TECH**BRIEF**

Safety Evaluation of Pedestrian Countdown Signals

FHWA Publication No.: FHWA-HRT-19-046

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This document is a technical summary of the Federal Highway Administration report, *Safety Evaluation of Pedestrian Countdown Signals* (FHWA-HRT-19-045).[1]

Objective

The Federal Highway Administration (FHWA) organized a pooled fund study of 40 States to evaluate low-cost safety strategies as part of its strategic highway safety effort. The purpose of the FHWA Evaluation of Low-Cost Safety Improvements Pooled Fund Study is to evaluate the safety effectiveness of high-priority, low-cost safety strategies through scientifically rigorous, crash-based studies. One of the strategies selected for evaluation was the installation of pedestrian countdown signals (PCSs). The intent of this strategy is to reduce the frequency of pedestrian crashes, which tend to be high-profile and very severe.

The objective of the study was to estimate the safety effectiveness of the PCS strategy as measured by crash frequency. The study objective noted that changes in pedestrian signals could change driver behavior and affect not just pedestrian crashes but also the propensity for rear-end and angle crashes. In addition to determining the overall safety effect of the treatment, a further objective was to address whether the safety effect was different depending on the type of intersection (i.e., three-leg versus four-leg signalized intersections).

Introduction

A PCS treatment involves the display of a numerical countdown that shows how many seconds are left in the flashing DON'T WALK interval. The intention of this treatment is to provide pedestrians with more information on the remaining crossing time. The *Manual on Uniform Traffic Control Devices for Streets and Highways* recommends starting the countdown timer at the onset of the flashing DON'T WALK pedestrian phase.[2] A literature review of studies by Markowitz et al. crash-based evaluations of PCSs[9], Leonard et al. and Zegeer and Huang effects of PCSs on pedestrian behavior[5], Eccles et al. effects of PCSs on both pedestrian and motorist behavior[7], FHWA report on pedestrian safety for the United States Congress, and Transportation Association of Canada's unpublished informational report on PCSs[8] revealed that some of these studies found a decrease in crashes due to the PCS, whereas other concluded that the PCS led to an increase in crashes. The reported safety effects range from a reduction of 70 percent found by Van Houten

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et al. in Detroit, MI, to a 26 percent increase found by Richmond et al. in Toronto, ON.[3,4] It was clear to the project team that a well-designed evaluation with a large sample of sites from multiple cities would provide useful information to practitioners on the effectiveness of this treatment.

Methodology

This research examined the safety impacts of PCSs using data from Philadelphia, PA, and Charlotte, NC. The objective was to estimate the safety effectiveness of the PCS strategy as measured by crash frequency. The primary target crash type was pedestrian crashes. However, changes in pedestrian signals could change driver behavior and affect the propensity for rear-end and angle crashes. Because of this, the evaluation included the following crash types:

- Total intersection crashes.
- Intersection injury and fatal (KABC) crashes.
- Intersection rear-end crashes.
- Intersection angle crashes.
- Intersection pedestrian crashes.

The evaluation used an empirical Bayes (EB) methodology for observational before–after studies.[5] This methodology is considered rigorous in that it accounts for regression to the mean using a reference group of similar, but untreated, sites. In the process, the use of safety performance functions (SPFs) addressed the following:

- Overcoming the difficulties of using crash rates in normalizing for volume differences between the before and after periods.
- Accounting for time trends.
- Reducing the level of uncertainty in the estimates of safety effect.
- Properly accounting for differences in crash experience and reporting practice in amalgamating data and results from diverse jurisdictions.

The methodology also provides a foundation for developing guidelines for estimating likely safety consequences of a contemplated strategy.

The project team estimated the SPFs used in the EB methodology through generalized linear modeling assuming a negative binomial error distribution, which is consistent with the state of research in developing these models. In specifying a negative binomial error structure, the project team estimated an overdispersion parameter based on segment length from the model and the data.

The study included 218 treated intersections in Philadelphia, PA (47 three-leg and 171 four-leg intersections) and 115 treated intersections in Charlotte, NC (37 three-leg and 78 four-leg intersections). The reference group included 597 intersections in Philadelphia (45 three-leg and 552 four-leg intersections) and 136 intersections in Charlotte (54 three-leg and 82 four-leg intersections). The full report includes a detailed explanation of the methodology and the development of SPFs, including a description of how the estimate of safety effects for target crashes was calculated.[1]

Results

This section presents the research results of the study by crash and intersection types. Table 1 provides the CMFs by crash type for the observed number of crashes in the after period (with treatment), an estimate of the expected number of crashes in the after period (without the treatment), CMF, and a standard error (SE) of CMF.

The project team investigated pedestrian crash CMFs for three-leg and four-leg intersections separately, which resulted in the following CMFs:

- Three-leg intersections: CMF = 0.843 and SE of CMF = 0.132.
- Four-leg intersections: CMF = 0.922 and SE of CMF = 0.060.

These two CMFs were not statistically significant at the 90 or 95 percent confidence levels, and, based on a homogeneity test, neither were they statistically different from each other at these confidence levels.[6] However, they both indicated a reduction in crashes. For this reason, the project team combined the results for three-leg and four-leg intersections with the intent of obtaining a more stable CMF value with a lower SE that could be applied to either category of intersection.

The CMFs for total crashes (about an 8 percent reduction) and rear-end crashes (about a 12 percent reduction) were both statistically significant at the 95 percent confidence level. The CMF for pedestrian

Table 1. CMFs by crash type.

Crash Type	Observed Number of Crashes in the After Period (With Treatment)	EB Estimate of Expected Crashes in the After Period (Without Treatment)	CMF	SE of CMF
Total	4,499	4,885.8	0.921*	0.017
Injury and fatal	2,257	2,283.8	0.988	0.026
Rear end	1,542	1,761.3	0.875*	0.027
Angle	927	901.9	1.027	0.042
Pedestrian	397	434.9	0.912#	0.055

*CMF is statistically significant at the 95 percent confidence level.
#CMF is statistically significant at the 90 percent confidence level.

crashes (about a 9 percent reduction) was statistically significant at the 90 percent confidence level, which may be regarded as a reasonable standard for such rare crash types.

Economic Analysis

Using the number of total and injury and fatal crashes in the after period, the EB-expected number of total and injury and fatal crashes in the after period, and the number of intersection years in the after period, the project team determined the change in property-damage-only (PDO) crashes per intersection year and the change in injury and fatal crashes per intersection year. The expected benefit due to the PCS was estimated as 0.03 injury and fatal crashes per intersection per year and 0.37 PDO crashes per intersection per year.

This study used the most recent FHWA mean comprehensive crash costs disaggregated by crash severity and location type to estimate the annual economic benefits.[7,8] These costs were developed based on 2001 crash costs, and the unit cost (in 2001 U.S. dollars (USD)) for KABC and PDO crashes in urban areas was $91,917 and $7,068, respectively.[25] This was updated to 2016 USD by applying the ratio of the U.S. Department of Transportation (USDOT) 2016 value of a statistical life of $9.6 million to the 2001 value of $3.8 million.[26] Applying this ratio of 2.53 to the unit costs resulted in an aggregate 2016 unit cost of $232,211 for KABC crashes and $17,856 for PDO crashes. The expected annual benefit due to fewer crashes after PCS was $12,900.

The project team estimated the annualized cost of the treatment through the equation in figure 1:

Figure 1. Equation. Annual cost.

$$\text{Annual Cost} = \frac{C \times R}{1 - (1 + R)^{-N}}$$

Where:

C = treatment cost; the average cost of PCS installation was assumed to be $4,000.

R = discount rate (as a decimal); assumed to be 0.07.

N = expected service life (years) of 10 yr.

The annualized cost per year for PCS installation was $570. The project team calculated the benefit–cost (B/C) ratio as the ratio of the annual crash savings to the annualized treatment cost. The B/C ratio was 23.

Summary and Conclusions

The project team obtained geometric, traffic, and crash data from signalized intersections in Charlotte, NC, and Philadelphia, PA, to evaluate the safety effects of PCSs. A before–after EB analysis was performed using data from 115 treated intersections in Charlotte and 218 treated intersections in Philadelphia. The evaluation also included 136 reference intersections in Charlotte and 597 reference intersections in Philadelphia. The project team investigated the possibility of using data from two additional cities; however, the data from these cities could not be used in this evaluation. Minor road AADT data were not available in Philadelphia for most of the intersections and thus could not be used in estimating the SPFs. In addition, unlike Charlotte, Philadelphia did not have specific pedestrian volume counts for most of its intersections, and the pedestrian volumes were estimated based on information on the pedestrian activity within a particular zone.

Table 1 details CMFs for the PCS treatment. The CMF for total crashes (about an 8 percent reduction) and rear-end crashes (about a 12 percent reduction) were statistically significant at the 95 percent confidence level. The CMF for pedestrian crashes (about a 9 percent reduction) was statistically significant at the

90 percent confidence level, which may be regarded as a reasonable standard for such rare crash types. The economic analysis revealed a B/C ratio of 23.

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Researchers—This study was conducted as part of FHWA's Evaluation of Low-Cost Safety Improvements Pooled Fund Study by VHB under contract DTFH61-13-D-0001. The principal investigators were Raghavan Srinivasan, Bo Lan, Daniel Carter, Sarah Smith, Kari Signor, and Bhagwant Persaud.

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Key Words—Cable median barrier, shoulder rumble strips, low-cost, safety improvements, safety evaluations, empirical Bayesian.

DECEMBER 2019

FHWA-HRT-19-046
HRDS-20/12-19(300)E