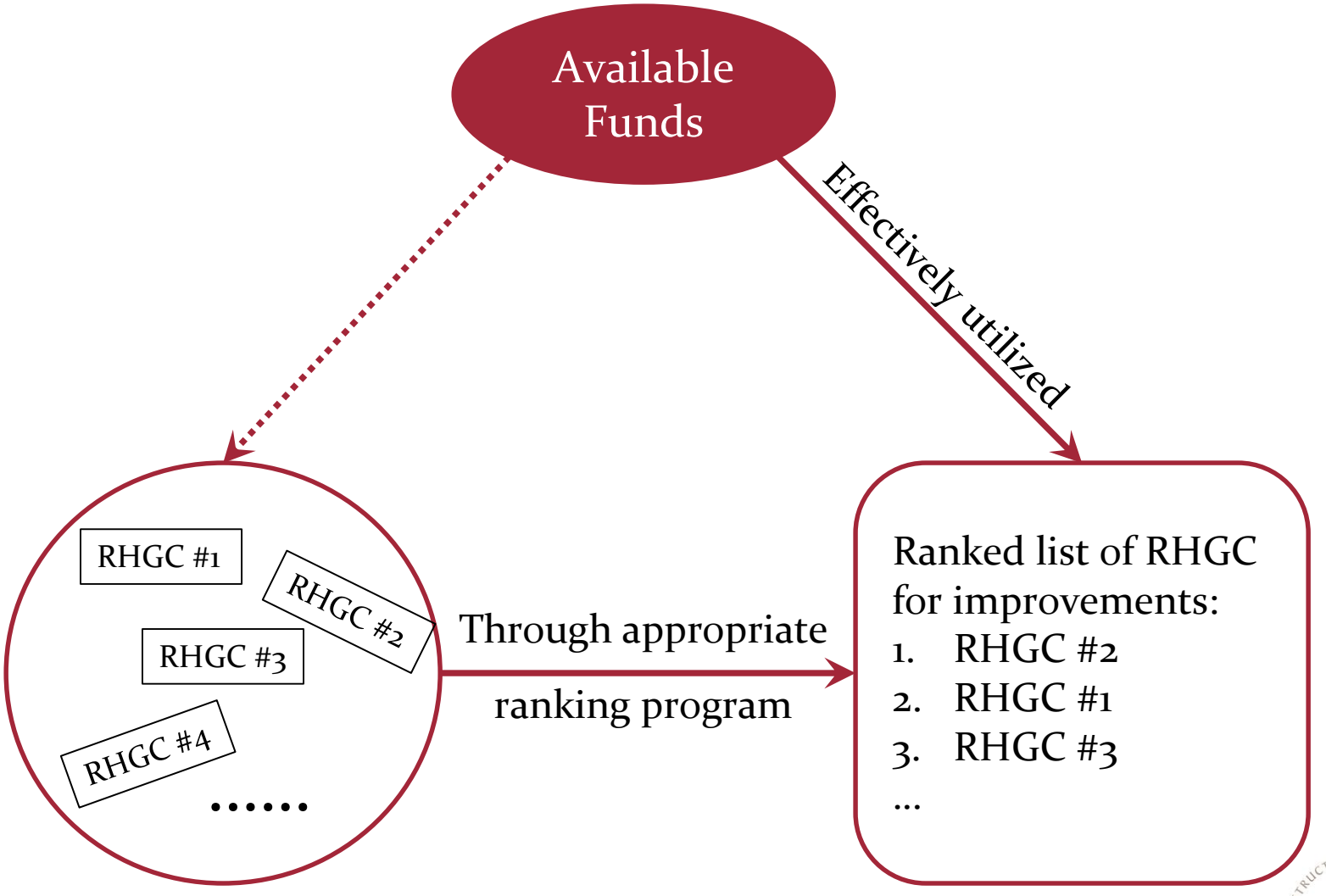
Background of Study



What can make RHGCs safer?

- ✓ Track and signal inspection and maintenance
- ✓ Warning device upgrade
- ✓ Educate the public about proper behavior at RHGCs

Background of Study



Background of Study

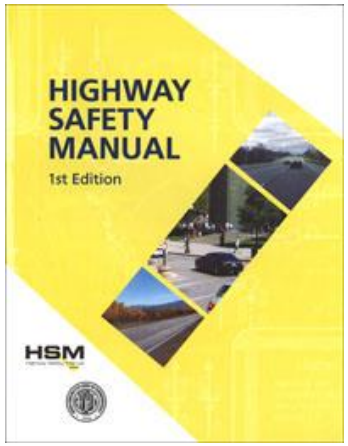
- The crash prediction model from the RHGC safety assessment approach recommended by the US Department of Transportation:
  - Base formula* (1986)
  - Weighted formula for observed crashes* (1986)
  - Final adjustment for current collision trends** (2007)
- Related studies
  - RHGC crash analysis (influencing factors, prediction model)
  - Effective analysis of warning devices at RHGCs (e.g., stop sign)

* *Railroad-Highway Grade Crossing Handbook (1986)*

** Accident Prediction and Resource Allocation Procedure Normalizing Constants (2007)

Objective of Study

- Objective of Study
  - Develop safety performance functions (SPFs) for crashes occurring at RHGCs in line with the Highway Safety Manual (HSM).



- *Tools and techniques to integrate safety in to transportation planning*
- *Predictive method gives expected average crash frequency*

  - Understand how RHGC characteristics affect crash occurrences.

Data Description

Federal Railroad Administration (FRA) database

- *Highway-rail crossing inventory*
- *Highway-rail crossing history file*
- *Highway-rail crossing accident database*

Alabama Department of Transportation (ALDOT) database

- *Rail-highway at-grade crossing inventory*

Data Description

FRA highway-rail crossing inventory

ALDOT RHGC inventory

Cross reference & Refine

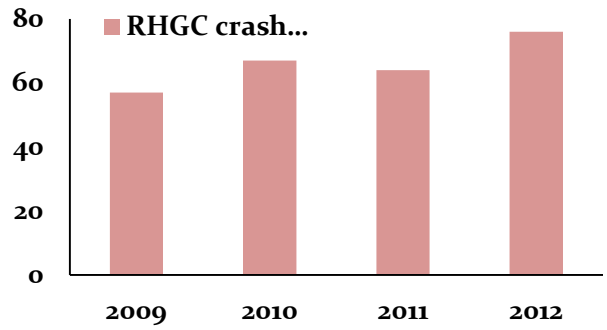
2,720 active public RHGCs

FRA highway-rail crossing accident data (1998-2012)

Crash observations at 2,720 RHGCs

Crash Facts

- 1,332 crashes occurred from 1998-2012.
- RHGC crashes generally increased from 2009-2012



Data Description

15-year Crash observations at 2,720 RHGCs

Crossing ID	Crossing characteristics	Crash count over 1998-2002	Crash count over 2003-2007	Crash count over 2008-2012
306359C	Attributes that represents the latest statuses of crossings	2	1	0
726916V		0	0	0
…		…	…	…

Samples

Data processing to make sure:

- Each sample is from a five-year interval without changes of the crossing.
- Each sample has the corresponding status of the RHGC.

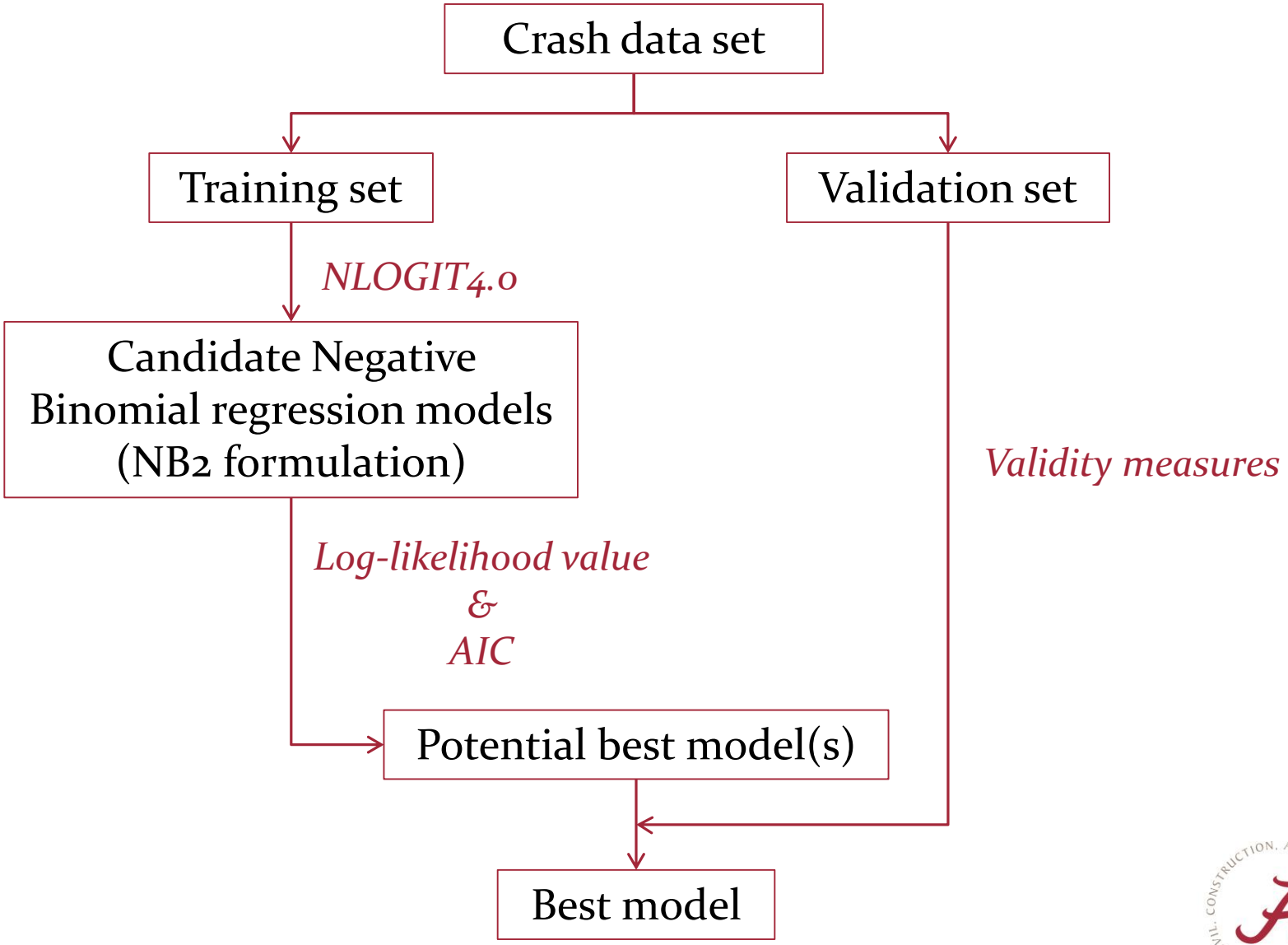
FRA highway-rail crossing history file

Final sample set for modeling (2,198 samples)

Modeling Methodology

- Data Analysis
  - Crashes are rare and random events
  - Discrete count models
  - Observed crash counts as over-dispersed data
  - Negative Binomial model (NB2 formulation)
- Best Model Identification (goodness of fit)
  - Log-likelihood value
  - Akaike Information Criterion (AIC)
- Model Validation
  - Validation date set
  - Model validity measures

Modeling Methodology



Modeling Development

- Variable description
  - Crash count over five consecutive years for a crossing serves as the dependent variables.
  - 152 variables from the crossing inventory.
  - Many variables are redundant giving same information.
  - Many variables not included in the analysis because of missing values and description.
  - 60 variables were shortlisted for detail investigation.
  - After further investigation 27 variables were used in the model.

Modeling Results

SPF for Alabama RHGC crashes

Variables	Best model	Comparable model
Intercept	-6.0066	-5.2083
LnAADT	0.3388	0.1978
Percentage truck	0.0228	0.0246
Number of bells	-0.5593	
Variable indicating at least 1 train per day	-1.269	
Pavement markings	0.2967	0.2378
Max train speed	0.0219	
Minimum train speed	0.013	0.0271
Dispersion Parameter	1.7198	2.0929
Log-Likelihood	-366.182	-371.133
AIC	0.759	0.765

Conclusion

- Developed the safety performance function (SPF) for rail-highway at-grade crossings in Alabama.
  - Two models currently are viable.
  - The U.S. DOT model contains variables that are irrelevant to the prediction of RHGC crashes, at least in Alabama.
- The models are based on Alabama data
  - Alabama-specific RHGC SPFs may not apply in other states.
  - Test using calibration factor or develop new SPFs.

Future Research

- Use Conway–Maxwell–Poisson (CMP) distribution to model crash counts at RHGCs.
  - Advantages of CMP –
    - ✓ Very flexible and spans over three distribution (Geometric, Poisson and Bernoulli)
    - ✓ Performs well for both over-dispersed and under-dispersed data set
  - Motivation of using CMP –
    - ✓ Model RHGC crash counts at different levels of severity
- Work with ALDOT to develop a ranking program to prioritize RHGCs for improvements.

Thanks!

Questions / Comments?

Notes

USDOT Accident Prediction Model

- *EI* = factor for exposure index based on product of highway and train traffic
- *MT* = factor for number of main tracks
- *DT* = factor for number of through trains per day during daylight
- *HP* = factor for highway paved (yes or no)
- *MS* = factor for maximum timetable speed
- *HT* = factor for highway type
- *HL* = factor for number of highway lanes

HSM Methodology Prediction Model

- Train Speed (Max and Min)
- AADT
- Truck Percentage
- Warning device Present
- Pavement Markings
- Train Activity (< 1 per day)