

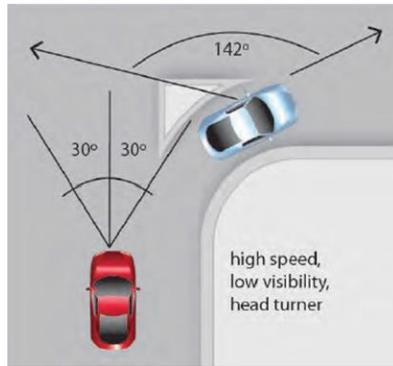
**Request for Research Funding for FY 2023-2024**

**Project Number** (Research Center Use Only): TEO-24-02

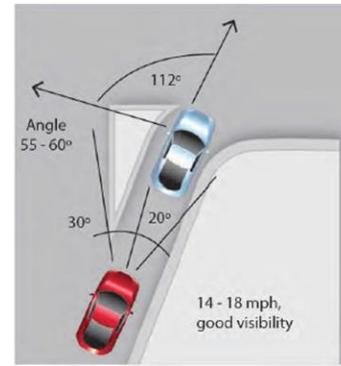
<b>Requesting Office</b>	District 7 Traffic Operations and Safety	Priority High	2 of 11
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**Proposed Title** Guidelines and Toolbox for Reducing Pedestrian Crashes with Turning Vehicles at Signalized Intersections

<b>Justification</b>	<p><b>Current Situation</b></p> <p>Florida experiences serious pedestrian safety problems. Four of the top 10 most dangerous metro areas to walk in the U.S. are in Florida, according to the 2022 edition of Dangerous by Design (<a href="https://smartgrowthamerica.org/dangerous-by-design/">https://smartgrowthamerica.org/dangerous-by-design/</a>). The metro area of Tampa-St. Petersburg-Clearwater is <b>ranked at 4<sup>th</sup></b> in this list and is <b>the most dangerous major metropolitan area</b> (population &gt; 1M) for pedestrians in Florida. Urban sprawl has led to the proliferation of low-density neighborhoods that rely on high-speed, and wider streets to connect homes, offices, shops, and schools make these roads more dangerous for those who are walking or biking. Considering the challenges, one of the top priorities for the Florida Department of Transportation (FDOT) has been to develop and implement effective countermeasures to significantly improve pedestrian safety. As Florida’s roadways are getting more and more congested, according to the 2020 edition of the Urban Congestion Trends Report (<a href="https://ops.fhwa.dot.gov/publications/fhwahop21010/index.htm">https://ops.fhwa.dot.gov/publications/fhwahop21010/index.htm</a>), there has been a growing interest to investigate and promote innovative treatments at signalized intersections that can effectively improve safety for crossing pedestrians and bicyclists while still maintaining or improving vehicular traffic capacity.</p> <p>According to FDOT’s Pedestrian and Bicycle Crash Typing project conducted by the Center for Urban Transportation Research (CUTR), approximately 10% of fatal pedestrian crashes and 43% of serious pedestrian crashes at intersections were associated with turning vehicles. Nearly 55% of possible and no injury pedestrian crashes were associated with turning vehicles. Significant potential conflicts, near miss, and non-yielding behaviors exist between turning vehicles and pedestrians at intersections. The potential causes for pedestrian crashes with turning vehicles at signalized intersections include, but are not limited to, the following:</p> <ul style="list-style-type: none"> <li>• When right-turning vehicles and pedestrians on the same approach receive concurrent green and WALK indications, drivers either do not yield to pedestrians or do not see pedestrian due to a blockage of their view.</li> <li>• When right-turn-on-red (RTOR) is permitted, right-turning drivers look to their left-hand side to find a gap to make right turns, and never see the pedestrian/bicyclist on their right side.</li> <li>• When RTOR is permitted, a significant percentage of drivers do not come to a full stop before turning right on red, which is a traffic violation and causes a potential safety hazard for pedestrians and bicyclists.</li> <li>• Pedestrians cross streets on red, which does not comply with the pedestrian laws.</li> <li>• Drivers or/and pedestrians/bicyclists do not comply with traffic laws.</li> </ul> <p>A number of engineering countermeasures have been developed to mitigate the conflicts between pedestrians and turning motor vehicles by spatial or temporal separation, or via innovative approaches to warn drivers and/or pedestrians of the potential or immediate conflict between them. Based on recent and current research, there are a number of promising pedestrian crash prevention countermeasures available or being researched, including:</p> <ul style="list-style-type: none"> <li>• Installing proper key pedestrian feature static signs (No Turn on Red, Right Turn on Red After Stop, Turning Vehicles Yield to Pedestrians, and Stop Here on Red”) and blank-out signs.</li> <li>• Installing “Turning Vehicles Stop for Pedestrians” blank-out signs instead of a “No Right Turn” sign being illuminated for a long time during the green signal indication.</li> <li>• Deploying Leading Pedestrian Intervals (LPIs) based on FDOT guidelines in the Traffic Engineering Manual (TEM).</li> <li>• Constructing proper geometric improvements at signalized intersections, such as adding pedestrian islands.</li> <li>• Detecting the presence of pedestrians and providing a warning or an alert to drivers that the crosswalk is being used (California project currently underway (MUTCD Request to Experiment 4(09)-62) that adds yellow LED borders on pedestrian signals to help draw motorist attention to the crosswalk signal).</li> <li>• Implementing High Friction Surface Treatment (HFST) to stop turning vehicles before hitting pedestrians.</li> <li>• Applying automatic pedestrian detection technology integrated with advanced traffic controllers to automatically place or remove a pedestrian call at a signalized intersection.</li> <li>• Applying connected vehicle technologies to bring an alert to nearby drivers that a crosswalk is activated.</li> </ul> <p>Another countermeasure is an innovative geometric design, tighter-radius right-turn lane, that reduces turning radii and provides a near perpendicular angle of entry, as shown below. Compared to the traditional design, the tight design would (1) slow turning speeds, (2) reduce crosswalk length, (3) improve pedestrian visibility, (4) improve sight distance, (5) decrease angle of driver head turning, and (6) reduce right-of-way impacts.</p>
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**Traditional Wide Design**



**New Tight Design**

***Research Needed***

Four of the top 10 most dangerous metro areas to walk in the U.S. are in Florida, according to the 2022 edition of *Dangerous by Design*. The metro area of Tampa-St. Petersburg-Clearwater is ranked at 4<sup>th</sup> in this list and is the most dangerous major metropolitan area (population > 1M) for pedestrians in Florida. Focused research is urgently needed to identify problems with pedestrian crossings and turning vehicles, and to develop strategies to deploy cost-effective, innovative, and implementable countermeasures in FDOT District 7 and other districts in Florida to reduce pedestrian fatalities, serious injuries, and crashes, and significantly alleviate the conflicts between turning vehicles and pedestrians at signalized intersection. It is also essential to look at how well people respond to and respect the different treatments. Tampa Bay has a good assortment of treatments which are ideal and suitable for field data collection and evaluation of various countermeasures under various scenarios prevailing at signalized intersections. Typically, no one-size-fits-all approach is feasible towards achieving more positive outcomes in safety. A robust tool and guidelines for selecting the most appropriate countermeasure(s) for implementations to reduce pedestrian fatalities, injuries, and crashes involving turning vehicles and increase compliance to the traffic laws are urgently needed.

***Proposed Research Goal and Approach***

This proposed research project aims to provide FDOT and local transportation agencies with guidelines for selecting the most appropriate countermeasure(s) for reducing pedestrian related fatalities, injuries, and crashes involving turning vehicles, and increasing compliance with traffic laws to significantly improve and enhance pedestrian and bicycle safety at signalized intersections. The proposed project fully supports the traffic engineering principles and practices of the FDOT Traffic Engineering and Operations Office to improve pedestrian and bicycle safety.

The major objectives for the proposed research project are as follows:

- Perform a comprehensive literature review regarding the various right-turn and left-turn treatments at signalized intersections to increase pedestrian safety.
- Perform a review of practices and implemented right-turn and left turn treatments at signalized intersections to reduce the crashes or conflicts between turning vehicles and pedestrians, and the implications from their implementation in Florida and across the U.S.
- Conduct selected site visits and field observations of locations in Florida with successful treatments that have significantly reduced the pedestrian crashes or conflicts between turning vehicles and pedestrians.
- Conduct before-after studies to evaluate the tighter-radii right-turn design effect on improving pedestrian safety-related driving or walking behaviors, such as vehicle-yielding-to pedestrians, right turn speed, compliance with pedestrian signals, etc.
- Analyze information collected from the review of literature and practices, in-depth interviews, and site visits.
- Develop guidelines for selecting the most appropriate countermeasure(s) for reducing pedestrian related fatalities, injuries, and crashes involving turning vehicles, and increasing compliance with traffic laws.
- Document all of research analysis and findings and provide comprehensive guidelines and recommendations.

***Research Effects on FDOT Mission Critical Focus Areas***

FDOT’s mission is to provide a safe transportation system that moves people and goods, improves economic prosperity, and preserves the quality of Florida’s environment and communities. The mission of the FDOT Traffic Engineering and Operations office is to improve safety and mobility through the efficient application of traffic engineering principles and

	practices. This proposed project fully aligns with missions of FDOT and the Traffic Engineering and Operations office and will develop guidelines, identify effective strategies, and provide recommendations for effectively reducing pedestrian fatalities, injuries, and crashes with turning vehicles at signalized intersections.
<b>Impact</b>	<p><b>How shall the results impact practice? Consequences of not doing the research?</b></p> <p>The proposed research will conduct in-depth and comprehensive analysis of all information collected from the review of literature and practices, in-depth interviews, and site visits for effective treatments under various traffic, geometric, and demographic conditions. The research team will develop a robust tool and guidelines for selecting the most appropriate countermeasure(s) for reducing pedestrian related fatalities, injuries, and crashes involving turning vehicles, and increasing compliance with traffic laws. It will also document all research analysis and findings and provide comprehensive guidelines and recommendations. Therefore, the results from this research project will directly impact practice. The recommended treatments will be practical and implementable for FDOT and local transportation agencies. FDOT and the local transportation agencies can use the tool and guidelines developed from this research project to select the most appropriate countermeasure(s) for implementation to mitigate or prevent the pedestrian crashes, injuries, and fatalities involved with turning vehicles at signalized intersections.</p> <p>Consequences of <u>not</u> conducting the research include the following:</p> <ul style="list-style-type: none"> <li>• FDOT will not receive a comprehensive literature review of various right-turn and left-turn treatments at signalized intersections to increase pedestrian safety.</li> <li>• FDOT will not receive a compressive review of practices and implemented right-turn and left-turn treatments at signalized intersections to reduce the crashes or conflicts between turning vehicles and pedestrians, and the implications from their implementation in Florida and across the U.S.</li> <li>• FDOT will not receive the results and findings from in-depth interviews of selected transportation agencies on their successful treatments to significantly reduce the pedestrian crashes or conflicts between turning vehicles and pedestrians.</li> <li>• FDOT will not obtain a detailed analysis and report for all valuable information and various right-turn and left-turn treatments collected from the comprehensive review of literature and practices, in-depth interviews, and site visits to improve pedestrian safety at signalized intersections.</li> <li>• FDOT will not obtain a robust tool and guidelines developed from this research project for selecting the most appropriate countermeasure(s) for reducing pedestrian related fatalities, injuries, and crashes involving turning vehicles, and increasing compliance with traffic laws.</li> </ul>
<b>Affected Offices</b>	State Traffic Engineering & Operations Office; State Safety Office; District Traffic Operations and Safety Offices
<b>Existing Work</b>	<ul style="list-style-type: none"> <li>• <i>Understanding Interactions between Drivers and Pedestrian Features at Signalized Intersections – P-S Lin. A. Kourtellis, Z. Wang, R. Guo, and D. Dockstader, Federal Highway Administration (FHWA) and American Association of State Highway and Transportation Officials (AASHTO) Safety Task Force, FDOT BDV25-977-16/26, September 2015/November 2017.</i></li> <li>• <i>Development of Statewide Guidelines for Implementing Leading Pedestrian Intervals in Florida – P-S Lin., Z. Wang, C. Chen, R. Guo, and Z. Zhang, FDOT BDV25-977-22, December.</i></li> <li>• <i>Leading Through Intervals versus Leading Pedestrian Intervals: More Protection with Less Capacity Impact – P. G. Furth, R. S. Razavi, Transportation Research Record 2019, Vol. 2673(9) 152–164, DOI: 10.1177/0361198119843475 .</i></li> <li>• <i>Safety Effectiveness of Leading Pedestrian Intervals Evaluated by a Before-After Study with Comparison Groups – A. C. Fayish, F. Gross, Transportation Research Record 2010, Vol. 2198 15–22, DOI: 10.3141/2198-03.</i></li> <li>• <i>Field Evaluation of a Leading Pedestrian Interval Signal Phase at Three Urban Intersections – R. V. Houten, R. A. Retting, C.M. Farmer, and J. V. Houten, Transportation Research Record 2000, Vol. 1734 86–92.</i></li> <li>• <i>Trial Implementation of a Leading Pedestrian Interval: Lessons Learned – S. M. L. Hubbard, D. M. Bullock, and J. H. Thai, ITE Journal, October 2008.</i></li> <li>• <i>A Study of Pedestrian Compliance with Traffic Signals for Exclusive and Concurrent Phasing – J. N. Ivan, K. McKernan, Y. Zhang, N. Ravishanker, S. A. Mamun, Accident Analysis and Prevention 98 (2017) 157–166.</i></li> <li>• <i>Field Evaluation of Two Methods for Restricting Right Turn on Red to Promote Pedestrian Safety – R. A. Retting, M. S. Nitzburg, C. M. Farmer, and R. L. Knoblauch, ITE Journal, January 2002.</i></li> </ul>
<b>Keywords Used in Existing Work Search</b>	Pedestrian safety, pedestrian conflicts, turning vehicles, MUTCD, turning vehicles stop for pedestrians, right turn on red, RTOR, turning vehicles yield to pedestrians, stop here on red, right turns on red after stop, blank-out signs, leading pedestrian interval, LPI, signalized intersections, left-turn treatment, right-turn treatment, conflict, yielding, pedestrian crossing behavior, interactions, pavement marking, practice, implementations

<b>Related Contracts (Give contract numbers)</b>	BDK80-977-32 – Comprehensive Study to Reduce Pedestrian Crashes in Florida BDV25-977-003-01 – Crash Typing of Pedestrian and Bicycle Crashes BDV25-977-16 – Understanding Interactions between Drivers and Pedestrian Features at Signalized Intersections BDV25-977-22 – Development of Statewide Guidelines for Implementing Leading Pedestrian Intervals in Florida BDV25-977-26 – Understanding Interactions between Drivers and Pedestrian Features at Signalized Intersections – Phase 2 BDV25-977-43 – Understanding Interactions between Drivers and Pedestrian Features at Signalized Intersections – Phase 3 BDV30-977-13 –Flashing Right Turn Signal with Pedestrian Indication: Human Factors Studies to Understand the Potential of a New Signal to Increase Awareness of and Attention to Crossing Pedestrians <a href="https://www.fdot.gov/research/documents.shtm">https://www.fdot.gov/research/documents.shtm</a>		
<b>Funding Request</b>	\$200,000	<b>Anticipated Duration</b>	18 months
<b>Project Manager</b>	Mr. Peter Hsu, P.E. Co-PMs: Mariano Amicarelli and Brenda Young	<b>Contracting Method</b>	Direct contract with the Center for Urban Transportation Research (CUTR) at University of South Florida; Dr. Lin
<b>Urgency</b>	Score = 1	Florida experiences serious pedestrian safety problems. Four of the top 10 most dangerous metro areas to walk in the U.S. are in Florida, according to the 2022 edition of Dangerous by Design. The metro area of Tampa-St. Petersburg-Clearwater is <b>ranked at 4<sup>th</sup></b> in this list and is <b>the most dangerous major metropolitan area</b> (population > 1M) for pedestrians in Florida. Conflicts involving pedestrians and turning vehicles occur frequently at many signalized intersections throughout Florida, which points to an alarming need for effective countermeasures aimed at fostering better safety outcomes. According to FDOT’s Pedestrian and Bicycle Crash Typing project completed in July 2018 by CUTR, approximately 10% of fatal pedestrian crashes, 43% of serious pedestrian crashes, and nearly 55% of possible and no injury pedestrian crashes at intersections were associated with turning vehicles. Therefore, there is an urgency for FDOT to sponsor the proposed research.	
<b>Implementability</b>	Score = 1	The treatments developed and recommended from this research project will be based on a comprehensive review and assessment of all available treatments, so they will be adequate, practical, and implementable for FDOT and local transportation agencies. FDOT and the local transportation agencies can use the tool and guidelines developed from this research project to select the most appropriate countermeasure(s) for implementation to mitigate or prevent the pedestrian crashes, injuries, and fatalities involved with turning vehicles at signalized intersections. The research findings, tool, and guidelines will support and benefit FDOT, Districts, and local transportation agencies directly to mitigate or prevent the conflicts between pedestrians and turning vehicles at signalized intersections.	
<b>Project Benefits (Succinct, complete explanation)</b>			
<ul style="list-style-type: none"> <li>• Understand the characteristics and effectiveness of various right-turn and left-turn treatments at signalized intersections, and the implications from their implementation across the Florida and U.S. through a comprehensive literature and practice review.</li> <li>• Develop appropriate performance measures to analyze the effectiveness and efficiency of various treatments.</li> <li>• Document successful treatments and how they significantly reduced the pedestrian crashes or conflicts between turning vehicles and pedestrians.</li> <li>• Develop a robust tool and implementation guidelines for selecting the most appropriate countermeasure(s) for implementations.</li> <li>• Provide recommendations to FDOT on making policy/practice revisions or changes in light of the in-depth analysis of various treatments.</li> <li>• Support future implementation to effectively improve pedestrian safety at signalized intersections in Florida.</li> <li>• Reduce pedestrian fatalities and serious injuries after the implementation of adequate treatments at signalized intersections.</li> <li>• Slightly reduce vehicle delays due to the reduction of conflicts between turning vehicles and pedestrians after the implementation of adequate treatments at signalized intersections.</li> </ul>			
<b>Project Benefits (Select all that apply and explain)</b>	<b>Quantifiable Benefits (units, dollars, etc....if applicable)</b>	<b>Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits</b>	
<input type="checkbox"/> Materials Enhancement			
<input type="checkbox"/> Materials Savings			

<ul style="list-style-type: none"> <li>○ Time Savings</li> </ul>	<p>Value of travel time savings</p> <p>The total estimated annual cost saving for reduction of vehicle delay at signalized intersections is about \$168M</p>	<p>According to the 2017 American Community Survey (<a href="https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t">https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t</a>), 8.9 million workers age 16 and over traveled an average of 27 minutes for their commute in Florida. Due to the reduction of conflicts between turning vehicles and pedestrians after the implementation of adequate treatments at signalized intersections, vehicle delays could be slightly reduced. Assuming a modest 15-second reduction for each commuter due to the reduction of conflicts with pedestrians at signalized intersections during commutes via implementation of adequate turn-movement treatments, 250 days of commute in a year, and time value of \$18.12 per hour per person, the total estimated annual cost saving for reduction of vehicle delays at signalized intersections is about \$168M (=8,900,000 x 0.25 x 250 x 18.12 / 60).</p>
<ul style="list-style-type: none"> <li>○ Lives Saved/Injuries Prevented</li> </ul>	<p>Reduction on number of crashes, fatalities and injuries</p> <p>14 lives per year can be saved and 163 serious injuries per year can be prevented. The estimated annual social cost saving is about \$275M.</p>	<p>Based on data from the Florida DHSMV (<a href="https://www.flhsmv.gov/traffic-crash-reports/crash-dashboard/">https://www.flhsmv.gov/traffic-crash-reports/crash-dashboard/</a>), there were 8,117 pedestrian crashes in Florida with 715 fatalities and 1,265 serious injuries in 2020. According to FDOT's Pedestrian and Bicycle Crash Typing project conducted by the Center for Urban Transportation Research (CUTR), approximately 10% of fatal pedestrian crashes and 43% of serious pedestrian crashes at intersections were associated with turning vehicles. With an estimated 20% reduction in pedestrian fatalities and 30% reduction of serious injuries involving turning vehicles at signalized intersections by applying the appropriate treatment for signalized intersections, we can save about 14 lives (=714 x 0.1 x 0.2) and 163 serious injuries (=1,265 x 0.43 x 0.3) per year. The estimated annual social cost saving of 14 lives and 163 serious injuries is about \$275M (= 14 x \$10.1M + 163 x \$0.819M).</p>
<ul style="list-style-type: none"> <li>○ Other (Explain)</li> </ul>	<p>Saving of fuel due to travel time reduction</p>	<p>Due to a slight travel time reduction of commuters and pedestrian crash reduction, there will be significant savings on fuel consumption and a reduction on emissions.</p>