SPR Subpart B Project: TEO-23-17

Requesting Office	FDOT District 7 Traffic Operations	**Priority** Highest	17 of 23

Proposed Title	Benefit-Cost Analysis to Use Big Data via Data Service – A Focused Study Using Near-Miss Data to Improve Pedestrian and Bicycle Safety

Justification	*Current Situation*

Current Situation

For many years, transportation professionals have either relied on crash data or crash surrogate data (e.g., near-miss incidents) to assess crash risk, identify crash causes and solutions, implement countermeasures, and evaluate their effectiveness. To conduct a meaningful before-after crash data analysis, sufficient crash data are needed. As a crash is a rare event, usually three years of before and after crash data are needed for detailed crash data analysis. This approach becomes inefficient and reactive for reducing or mitigating crash risk in a timely manner. On the other hand, surrogate data such as near-miss incidents, which are highly correlated to crash risks, could be collected and analyzed to quickly identify existing risks and develop and implement countermeasures in a timely manner. This is a proactive and popular alternative approach to crash data analysis.

Traditionally, the collection of crash surrogate data is generally via field manual observations, cameras, or sensors. Transportation agencies need to invest manpower, time, resources, cameras, and sensors to collect and analyze data for specific locations. With the advancement in automated vehicle technologies, many car manufacturers use high-tech camera systems (e.g., Mobileye) and sensors to detect surrounding objects such as other vehicles, pedestrians, bicyclists, traffic signs, traffic signals, pavement markings, pavement conditions, work zones, and other roadside traffic control devices. These systems use state-of-the-art algorithms to detect potential dangers and analyze risks to (1) provide warnings to drivers, (2) take proper immediate actions such emergency braking if drivers cannot react in time to avoid a crash or mitigate injury severity, or (3) assist a vehicle to drive by itself.

Increasing numbers of vehicles on our roadways are equipped with high-tech camera systems and advanced sensors and communication systems, essentially becoming probe vehicles that collect data, which are valuable to transportation agencies for safety and mobility analyses of near-miss incidents, traffic flow, intersection travel time, harsh braking and cornering, vehicle headways, and pedestrian and bicycle volumes. Probe vehicle data are not limited to specific locations and could likely be cost-effectively used by transportation agencies to identify risks and prevent crashes. Transportation agencies may purchase needed near-miss data from data providers to analyze and take proactive actions to prevent crashes, thus improving safety and saving lives and injuries and also reducing non-recurring traffic congestion caused by crashes.

Research Needed

The collection and availability of big data is at the forefront of many industries worldwide, including the transportation industry. In the transportation field, big data are becoming available in massive amounts and contain valuable information on traffic and roadway conditions and activities through multiple resources. As connected autonomous vehicle (CAV) technologies become more advanced and mature, so do the abilities and availability of big data in transportation. It has become crucial to research the following questions and seek answers: "What are the major advantages that big data have brought to the transportation industry? Who can provide big data? How can they be used? Are they affordable? What is the benefit/cost ratio of big data?" This proposed research is needed to answer these questions and assess the ability, availability, and affordability of using big data to improve transportation safety and mobility.

Florida shares the national traffic safety vision of "Target Zero," which focuses on how to accomplish the elimination of fatalities and reduction of serious injuries on public roadways. Pedestrian and bicycle safety is one of the highest priorities of the Florida Department of Transportation (FDOT). Florida's Pedestrian and Bicycle Strategic Safety Plan (PBSSP), updated in October 2021, advances Florida's safety vision by supporting the safety of people who walk and bike, which aligns with the principles established in FDOT's Strategic Highway Safety Plan (SHSP). The overarching goal of the PBSSP plan is to eliminate pedestrian and bicyclist fatalities and serious injuries resulting from traffic crashes on public roads by decreasing the number of non-motorized fatalities and serious injuries based on a five-year rolling average. One proactive approach is to systematically take proper actions at locations with frequent near-miss crash incidents to prevent pedestrian and bicycle crashes. There are many unknown near-miss pedestrian and bicycle crash incidents on our roadways and intersections, but only limited actions have been taken to investigate the development of countermeasures to mitigate problems as a result of the constraints of manpower, funding, and resources.

Near-miss data could be particularly important for pedestrian and bicycle safety. In addition to using crash data for analyzing pedestrian safety issues, near-miss (pedestrian-vehicle conflict) data could be beneficial in spotting dangerous locations for pedestrian crossings (Bull et al., 2017). Similarly, safety presents a major obstacle to bicycling. A recent study showed that areas with a greater share of bicycle commuting experienced lower near-miss-to-collision reporting ratios (Laberee et al., 2021). A pilot study in Bellevue, Washington, used anonymized video and big data to reveal that bicyclists are 10 times more likely to be victims of near-miss crashes but represent only 0.1 of roadway users. It was found from camera observations that more than 10% of Bellevue drivers were speeding when they passed a camera, with 50% exceeding the local speed limit by 11 mph or more (Wilson, 2020). This information helped DOT to comprehend how vehicle speeding is hindering pedestrian and bicycle safety.

Other studies elaborated more on near-misses and their contributing factors. Near-miss crashes could be used as a surrogate safety measure based on driver behaviors and other risk factors (Guo et al., 2010). For the most part, contributing factors for crashes are very similar to near-miss factors. A busy urban environment was found to be a factor that links crashes to near-misses. It was discovered that after a near-miss, a person was three times more likely to crash in a dangerous situation than if no near-miss was experienced at all (Association of Psychological Science, 2018). Other past research demonstrated that crash risk escalated from 23.2% to 44.5% with the presence of near-miss crashes caused by sleepy drivers (e.g., ≥4 near-miss sleepy accidents) (Powell et al., 2007). The Advanced Mobility Analytics Group (AMAG) employed data from 49 signalized intersections in British Columbia to estimate the average ratio between near-misses and crashes as 1 in 227 per year. AMAG also stated that a minimum of 5 unique near-miss metrics are required for reliable prediction of crash risk. Measuring critical conflicts using available video camera data can revolutionize roadway safety (Advanced Mobility Analytics, 2021).

As pedestrian and bicycle safety is essential for Florida and one of the highest priorities of FDOT, it is practical, beneficial, and needed to conduct a benefit-cost analysis via a focused study using near-miss big data to assess its ability, availability, and affordability to improve pedestrian and bicycle safety. The results of this research could provide direct assessment on using near-miss big data to improve pedestrian and bicycle safety in Florida and also can shed light on innovative approaches to use big data to improve safety, mobility, and efficiency.

Proposed Research Project Objectives

The proposed research will explore the use of available big data to benefit transportation agencies to improve safety, mobility, and efficiency by conducting a detailed benefit-cost analysis on the use of big data, compare this innovative approach with traditional methods, and evaluate its ability, availability and affordability via a focused study using near-miss pedestrian and bicycle crash incidents to identify locations, risks, and countermeasures to improve pedestrian and bicycle safety. Project objectives will include the following:
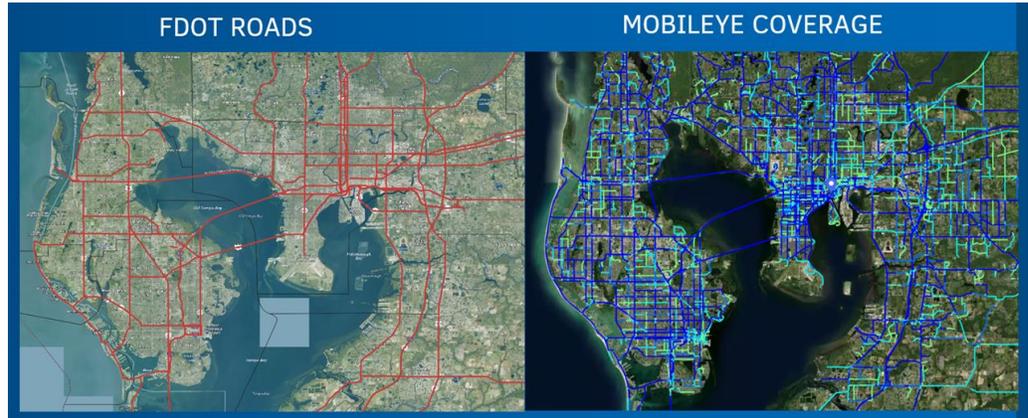
1. Conduct a comprehensive literature review on the use of big data in transportation.
2. Acquire big data on near-miss pedestrian and bicyclist crash incidents via a selected data service provider for a focused benefit-cost analysis.
3. Use the acquired data collected by vehicles equipped with advanced camera technology to conduct research to assess the relationship between near-miss pedestrian and bicycle crash incidents and actual crashes.
4. Perform a benefit-cost analysis on using acquired near-miss big data to evaluate its ability, availability, and affordability for improving pedestrian and bicycle safety.
5. Document near-miss data analysis, results, research findings, successes, and learns learned.
6. Provide recommendations on how to cost-effectively use big data to improve safety, mobility, and efficiency.

The CUTR research team has identified transportation big data providers, the availability of near-miss data and features, pedestrian and bicycle near-miss crash incident data, and other related data. Data for the Tampa Bay area from Mobileye will be acquired for this proposed research. Mobileye, a global leader in the development of computer vision and machine learning, data analysis, localization, and mapping for advanced driver assistance systems and autonomous driving solutions, has cameras on many vehicles worldwide that can detect near-misses. Its technology uses a single camera to scan the road ahead and detect potential dangers. Installing cameras at every key intersection and every half-mile of roadways would be costly, and many near-misses have gone unreported due to lack of manpower, resources, funding, and technology. Using third-party big data on near-miss crashes from a company such as Mobileye could be important in the future and may help FDOT and local transportation agencies save lives, prevent serious injuries, and save significant time and money.

Research Effects on FDOT Mission Critical Focus Areas

FDOT's mission is to provide a safe transportation system that ensures the mobility of people and goods, enhances 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 research fully supports these missions. The proposed research will contribute to improved safety and mobility, especially mitigating pedestrian and bicycle fatalities and injuries (an

important focus area) and reducing non-recurring delay using near-miss big data. The proposed research also fully supports FDOT's vital few of Improve Safety, Enhance Mobility and Inspire Innovation.

Dark blue indicates highest volume of vehicles equipped with Mobileye camera systems,
light green indicates lowest; very low volume; volume less than 50 drives not included

Figure 1. Map of FDOT Roadways and 90-day Mobileye coverage in Tampa Bay Area

Impact	The major results from this proposed research will include (1) a comprehensive literature review on the use of big data in transportation, (2) a quantified relationship between near-miss pedestrian and bicycle crash incidents and actual crashes, (3) a comparison of pros and cons between traditional approaches to collecting near-miss data and innovative approaches to use big data, (4) a detailed benefit-cost analysis to evaluate the ability, availability and affordability of using near-miss crash incident data to improve pedestrian and bicycle safety, and (5) research findings, success stories, lessons learned, and recommendations on how to use other big data to improve transportation safety, mobility and efficiency. FDOT and local transportation agencies can use the results and findings from this proposed groundbreaking study to cost-effectively use big data to help save lives and money, prevent injuries, and improve safety and mobility on a large scale. Using the systematic reporting of near-miss crash incidents, transportation agencies could quickly identify intersections and roadway segments with high risks and proactively take actions to reduce those risks to improve pedestrian and bicycle safety and enhance mobility. Moreover, near-miss crash incidents can be used as crash surrogates for risk assessment when the sample of observed crashes is not large enough. It is expected that this proactive approach to improve safety and enhance mobility will be well-received by the general public. Consequences of <u>not</u> conducting the research include the following: • FDOT and local transportation agencies would not obtain the results of a literature review on the use of big data in transportation to improve safety and enhance mobility. • FDOT and local transportation agencies would learn the valuable relationship between near-miss pedestrian and bicycle crash incidents and actual crashes via a focused study. • FDOT and local transportation agencies would not obtain pros and cons between the traditional approach to collect near-miss data and the innovative approach to use big data. • FDOT and local transportation agencies would not obtain a detailed benefit-cost analysis to evaluate the ability, availability, and affordability of using near-miss crash incident data to improve pedestrian and bicycle safety. • FDOT and local transportation agencies would not know how to obtain and use near-miss pedestrian and bicycle crash incident data via data service providers to proactively and cost-effectively prevent pedestrian and bicycle fatalities and injuries. • FDOT and local transportation agencies would not obtain research findings, success stories, lessons learned, and recommendations on how to use other big data to improve transportation safety, mobility, and efficiency.
Affected Offices	State Traffic Engineering and Operations Office, State Safety Office
Existing Work	Selected existing work on the benefits of using near-miss data to prevent crashes, especially crashes involving pedestrians and bicyclists, includes the following: • L. de Rome, J. Brown, M. Baldock, and M. Fitzharris, "Near-Miss Crashes and Other Predictors of Motorcycle Crashes: Findings from A Population-Based Survey," *Traffic Injury Prevention*, 19(sup2), 2018.

- F. Guo, S. G. Klauer, M. T. McGill, and T. A. Dingus, "Evaluating the Relationship Between Near-Crashes and Crashes: Can Near-Crashes Serve as a Surrogate Safety Metric for Crashes?" U.S. Department of Transportation National Highway Traffic Safety Administration Report DOT HS 811 382, September 2010.
- N. B., Powell, K. B. Schechtman, R.W., Riley, C. Guilleminault, R. P. Y. Chiang, and E. M. Weaver, "Sleepy Driver Near-Misses May Predict Accident Risks," *Sleep*, 30(3), 2007, 331-342.
- C. B. Bull, L. A.V. Hagen, A. Lubin, G. Shivaraman, and D. Chibbaro, "Predictable is Preventable: Tracking Pedestrian Near-miss Incidents," New Jersey Safe Routes to School Resource Center, Alan M. Voorhees Transportation Center, February 2017.
- K. Labereea, T. Nelson, M. Branion-Calles, C. Ferster, and M. Winters, "Crowdsourced Bicycling Crashes and Near Misses: Trends in Canadian Cities," *Urban Planning and Transport*, 9(1), 2021, 450–464.
- A. R. Mussah, "What Effect Does Driver Maneuvers Have on The Safety of Pedestrians and Cyclists? An In-Depth Descriptive Analysis of Vulnerable User Crashes and Near-Misses," Master's thesis, University of Tennessee, 2017, https://trace.tennessee.edu/utk_gradthes/4996.

Keywords Used in Existing Work Search	Cost-benefit analysis, Big data, Near-miss, Crashes, Pedestrian and bicycle safety, Video camera, Mobileye
Related Contracts	FDOT Contract BDV31-977-77, Data Management and Analytics for UF Smart Testbed FDOT Contract BDV29-977-49, Guidelines for Installing Pedestrian Treatments at Midblock Locations FDOT Contract BE548, Application of Dynamic Crash Prediction Methodologies to FDOT Safety and Transportation System Management and Operational (TSM&O) Programs FDOT Contract BDV31-977-119, Life Cycle Costs and Benefits Analysis of Freight Transportation Projects FDOT Contract K-TRAN: KU-21-4, Evaluation of Near-Miss Crashes Using a Video-Based Tool IDOT Contract Addendum 619, Automating Near-Miss Crash Detection Using Existing Traffic Cameras University Transportation Center for Alabama Contract 25141, UTCA Project 15405, Near Miss Information Visualization Application for BIM NCHRP Project 17-100, Leveraging Artificial Intelligence and Big Data to Enhance Safety Analysis (proposed) WDOT Contract RS06220, Enhancing Crash Data Reporting to Highway Safety Partners in Wyoming by Utilizing Big Data Analysis and Survey SaferSim Contract 69A3551747131, Understanding Bicyclists' Behaviors Through Learning from Big Trip Data

Funding Request	$240,000	**Anticipated Duration**	18 months
Project Manager	Peter Hsu, P.E.	**Contracting Method**	Direct contract with Center for Urban Transportation Research (CUTR) at the University of South Florida
Equipment	Estimated equipment cost (or N/A) N/A	N/A	
Urgency	1	Florida has the 3rd largest population and the 3rd largest total annual vehicle miles traveled (VMT) in the US; it also had the largest number of bicyclist fatalities, the 2nd largest number of pedestrian fatalities (more than 22% of traffic fatalities in Florida), and the 3rd largest number of traffic fatalities. Florida also has the 3rd highest pedestrian fatality rate and the highest bicyclist fatality rate in the nation. Additionally, the use of data is highlighted among the seven Emphasis Areas of the PBSSP as important for improving pedestrian and bicycle safety. Several studies proved the benefit of using near-miss crash incidents for proactively preventing fatalities and injuries. With advances in technology, big data and near-miss data for pedestrian and bicycle crashes are becoming available via data service providers. This is essential for exploring and conducting needed research to assess the ability, availability, and affordability of big data to identify locations with high risks and take proper actions to reduce these risks to prevent pedestrian and bicyclist fatalities and serious injuries in Florida.	

		Therefore, there is an urgent need to conduct the proposed research to understand the importance of using near-miss crash data via big data service providers to significantly reduce pedestrian and bicyclist fatalities and serious injuries on Florida roadways.
Implementability	1	The results, findings, and report from this research will be useful to FDOT and others. This proposed project will conduct a focused study on the use of near-miss pedestrian and bicyclist crash incident data in Tampa Bay to identify locations with high risks and recommend proper action to reduce or eliminate the risks. This project will conduct a benefit-cost analysis to evaluate and demonstrate the value of using big data to help transportation agencies improve safety, mobility, and efficiency. It has the greatest likelihood to implementing results

Project Benefits (Succinct, complete explanation)

The significant benefits for conducting this proposed research project include the following:

1. Understand the use of big data to improve transportation safety, mobility, and efficiency via a comprehensive literature review to help FDOT and local agencies start to use big data with confidence to cost-effectively improve safety and mobility.

2. Learn the relationship or correlation between near-miss pedestrian and bicycle crash incidents and actual crashes and the confidence to use near-miss incident data to predict the probability of actual crashes.

3. Understand the pros and cons between the traditional approach to collecting near-miss data and the innovative approach of using big data, which could provide significant value and benefit of using big data.

4. Obtain detailed benefit-cost analysis results from evaluation of the ability, availability, and affordability of near-miss pedestrian and bicycle crash incident big data to improve pedestrian and bicycle safety.

5. Obtain research findings, success stories, lessons learned, and recommendations on how to use other big data to improve transportation safety, mobility, and efficiency.

6. Provide a demonstration and guidance via a focused study to use near-miss pedestrian and bicycle crash incident big data to improve pedestrian and bicycle safety in Tampa Bay.

Project Benefits (Select all that apply and explain)	Quantifiable Benefits (units, dollars, etc.…if applicable)	Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits.
o Materials Enhancement		
o Materials Savings		
o Time Savings	Reduction of non-recurring delay due to pedestrian- and bicycle-related crashes	A reduction in pedestrian, bicyclist, and driver fatalities, injuries, and crashes resulting from identifying near-miss crash incident locations and taking proper action to reduce the risks could be significant, which could lead to reduction of non-recurring congestion caused by pedestrian, bicycle, and vehicle crashes.
o Lives Saved/ Injuries Prevented	13 lives saved, 30 serious injuries, and 80 moderate injuries prevented per year Total cost savings of lives and injuries could reach $169M per year	The results and outcomes from this project could lead to affecting change in various safety areas and help reduce fatalities and injuries in Florida. The benefit could be significant—many lives could be saved, injuries could be reduced, and crashes involving pedestrians, bicyclists, drivers, and motorcyclists could be mitigated. An estimated 2% reduction in pedestrian and bicyclist fatalities per year can be achieved by proactively take proper actions at locations in Florida with frequent near-miss pedestrian and bicyclist crash incidents identified using big data, which can save about 13 lives, 30 serious injuries, and 80 moderate injuries per year with an estimated saving of $169M (=13 x $10,100,000 + 30 x $818,636 + 80 x $163,254) in social costs in terms of loss of productivity.
o Other (Explain)		Findings from this project could benefit other areas of transportation to use big data.