

Request for Research Funding for FY 2021-2022

Requesting Office	FDOT District 4	Priority	1 of 1 (projects may not have the same ranking – no ties)
Proposed Title	Application of Dynamic Crash Prediction Methodologies to FDOT Safety and Transportation System Management and Operational (TSM&O) Programs, Phase II		
Justification	<p>Describe the current situation, why the research is needed, and how the research affects your office's mission critical focus areas</p> <p>Current situation:</p> <p>According to the 2060 Florida Transportation Plan, Florida's transportation system aims to evolve over the next 50 years to support the transformation of Florida's economy and communities and proposes a vision of a fatality-free and congestion-free transportation system in Florida. Many challenges remain in achieving this goal, as Florida is experiencing a significant increase in traffic crashes—from 227,998 in 2001 to 403,626 in 2018 and a high-yearly fatality (> 3,000 in 2016–2018) (1). Principal roads in urban areas (including interstates, expressways, and major arterials) accounted for a significant portion of traffic crashes (41%), although these roads comprise only around 15% of center miles on the Florida roadway system (2). The yearly congestion for seven selected urban areas in Florida in 2015 was found to cost \$8.75 billion as the result of approximately 388 million hours in travel delay and 175 million excess gallons of fuel consumed (3). The traffic crashes, combined with other incidents (debris, breakdowns), accounts for 25% of total congestion (4).</p> <p>The Florida Department of Transportation (FDOT) Transportation System Management and Operations (TSM&O) program has been collecting, archiving, and analyzing a wide range of traffic, crash, event, and other data on the State Highway System (SHS). "Big" data have been used in various ITS/TSM&O applications that focus on improving mobility with limited consideration of safety. FDOT could potentially proactively reduce crash risk and enhance traffic flow through an innovative proactive safety strategy based on dynamic crash prediction. This prediction uses information provided by ITS devices and other sources combined with advanced data analytics to predict crash risk in real-time based on prevailing traffic conditions and to select and apply ITS/TSM&O actions to prevent crashes before occurrence or respond more quickly if crashes occur. FDOT and many local agencies have shown interest in this innovative technology and have plans to implement it. However, the lack of clear understanding of dynamic crash prediction in performance, data needs, integrability, and impacts prevents or delays its implementation in Florida.</p> <p>To demonstrate the application of dynamic crash prediction in Florida's roadway environment, an FDOT-funded research project named "Application of Dynamic Crash Prediction Methodologies to FDOT Safety and Transportation System Management and Operational (TSM&O) Programs" was conducted by the University of South Florida (USF) and Florida International University (FIU) in 2018–2020. This project documented the current state-of-practice of dynamic crash prediction and compared existing methods/systems. Based on the comparison, one vendor (WayCare) that provided a mature dynamic crash prediction platform was selected for evaluation as part an off-line pilot study to evaluate its performance. The accuracy and timeliness of the system were evaluated at selected study sites covering both interstates and major arterials. The pilot study demonstrated that the system could work with existing Traffic Management Center (TMC) sensor data and effectively predict crash risk for specific time windows on both freeway segments and major arterials. This proposal is for the demonstration of the application of the system to predict and manage crash risks in a real-world traffic management center in real-time operations.</p> <p>Why the research is needed:</p> <p>With an alert from a dynamic crash prediction system, TMCs can apply actions to prevent crashes and/or minimize negative impacts on traffic flow. Crash prevention strategies (actions) could include existing ITS/TSM&O applications (DMS safety messages), law enforcement action (high visibility police cars), and next generation technologies (connected vehicles). The crash prevention strategies determine the effects of dynamic crash prediction on transportation safety and mobility. Very little experience with and knowledge</p>		

	<p>about crash prevention actions after receiving a dynamic crash prediction alarm is available in previous studies. The completed project (Phase I) focused on the evaluation of dynamic crash prediction ability and suggested three crash prediction actions (DMS safety messages, stationary police cars with flashing lights, and information-sharing) based on WayCare's experience and the availability of TSM&O applications in FDOT District 4 rather than a comprehensive evaluation of the actions. However, a clear understanding of crash prevention actions, including operation strategies and benefits, is critical for transportation agencies to implement dynamic crash prediction. Thus, it is necessary to conduct a follow-up research project (Phase II) to demonstrate and test crash prevention actions that integrate the dynamic crash prediction platform tested in Phase I through an online pilot study.</p> <p>Research Objectives:</p> <p>The overall research objective of the proposed project is to evaluate crash prevention actions combined with dynamic crash prediction for various traffic scenarios on Florida roads in real-world real-time environment. The research objectives of Phase II are to:</p> <ul style="list-style-type: none"> • Migrate the WayCare off-line model tested in Phase I of the project to an online model, including model recalibration, with the latest data to improve prediction performance. • Set up a connection between the WayCare platform and FDOT's TMC system (SunGuide) for real-time data exchange considering data protocol and security. • Develop a detailed plan for proposed crash prevention actions (DMS, law enforcement, Road Ranger patrol) with different traffic scenarios, including activation conditions, duration, location, safety message contents, etc. • Explore the integration of connected vehicle (CV) technologies and applications with dynamic crash prediction as crash prevention actions; if possible, include CV technologies in an action plan. • Identify local agencies and resources for implementing crash prevention actions. • Coordinate with FDOT District 4 and local agencies to conduct an online pilot study to demonstrate the proposed crash prevention actions with the trained dynamic crash prediction model. • Identify performance measures and evaluate the safety and mobility benefits of dynamic crash prediction and prevention through an online pilot study. • Develop implementable Standard Operating Guidelines (SOGs) for implementing dynamic crash prediction and prevention in Florida. <p>Reference:</p> <ol style="list-style-type: none"> (1) FLHSMV, <i>Traffic Crash Facts Annual Report</i> 2019. (2) FDOT, <i>Crash Analysis Report (CAR) System</i> 2014 (3) TTI, <i>Congestion in Florida, 2015 Urban Mobility Scorecard</i>, 2015 (4) FHWA, <i>Reducing Non-Recurring Congestion</i>, https://ops.fhwa.dot.gov/program_areas/reduce-non-cong.htm
<p>Impact</p>	<p>How shall the results impact practice? Consequences of not doing the research?</p> <p>FDOT and local agencies in Florida and other states, are interested in implementing dynamic crash prediction to proactively reduce traffic crashes and consequential impacts on traffic flow. Very limited knowledge about the integration of crash prevention actions with dynamic crash prediction prevents or delays the practice of the new innovative technology. The research project can provide experience and guidelines for transportation agencies in following aspects:</p> <ul style="list-style-type: none"> • Integrating dynamic crash prediction with FDOT's traffic management system. • Crash prevention strategies when receiving a crash risk alarm. • Safety and mobility benefits of the new technologies. • Resources needed to implement the technologies and how to coordinate the involved agencies. <p>As a pioneering study across the US, the knowledge obtained from this project is critical to the implementation of dynamic crash prediction in Florida and other states. Without the research, transportation agencies will not obtain the experience and guidelines to apply crash prevention actions after receiving</p>

	dynamic crash prediction alarms and may not effectively implement the new technology to address the serious challenges in transportation safety and mobility.		
Affected Offices	<p>Identify any office and names of office personnel that will need to be involved in the scoping or conduct of the research, will be affected by implementation of the results, or will need to participate in the implementation process—including OTIT, if enterprise data/network software application will be a deliverable, and district staff, as appropriate, e.g., through statewide meetings. If the requesting office will not be the implementing office, please identify which office and names of specific personnel which will have to serve in that capacity—have they been involved?</p> <p>FDOT District 4, FDOT Traffic Engineering & Operations, FDOT Safety Office</p>		
Existing Work	<p>Learning About and Using the Research in Progress (RiP) Database http://www.trb.org/main/blurbs/176215.aspx – At a minimum, the Transportation Research International Documentation (TRID) and the Research in Progress (RIP) online databases should be reviewed by an expert in the research subject matter to ensure that the research effort and resources do not duplicate prior or ongoing work. TRID: https://trid.trb.org/Results RIP: https://rip.trb.org/</p> <p>Dynamic crash prediction is an innovative technology without mature implementation cases. Many academic papers (70+) have discussed the concepts, theories, models, and algorithms of these new technologies. However, no studies have focused on implementation in real roadway environments and evaluated its safety and mobility benefits. Few papers have explored variable speed limits with dynamic crash prediction. Previous studies provide limited information on dynamic crash prediction implementation.</p> <p>FDOT funded a research project (BE548) in 2018–2020 to summarize the current state-of-practice of dynamic crash prediction. One vendor (WayCare) was identified to provide an implementable dynamic crash prediction platform with a short pilot study in Las Vegas in 2018. The Nevada pilot study, which did not conduct a comprehensive evaluation, provided some useful information rather than an implementable guideline. BE548, as the first research project to evaluate dynamic crash prediction systems/platforms in the US, identified the data needs/preparation and evaluated the prediction accuracy and timeliness of the new technology through an offline pilot study. Due to time and budget limits, however, it did not test crash prevention actions with dynamic prediction with real roadway conditions and provide accurate estimation of safety and mobility benefits.</p> <p>As a follow-up study to BE548, this project (Phase II) aims to test crash prevention actions combined with dynamic crash prediction through an online pilot study and provide implementation guidelines for FDOT and local agencies.</p>		
Keywords Used In Existing Work Search (Cannot leave blank)	Dynamic crash prediction, pilot study, proactive safety management, big data, machine learning, crash prevention		
Related Contracts (Give contract numbers)	BE548, Application of Dynamic Crash Prediction Methodologies to FDOT Safety and Transportation System Management and Operational (TSM&O) Programs		
Funding Request	Estimated cost \$271,000	Anticipated Duration	18 months
Project Manager	Nichole Forest	Contracting Method	Direct contract with the research team jointed by University of South Florida (USF) and Florida International University (FIU).

<p>Urgency</p>	<p>Score 1 1= highest , most immediate need</p>	<p>Comments* (elaborate as appropriate on justification/impact comments to explain the urgency of the need . . . is a solution needed immediately, needed within a certain period of time or by a known or anticipated deadline, desired for enhancement, etc.)</p> <p>Florida is experiencing challenges with traffic crashes and congestion that are significantly higher than the national average. With population increases, the challenges become more serious. FDOT and local agencies are interested in implementing dynamic crash prediction, an innovative safety strategy, to proactively reduce traffic crashes and improve mobility on urban principal roads. However, a lack of knowledge and guidelines prevents or delays the implementation of this new technology to address Florida's safety and mobility challenges. Th proposed project is a pioneering study in the US to demonstrate and evaluate the integration of dynamic crash prediction and crash prevention actions in Florida's roadway environment. The projects results, including implementation guidelines and assessment of safety/mobility benefits, are critical for traffic agencies to apply dynamic crash prediction for addressing the challenges. Thus, it is urgent to conduct an online pilot study to promote the implementation of these new technologies in Florida.</p>
<p>Implementability</p>	<p>Score 1 (1=greatest likelihood of and proximity to implementing results)</p>	<p>Comments* (consider both the likelihood of implementation and the length of time and resources required to implement the results of the research.) Identify any prerequisites to, requirements for, or barriers to implementing the anticipated results of this research (e.g., new or change to existing specifications, development of production units of prototype device, legislative change); please indicate if multiple phases of work shall be required</p> <p>The WayCare system is a cloud-based platform that provides traffic analysis and management, including a mature dynamic crash prediction function. Several Florida agencies (City of Tampa, Pinellas County, Hillsborough County, City of Fort Lauderdale) have implemented or are considering use of the WayCare system. However, the function of dynamic crash prediction is not activated with their implementation because they lack implementation knowledge. As the WayCare system does not need physical implementation in TMCs and is compatible with existing ITS/TSM&O applications, FDOT and local agencies can easily implement the dynamic crash prediction function with the project outcomes (implementation guidelines). In implementation, the coordination with different agencies, such as Florida Highway Patrol and local governments, may be required and will be demonstrated in this project.</p>
<p>Project Benefits (Succinct, complete explanation)</p> <p>Florida is facing challenges in transportation safety and mobility. In 2018, 403,626 traffic crashes occurred on Florida roads and resulted in 3,135 fatalities and 255,353 injuries. These crashes contributed to a significant portion of non-recurring congestions (up to 25%). This project will promote the implementation of dynamic crash prediction technologies that can predict crash risk based on the big ITS data and apply ITS/TSM&O actions to prevent crashes before they occurrence. Consequently, results of this project are beneficial to improve traffic safety and mobility on Florida roads, especially for urban principal roads that equip plenty ITS/TSM&O applications and account for a significant portion of traffic crashes (41%) and congestion.</p>		
<p>Project Benefits (Select all that apply and explain)</p>	<p>Quantifiable Benefits (units, dollars, etc...if applicable)</p>	<p>Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits</p>

○ Materials Enhancement		
○ Materials Savings		
○ Time Savings	It is not applicable without the proposed study results. A justification of project benefits is given in the right column.	<p>According to TTI's 2015 Urban Mobility Scorecard, a yearly congestion cost of \$8.75 billion was caused by approximately 388 million hours in travel delay and 175 million excess gallons of fuel consumed for seven selected urban areas in Florida. It is estimated that incidents (traffic crashes, disable cars, debris) account for 25% of annual congestion. Thus, non-recurring congestions (caused by incidents) result in traffic delay for 97 million hours (=388 million hours × 25%), excess fuel consumed for 43.75 million excess gallons (=175 million gallons × 25%), and congestion cost of \$2.19 billion each year in the seven urban areas in Florida.</p> <p>It is expected that dynamic crash prediction applications could prevent considerable traffic crashes and consequential non-recurring congestions on urban corridors (including freeways). However, the percentage of crashes that can be reduced by dynamic crash prediction is unknown. The proposed study will estimate the crash reduction percentage. The time savings of non-recurring congestion can be quantified by</p> <p><i>Non-recurring congestion cost (\$2.19 billion each year) × the percentage of crashes reduction (will be developed in the proposed study)</i></p> <p>The crash prevention actions may directly impact traffic operations (i.e., reduced speed). The proposed study will estimate the mobility impacts through a pilot study. The total time savings due to dynamic crash prediction will be calculated by summing non-recurring congestion reduction and direct mobility impacts.</p>
○ Lives Saved/Injuries Prevented	It is not applicable without the proposed study results. A justification of project benefits is given in the right column.	<p>Based on the Florida Traffic Crash Facts Annual Report 2019 published by the Florida Department of Highway Safety and Motor Vehicles, there were 403,626 traffic crashes that resulted in 3,135 fatalities and 255,353 injuries. On principal urban roads, the total number of fatalities was 1,285 (= 3,135 × 41%), and the total number of injuries was 104,694 (=255,353 × 41%).</p> <p>The dynamic crash prediction systems are primarily implemented on urban principal roads. However, it is unknown that how many crashes can be reduced by dynamic crash prediction and prevention. The proposed study will estimate the safety benefits (crash reduction factors, CRFs) for the dynamic crash prediction. The benefits of lives saved and injuries prevented can be quantified by:</p> <p><i>\$4,008,900 (per fatality) × 1,285 (fatalities on principal urban roads) × CRFs for fatalities (developed in the proposed study)</i></p> <p><i>\$147,500 (per injury) × 104,694 (injuries on principal urban roads) × CRFs for injuries (developed in the proposed study)</i></p>
○ Other (Explain)		

*Comments should explain and support urgency, financial benefit, and implementability scores