

**Request for Research Funding for FY 2020–2021**

<b>Requesting Office</b>	Traffic Engineering and Operations	<b>Priority</b> High	3 of 6
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**Proposed Title**      Development of Crash Modification Factors for Speed Management Using Pedestrian-friendly Traffic Signal Progression

**Justification**

**Describe the current situation, why the research is needed, and how the research affects your office’s mission critical focus areas**

According to the *Dangerous by Design* report published by Smart Growth America and the National Complete Streets Coalition (1), Florida has been the most dangerous state for pedestrian safety. Nine of the 20 including Eight of the 10 deadliest U.S. cities for pedestrians are in Florida, with Orlando-Kissimmee-Sanford ranked as the least safe for pedestrians, Deltona-Daytona Beach-Ormond Beach ranked 2nd, Palm Bay-Melbourne-Titusville ranked 3rd, North Port-Sarasota-Bradenton ranked 4th, Lakeland-Winter Haven ranked 5th, Jasonville ranked 6th, Cape Coral-Fort Myers ranked 8th, Tampa-St. Petersburg-Clearwater ranked 9th, and the Miami-Fort Lauderdale–West Palm Beach metropolitan area ranked at #14.

**THE TOP 20**  
Most Dangerous Metropolitan Areas for Pedestrians  
(2008-2017)



*Figure 1. 20 U.S. cities with highest rates of pedestrian fatalities  
(Source: Smart Growth America)*

Florida public roads, which were designed mostly for vehicle mobility in the past, exhibit relatively high speeds resulting in high risk for pedestrians. An American Automobile Association (AAA) study (2) indicates that the average risk of severe injury for a pedestrian struck by a vehicle reaches 10% at an impact speed of 16 mph, 25% at 23 mph, 50% at 31 mph, 75% at 39 mph, and 90% at 46 mph. The average risk of death for a pedestrian reaches 10% at an impact speed of 23 mph, 25% at 32 mph, 50% at 42 mph, 75% at 50 mph, and 90% at 58 mph. Risks vary significantly by age; for example, the average risk of severe injury or death for a pedestrian age 70 struck by a car traveling at 25 mph is similar to the risk for an pedestrian age 30 struck at 35 mph. Thus, speed management is an effective treatment to prevent pedestrian fatalities and injuries in urban arterials.

Traffic signal progression is a widely-used traffic control strategy for mobility on Florida urban arterials to link traffic signals together along a street so that "platoons" of vehicles can pass through many signalized intersections without

	<p>getting stopped at a red light. This control treatment greatly improves the mobility performance on arterials. A study (3) indicates that signal coordination may increase the average speed by 6% on a corridor. However, traffic signal progression may increase pedestrian injuries and fatalities on arterials; high speed, associated with a long stopping sight distance (SSD), means a higher likelihood of pedestrian crash occurrence and a higher risk of injuries and fatalities in a pedestrian crash. However, a properly design of a pedestrian-friendly traffic signal coordination timing can manage progression speed to reduce the risk for severe injury and fatality of a pedestrian struck by a vehicle.</p> <p>Elimination of pedestrian fatalities and serious injuries resulting from traffic crashes on public roads, as established in the State Highway Safety Improvement Plan and/or Strategic Highway Safety Plan, has been the critical mission for various Florida Department of Transportation (FDOT) offices such as Safety, Traffic Engineering and Operations, and District Offices. With the continuous increase in Florida’s population, the challenge to improve pedestrian safety is becoming urgent. To respond to the challenge, FDOT has implemented various countermeasures, including engineering, education, enforcement, and emergency services (4 E’s), to reduce pedestrian crashes and prevent pedestrian injuries and fatalities. However, existing documents and studies do not address the safety impacts of traffic signal progression, especially for pedestrians. The absence of an understanding of crash-causation for traffic signal progression prevents FDOT from implementing cost-effective traffic signal control strategies to improve pedestrian safety and arterial mobility.</p> <p>The proposed research project aims to (1) investigate the impact of traffic signal progression speeds on urban corridors and signal timing operation parameters (cycle length, phases, offset, etc.) at signalized intersections on pedestrian crash frequency and severity, (2) establish pedestrian-friendly progression speed guidelines and signal timing strategies to effectively improve pedestrian safety, and (3) develop crash modification factors for speed management of traffic signal progression. The specific research objectives include the following:</p> <ul style="list-style-type: none"> <li>• Address traffic signal timing and progression-related factors contributing to pedestrian fatalities, injuries, and crashes such as signal timing parameters, high signal progression speeds, roadway characteristics, and others.</li> <li>• Investigate the influence of traffic signal progression on vehicle speed, which is a surrogate safety measure related to pedestrian fatalities, injuries, and crashes on urban arterials.</li> <li>• Develop Crash Modification Factors/Functions (CMFs) to quantify the impacts of pedestrian-friendly traffic signal progression on pedestrian crash frequency by injury severity.</li> <li>• Provide recommendations on how to utilize traffic signal control strategies on urban arterials for improving pedestrian safety and maintaining vehicle mobility.</li> </ul> <p>Results of this research could help FDOT better understand the crash-causation of traffic signal progression speeds and signal timing parameters for pedestrian fatalities and injuries on Florida urban arterials, and implement cost-effective traffic signal progression and signal timing strategies to effectively reduce pedestrian fatalities, injuries and crashes. The developed CMFs can be widely used by FDOT and local agencies via their Transportation System Management and Operations (TSM&amp;O) programs to improve pedestrian safety in Florida.</p> <p><i>References</i></p> <ol style="list-style-type: none"> <li>1. <a href="#">Dangerous By Design 2019</a>, Smart Growth America and the National Complete Streets Coalition, 2019.</li> <li>2. <i>Tefft, B. C. Impact Speed and a Pedestrian’s Risk of Severe Injury or Death. Accident Analysis &amp; Prevention, Vol. 50, 2013, pp. 871–878.</i></li> </ol>
<p><b>Impact</b></p>	<p><b>How shall the results impact practice? Consequences of not doing the research?</b></p> <p>FDOT Central and Districts offices are conducting various safety and TSM&amp;O programs and projects to improve mobility and safety performance of urban arterials. The research results would benefit practices by the following:</p> <ul style="list-style-type: none"> <li>• Guide traffic signal timing review for improving pedestrian safety on urban streets.</li> <li>• Assess existing traffic signal timing on urban streets for pedestrian safety.</li> <li>• Guide development of pedestrian-friendly traffic signal progression timing to improve pedestrian safety and maintain vehicle mobility.</li> <li>• Quantify the impacts of pedestrian-friendly traffic signal progression on pedestrian crash frequency by injury severity</li> <li>• Use CMF developed from this research to support signal retiming project and conduct benefit-cost analysis.</li> <li>• Conduct <i>Highway Safety Manual</i> (HSM)-compatible safety analysis and economic appraisals in urban arterial traffic signal system improvement projects.</li> </ul> <p>There is very limited existing documents and studies about the safety impacts of traffic signal progression on pedestrian fatalities, injuries and crashes. Without conducting this research project, the knowledge, supporting data, analysis results, implementation guidelines, and CMFs for pedestrian-friendly traffic signal progression will still be not available. Without this research, FDOT and local agencies may find it difficult to address the existing safety risk for pedestrians on urban</p>

	streets and arterials. This cost-effective countermeasure via traffic signal progression to manage vehicle speeds in urban areas will not be widely used to improve pedestrian safety on urban streets and arterials.		
<b>Affected Offices</b>	State and District Traffic Engineering and Operations Office; State Safety Office		
<b>Existing Work</b>	<p>Limited documents and studies were found that examine the safety impacts of traffic signal progression/coordination along a corridor. Existing works are summarized below:</p> <ul style="list-style-type: none"> <li>• HSM and FHWA’s CMF Clearinghouse summarized CMFs for traffic signals at isolated intersections, including installation of traffic signals, replacement of traffic signals with roundabouts, use of LED signal bulbs, and adaptive traffic signal controls.</li> <li>• Six studies were found that investigated the safety impacts of traffic signal timing (cycle length, split phases, and change interval) at isolated intersections: <ul style="list-style-type: none"> <li>– Srinivasan, R., Evaluation of Safety Strategies at Signalized Intersections, Transportation Research Board, 2011.</li> <li>– Sharma, A., L. Vanajakshi, V. Girish, and M. S. Harshitha, Impact of Signal Timing Information on Safety and Efficiency of Signalized Intersections, Journal of Transportation Engineering, 138(4), 2011, 467–478.</li> <li>– Archer, J., and W. Young, Signal Treatments to Reduce Heavy Vehicle Crash-Risk at Metropolitan Highway Intersections, Accident Analysis &amp; Prevention, 41(3), 2009, 404–411.</li> <li>– Retting, R. A., J. F. Chapline, and A. F. Williams, Changes in Crash Risk Following Re-Timing of Traffic Signal Change Intervals, Accident Analysis &amp; Prevention, 34(2), 2002, 215–220.</li> <li>– Persaud, B., F. Gross, and R. Srinivasan, Evaluation of Two Treatments for Reducing Crashes Related to Traffic Signal Change Intervals, Transportation Research Record, 2298(1), 2012, 38–45.</li> <li>– Agbelie, B. R. D. K., and A. M. Roshandeh, Impacts of Signal-Related Characteristics on Crash Frequency at Urban Signalized Intersections, Journal of Transportation Safety &amp; Security, 7(3), 2015, 199–207.</li> </ul> </li> <li>• Two studies were found to explore the safety impact of traffic signal coordination on whole traffic crashes, but they concluded opposite findings: <ul style="list-style-type: none"> <li>– Guo, F., X. Wang, and M. A. Abdel-Aty, Modeling Signalized Intersection Safety with Corridor-Level Spatial Correlations, Accident Analysis &amp; Prevention, 42(1), 2010, 84–92. Authors reported that coordinated intersections are more unsafe than isolated ones with a CMF of 1.53, speculated that increased speed due to signal coordination may be the reason for the crash increase.</li> <li>– Stevanovic, A., J. Stevanovic, and C. Kergaye, Optimization of Traffic Signal Timings Based on Surrogate Measures of Safety, Transportation Research Part C: Emerging Technologies, 32, 2013, 159–178. Authors found that traffic signal coordination would reduce crash risk by 6.7%.</li> </ul> </li> </ul> <p><b>No studies were found that explored the impact of traffic signal progression on pedestrian fatalities, injuries, and crashes.</b></p>		
<b>Keywords Used In Existing Work Search</b>	Pedestrian, Traffic Signal, Coordination, Progression, Safety, Crash, Crash Modification Factor		
<b>Related Contracts</b>	N/A		
<b>Funding Request</b>	\$140,000	<b>Anticipated Duration</b>	18 months
<b>Project Manager</b>	Alan El-Urfali	<b>Contracting Method</b>	Direct contract with Center for Urban Transportation Research (CUTR) at the University of South Florida – Dr. Lin is the Principle Investigator
<b>Urgency</b>	1	Florida is facing a serious challenge to effectively reduce pedestrian fatalities and risk that is significantly higher than the national average. On average, more than 600 pedestrians were killed and over 8,000 pedestrians sustained injuries per year on Florida public roads. High speeds on Florida roads is a major factor contributing to pedestrian fatalities and injuries. Traffic signal coordination with progression is a cost-effective traffic control strategy but it tends to result in higher vehicle running speed on urban arterials. Thus, it is urgent to examine the impact of traffic signal progression on pedestrian safety in urban areas, recommend pedestrian-friendly traffic control strategies to reduce urban traffic signal progression speeds, and develop CMF to support and encourage FDOT Districts and local	

		transportation agencies to implement pedestrian-friendly traffic signal progress on their urban streets and arterials to effectively improve pedestrian safety.
<b>Implementability</b>	1	The CMFs of pedestrian-friendly traffic signal progression to reduce pedestrian fatalities, injuries and crashes developed in this study can be directly implemented into HSM-compatible urban arterial safety management and traffic signal design/upgrade projects. The identified crash-causation factors and recommendations from this research project can be used to guide urban arterial safety review and support decision-making for traffic signal timing upgrade/improvements. The recommended signal timing strategies, parameters, and pedestrian-friendly signal progression guidelines could be implemented by all FDOT Districts and many local transportation agencies in relatively short period of time.
<b>Project Benefits (Succinct, complete explanation)</b>		
<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="radio"/> Materials Enhancement		
<input type="radio"/> Materials Savings		
<input type="radio"/> Time Savings		
<input type="radio"/> Lives Saved/ Injuries Prevented	Up to 37 lives and 636 injuries saved per year (or up to \$479M of total cost saving per year for saving an estimated 37 lives and 636 injuries)	<p>According to the Florida Traffic Crash Facts Annual Report 2017 published by the Florida Department of Highway Safety and Motor Vehicles, there were 659 pedestrian fatalities and 8,126 pedestrian injuries on Florida public roads in 2017. The NHTSA Pedestrian Traffic Safety Fact Sheet (2017 Data) indicated that most pedestrian fatalities occurred in urban areas (80%), and more pedestrian fatalities occurred at mid-blocks (73%) and intersections (18%). In general, signal coordinate operations are activated on urban streets from 6:00 AM to 10:00 PM. On average, 62% of fatal pedestrian crashes and 86% of injured pedestrian crashes occurred during this period (Signal Four). With this information, we have the following calculation:</p> <ul style="list-style-type: none"> <li>• In 2017, an estimated total of 297 (<math>= 659 \times 80\% \times [73\% + 18\%] \times 62\%</math>) pedestrian fatalities occurred on urban streets between 6:00AM to 10:00PM.</li> <li>• In 2017, an estimated total 5,087 (<math>= 8126 \times 80\% \times [73\% + 18\%] \times 86\%</math>) pedestrian injuries occurred on urban streets between 6:00AM to 10:00PM.</li> <li>• Assuming that the average speed can be reduced 5 mph due to pedestrian-friendly traffic signal progression on urban streets and arterials, the probability of pedestrian fatalities and injuries could be reduced by 12.5% (AAA study).</li> </ul> <p>Based on the assumptions, the total number of lives that could have been saved was about 37 (<math>= 297 \times 12.5\%</math>) at a cost-saving of \$10,100,000 (per fatality) <math>\times 37 = \\$375,525,878</math> per year. The total number of injuries that could have been avoided was about 636 (<math>= 5,087 \times 12.5\%</math>) at a cost-saving of \$163,254 (per injury) <math>\times 636 = \\$103,819,873</math> per year. The total estimated cost saving is up to \$479M per year for saving lives and injuries.</p>
<input type="radio"/> Other (Explain)		<p>A pedestrian-friendly traffic signal progression not only can reduce the risks of pedestrian fatalities, injuries, and crashes, but can also maintain vehicle mobility on urban streets. The coordination signal timing adjustment is expected to be cost-effective and achievable in a short period of time. The pedestrian-friendly progression speed can make urban streets much safer for pedestrians and bicyclists.</p> <p>The CMF for pedestrian-friendly traffic signal progression developed from this research project can be used by FDOT Districts and local transportation agencies in Florida, as well as other state and local agencies.</p>

		The guidelines for implementing pedestrian-friendly traffic signal progression developed from this research project will provide FDOT Districts and local transportation agencies with the needed information for coordination signal timing design and implementation.
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\*Comments should explain and support urgency, financial benefit, and implementability scores