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SUCCESS FACTORS IN THE REDUCTION OF HIGHWAY-RAIL GRADE CROSSING

SUMMARY

Incidents at highway-rail grade crossings in the United States declined 44.7 percent from 1994 to 2007. This decline was likely a result of various crossing safety improvement programs conducted during that period. The U.S. Department of Transportation's (USDOT) Federal Railroad Administration (FRA) tasked the John A. Volpe National Transportation Systems Center (Volpe Center) to determine the safety factors that were responsible for the reduction of highway-rail grade crossing incidents. The study was conducted in two parts. In the first part, an examination of the reduction of highway-rail grade crossing incidents during the 1994–2003 period was completed. In the second part of the study, an analysis of success factors for the 2003 through 2007 period was completed.

Through literature reviews, discussions, and consultation with subject matter experts, a comprehensive list of success factors was developed. The list was prioritized and narrowed to the factors that have a high projected impact on incident reduction. The factors were then separated into those that could be approximated by fields in the Railroad Accident Incident Reporting System (RAIRS) Highway-Rail Grade Crossing database and those that would be analyzed without the RAIRS fields.

The analysis revealed five factors with RAIRS field equivalents that influenced highway-rail grade crossing safety from 1994 to 2003, and an additional two factors that had potential influence from 2003 to 2007. Those seven factors were:

- Commercial driver safety
- Locomotive conspicuity
- More reliable motor vehicles
- Sight lines clearance
- Grade crossing maintenance rule
- Reflectorization of freight rolling stock, and
- Pedestrian safety

In addition, other factors were analyzed separately: crossing consolidation, grade separation, warning device upgrades, education and enforcement, and Federal funding. The trend in incidents assigned to one of the seven factors and the overall grade crossing incident trend from 1994 to 2007 is shown below.

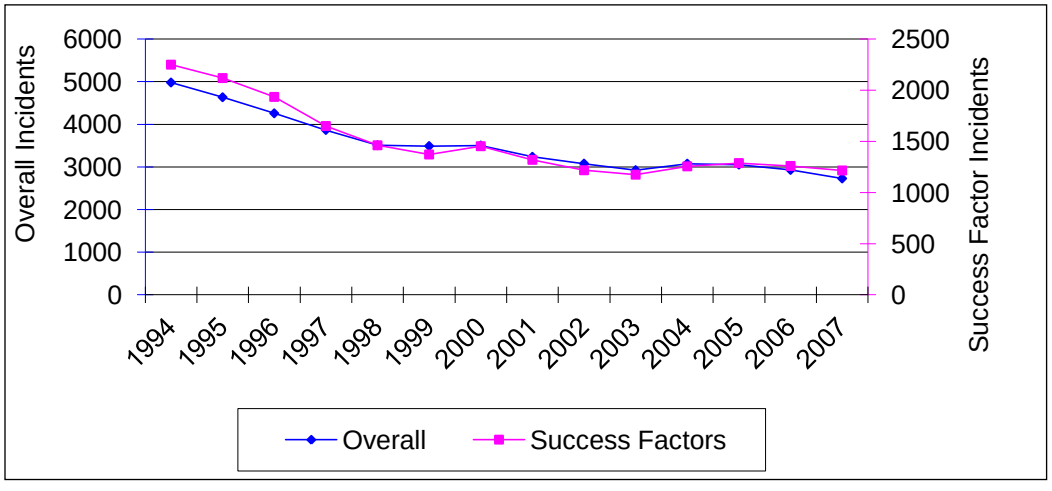

Figure 1. Trend in Overall Grade Crossing Incidents and Success Factor Incidents, 1994–2007

BACKGROUND

The 1994 USDOT Secretary's Action Plan suggested initiatives and actions to reduce highway-rail grade crossing incidents over a 10-year period in which incidents [1]. During those 10 years, incidents declined 41.2 percent.

In 2004, the USDOT Secretary issued an updated Action Plan [2]. This plan superseded the 1994 plan to improve safety at grade crossings across the Nation. From 2003 to 2007, incidents declined an additional 7.5 percent. The reasons for the declines were not attributed to particular safety initiatives.

OBJECTIVES

The first objective was to develop a methodology to evaluate the impact of highway-rail grade crossing safety programs on trends in incidents.

The second objective was to use the methodology to determine the most influential safety factors on the reduction of incidents from 1994 to 2003 and 2003 to 2007.

RESEARCH METHODS

To determine which safety factors had the largest influence on the reduction of incidents, the first step was to identify all possible factors during the study period. This was done through extensive literature reviews and group discussions. The list was narrowed to the factors with a high projected impact.

Of the factors selected, some could be approximated by fields within the RAIRS Grade Crossing database. The data fields selected were specifically related to the factors (e.g., incidents involving large trucks and buses were selected to represent commercial driver safety). The factors analyzed using RAIRS Grade Crossing data were measured using two metrics: percent impact and percent reduction.

The percent impact is the percentage of incidents that can be attributed to behaviors that the factor was attempting to change. The percent impact was calculated by dividing the number of incidents attributed to the factor by the total number of grade crossing incidents.

The percent reduction is the percentage of incidents reduced that can be attributed to the safety countermeasures for a factor. The percent reduction was calculated by dividing the change in the number of incidents for a factor from the first year of the study to the last by the change in the total number of grade crossing incidents from the first year of the study to the last. Together, these two metrics provide a complete picture of the factors' contributions to incident reduction.

As a result of the data collection process, one incident could be assigned to multiple factors. This resulted in an overlap of incidents among factors and inflated the estimate of the factors' effects. The methodology for isolating the incidents used the concept of a Venn diagram (overlapping circles that represent the propositions of the factors). Each incident in the database was assigned to a single factor, some combination of factors, or a category of unidentified factors. The factor isolation provided a more accurate measure of the factors' effect on incident reduction.

Factors that could not be approximated by fields in the RAIRS Grade Crossing database were examined in other ways. For example, factors that data was available from another source were analyzed using a predicted number of incidents avoided. These were also tested for correlation between the factor and the number of incidents. Factors for which no data was readily available were analyzed using relevant studies.

RESULTS

1994–2003

The original assessment of highway-rail grade crossing safety initiatives revealed nine factors that were rated high on projected impact. Of these nine, five could be approximated using

fields in the RAIRS Grade Crossing Database. Those five factors were commercial driver safety, locomotive conspicuity, sight lines clearance, the grade crossing maintenance rule, and more reliable motor vehicles. Four other factors were analyzed separately: crossing consolidation and grade separation, warning device upgrades, education and enforcement, and crossing improvement programs (e.g., Section 130 Program).

The five factors and the interactions between them had a combined percent impact of 55 percent. In addition, 80 percent of the reduction in incidents, from 1994 to 2003, can be attributed to the five selected factors. The two isolated factors with the largest effects on incident reduction during these years were commercial driver safety and locomotive conspicuity.

Percent impact and percent reduction values were also calculated for crossing closure, grade separation, and warning device upgrades by using the predicted number of incidents avoided. Because these factors could not be isolated, a separate analysis was performed. A test for correlation between the number of crossings closed/upgraded and the number of incidents showed a strong correlation in some years and weak correlation in others.

The Education and Enforcement and Crossing Improvement Programs factors were evaluated qualitatively. Reports and studies indicated these factors had positive influences on safety.

2003–2007

The study of the success factors in the reduction of highway-rail grade crossing incidents was expanded to include the years 2003 through 2007. The purpose of this work was to investigate whether the identified success factors were continuing to contribute to crossing safety and to determine whether any new factors were contributing to the decline in incidents from 2003 to 2007.

Table 1. Success Factor Results, 1994–2003

Factors	Percent Impact	Percent Reduction
Commercial driver safety	21.8%	34.6%
Locomotive conspicuity	15.0%	13.6%
Sight lines clearance	2.6%	3.6%
Grade crossing maintenance rule	1.1%	3.1%
More reliable motor vehicles	1.9%	3.1%
Combined interactions	*12.8%*	*21.9%*
Total	**55.2%**	**79.9%**

The five factors that were evaluated using RAIRS Grade Crossing data for 1994–2003 were analyzed using the same methodology for the years 2003–2007. The results showed that their effects were diminished by 2007.

Two additional factors were analyzed that were initiatives that began after 2003 and could be reasonably approximated by data fields within the RAIRS Grade Crossing database. The factors were freight car reflectorization and pedestrian safety. The numbers of pedestrian incidents were mostly unchanged during the period. The number of incidents that approximated freight car reflectorization incidents was relatively small. However, they showed a discernible downturn after the passing of the Reflectorization of Rail Freight Rolling Stock Final Rule (49CFR224) in 2005.

Table 2. Success Factor Results, 2003–2007

Factors	Percent Impact	Percent Reduction
Commercial driver safety	18.7%	1.02%
Locomotive conspicuity	15.5%	-5.1%
Sight lines clearance	1.8%	4.6%
Grade crossing maintenance rule	1.4%	4.6%
More reliable motor vehicles	1.6%	3.1%
Freight car reflectorization	1.0%	5.1%
Pedestrian safety	1.8%	-8.7%

CONCLUSIONS

During the study of success factors for 1994–2003, five factors were identified as major contributors to the grade crossing incident reduction. These factors accounted for nearly 80 percent of the reduction during that time period. The two factors with the largest effects on incident reduction were commercial driver safety and locomotive conspicuity.

The analysis of those five factors from 2003 to 2007 revealed that their major effects were diminished. Additional factors may have contributed to the declines from 2003 to 2007. The number of incidents assigned to the reflectorization of freight cars showed a discernible downturn after the passing of the final rule in 2005.

REFERENCES

[1] U.S. Department of Transportation, Secretary of Transportation. (1994 June). *Rail-highway crossing safety action plan*. Washington, DC: U.S. DOT.

[2] U.S. Department of Transportation, Secretary of Transportation. (2004 June). *Secretary's action plan for highway-rail crossing safety and trespass prevention*. Washington, DC: U.S. DOT.

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KEYWORDS

Highway-rail grade crossing, success factors, incident reduction, safety