



USE OF CONFLICT ANALYSIS TO ASSESS TURNING CONFLICTS WITH VULNERABLE USERS AT SIGNALIZED INTERSECTIONS

EXECUTIVE SUMMARY

ENHANCED ROAD SAFETY TRANSFER PAYMENT PROGRAM –
TRANSPORT CANADA

March 2023



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Enhanced Road Safety Transfer Payment Program

Prepared For: Transport Canada

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Version	Date	Comments
e01	February 28, 2023	Draft for Review
e02	March 24, 2023	Final Report

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1.0 EXECUTIVE SUMMARY

1.1 Background

The number of collisions involving vulnerable road users (VRU) has been on the rise in most urban areas across Canada. A substantial proportion of VRU collisions involve vehicle turning movement collisions at signalized intersections. To minimize the risk of turning collisions with VRUs at signalized intersections, road authorities have begun implementing and pilot testing several types of geometric and operational road safety countermeasures, including Leading Pedestrian Intervals (LPI). LPIs provide pedestrians with a walk indication starting a few seconds prior to the corresponding vehicular green signal.

This research project was completed through the Transport Canada Enhanced Road Safety Transfer Payment Program. The project used an innovative and emerging video analytics tool to facilitate the evaluation of the safety effectiveness of LPIs without having to wait several years to collect a sufficiently large sample size of collisions involving VRUs. To complete this project, True North Safety Group (TNS) partnered with Transoft Solutions (Transoft) for the conflict data processing, and with the municipalities of Durham, Guelph, and Oakville, for the pilot testing of LPIs at 14 intersections.

The results of this study represent valuable information for road authorities to determine if they should continue implementing LPIs on their road network and determine the preferred designs and locations to maximize safety benefits, and ultimately reduce the number of fatal and injury collisions.

1.2 Summary of Findings

The study team, in collaboration with the partnering municipalities, has identified 14 signalized intersections for the implementation and evaluation of LPIs. LPIs were implemented both at crosswalks where vehicle/pedestrian conflicts were present, as well as crosswalks where there were very few or no conflicts.

For the purposes of the analysis, each crosswalk-day combination was treated independently. A “site” was defined as the crosswalk across approach a at intersection i during period p , where p represented eight hours of data within the same day. The sites were assigned to two groups:

- ▶ **Before:** All sites where information was collected in the before period, i.e., prior to the implementation of LPIs.
- ▶ **After:** All sites where information was collected in the after period and where an LPI was implemented. Crosswalks where the LPI duration was changed, and information was collected again (‘after 2’) were also included in the after group.

During the analysis, it was noted that several sites showed very few or no conflicts of one or both types, including in the before period. Since no countermeasure can reduce the number of conflicts below zero, including sites where no known conflicts were present in the before period would lead to including sites where the only possible outcomes from the implementation of LPIs were an increase or no change in conflict frequency. Therefore, a minimum value of three conflicts over an eight-hour period was selected for sites in the before period, to allow all three possible outcomes

(decrease, no change, or increase in conflict frequency) while keeping a significant number of sites.

Sites were selected as follows:

- ▶ **Before:** Each crosswalk was selected for the days where three or more conflicts of the analyzed type were observed over an eight-hour period.
- ▶ **After:** All sites where the crosswalk was included in the before period.

Sites were selected independently for analysis relating to right-turn conflicts and left-turn conflicts.

Analysis was then completed on the results, using conflict rates at 220 sites. The rates were used to control for exposure (using conflicting pedestrian and vehicular volumes across the site). Average conflict rates were calculated for the before and after period, based on conflict type, LPI duration, pedestrian and vehicular volumes, and other geometric and operational characteristics. Statistical testing was completed on each set of results to determine if the before and after average conflict rates were statistically different. Where the before and after results were found to be statistically different, a ratio was calculated by dividing the average conflict rate for the after period by the average conflict rate for the before period. The resulting ratio was equivalent to a conflict rate modification factor (CRMF).

Results show that for sites where three or more conflicts per day were observed in the before period:

- ▶ LPIs reduced overall conflicts by 55%.
- ▶ LPIs reduced right-turn conflicts by 53%.
- ▶ LPIs reduced left-turn conflicts by 69%.
- ▶ LPIs reduced conflicts at most intersections studied.
- ▶ All LPI durations were shown to reduce conflict rates for both types of conflicts.
- ▶ For right-turn conflicts, an LPI duration of 7 s showed the greatest reduction in conflict rate (67%).
- ▶ For left-turn conflicts, an LPI duration of 5 s showed the greatest reduction in conflict rates (71%).
- ▶ Based on the results, a duration of 5 seconds appeared sufficient to optimize the effectiveness of LPIs.
- ▶ LPIs were effective at reducing conflicts for all pedestrian/turning vehicle volume combinations.
- ▶ LPIs were effective at reducing the average right-turn conflict rates for sites with a shared through/right-turn lane (reduction of 52%) but may be even more effective at reducing the average right-turn conflict rates for sites with a dedicated right-turn lane (reduction of 81%; however only one site was selected in the before period).
- ▶ LPIs were effective at reducing the average left-turn conflict rates for sites with a dedicated left-turn lane (reduction of 59%) but are even more effective at reducing the

average left turn conflict rates for sites with a shared through/left-turn lane (reduction of 85%).

- ▶ LPIs were very effective at reducing the average left-turn conflict rates for sites with a permitted-only left turn phase (80%).
- ▶ LPIs had no statistically significant effectiveness on left-turn conflicts where the left-turning motorists faced no opposing through vehicular traffic (no statistically significant reduction).
- ▶ It should also be noted that none of the selected sites with a protected left-turn phase were treated with an LPI, but the average conflict rate in the before period at these sites was similar to the average conflict rate at sites without protected left-turn phase that were treated with an LPI.

1.3 Recommendations

The results of this study did not lead to a clear justification system to be applied across agencies. Agencies have multiple needs, and the LPI implementation context and priorities may differ from one to the next. In addition, LPIs appear to be effective at reducing conflict rates in most situations, regardless of the LPI duration, pedestrian and vehicular volume combination, geometric conditions, or operational characteristics.

For these reasons, a justification system following a strict methodology is not suggested in this study. However, the CRMF identified through this analysis can be used in site selection and prioritization for LPI implementation. A custom methodology can easily be derived from the information presented below by assigning points to the various factors, considering relative weights based on an agency's needs and priorities.

Sites that do not meet the criteria listed below may also benefit from the implementation of LPIs and should therefore not necessarily be discarded. However, sites meeting one or more of the below criteria should be prioritized as they are expected to benefit most from LPIs.

Overall

The selection of sites for the implementation of LPIs should consider the actual presence of conflicts between pedestrians and right-turning vehicles. This can be confirmed by a video conflict study, observations at the site, a review of collision history, and/or a review of residents' complaints.

Right Turn Conflicts

The selection of sites should consider the presence of a dedicated turning lane. LPIs were found effective at reducing right-turn conflicts at sites with and without a dedicated right-turn lane, although the effectiveness is increased with the presence of a dedicated turning lane.

In addition, where a site is selected with the objective of reducing right-turn conflicts, the agency should consider implementing LPIs with a 7 s duration, as this duration was found to be the most effective at reducing right-turn conflicts.

Finally, although not included in this study, it is expected that right-turn on red restrictions, in addition to LPI implementation, may have a positive impact on the reduction of right-turn conflicts.

Left Turn Conflicts

The selection of sites should consider the following:

- ▶ The absence of a dedicated left-turn lane. LPIs were found effective at reducing left-turn conflicts at sites with and without a dedicated turning lane, although the effectiveness is increased where left-turning vehicles share a lane with through vehicles.
- ▶ The absence of a protected left-turn phase. LPIs were found effective at reducing conflicts at sites where left-turning vehicles must find a gap in opposing through vehicular traffic. Although none of the selected sites with a protected left-turn phase were treated with an LPI, the average conflict rate in the before period at sites with a protected left-turn phase (156) was similar to the average conflict rate at sites without a protected left-turn phase that were treated with an LPI (155).

In addition, where a site is selected with the objective of reducing left-turn conflicts, the agency should consider implementing LPIs with a 5 s duration, as this duration was found to be more effective than others.

Future Analyses

Based on the results of this study, the authors recommend a few key aspects that should be taken into consideration for future studies of the impacts of LPI implementation on right-turn and left-turn conflicts:

- ▶ The site selection should be designed to include sites where it is known that right-turn and/or left-turn conflicts are present. Sites should also be divided based on their geometric and operational characteristics, and LPIs should be implemented on selected sites with each combination of characteristics. Designing such a study would ensure that the selected sites would allow all three possible outcomes (decrease, no change, or increase in conflict frequency) from the implementation of LPIs.
- ▶ At least some of the sites selected should include right-turn on red restrictions for all times of day. The right-turn on red restrictions should be in place prior to data collection for the before period, to ensure roadway users are aware of and have time to adjust to the restrictions.
- ▶ As technology evolves and becomes more accurate, it would also be interesting to understand which conflicts coincide with the beginning of green period, which is the period affected by LPI implementation. Conflicts occurring at the end of a green phase or during clearance time would not be directly eliminated through LPI implementation.