

Semiannual Program Progress Performance Report for  
**Southeastern Transportation Center (STC)**  
US DOT Regional University Transportation Center



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# STC Program Progress Performance Report #9

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## 1. Accomplishments

### 1.a. What are the major goals of the program?

This document summarizes the activities initiated, continued, or completed by the Southeastern Transportation Center (STC) during the past six months. STC is the 2013 USDOT Regional University Transportation Center (UTC) representing Region 4, and is led by the University of Tennessee, Knoxville (UT). The STC's programmatic theme is [comprehensive transportation safety](#). As the 2013 UTC grant period winds down, the STC continues to support a full agenda of activities in all four of our program areas: research, education, work force development, and technology transfer. Progress and accomplishments in each of these activity areas are documented and discussed herein.

### 1.b. What was accomplished under these goals? What opportunities for training and professional development have the program provided?

## Major Research Initiatives (MRI)

### MRI 1: Crash Modification Factors and the Highway Safety Manual

#### UTK

Work is concluding on the initial match projects of this MRI and products, outputs and impacts will be fully reported as the research work is fully documented.

#### HSRC

The draft final report from the MRI1-Year 2 effort was completed. The draft report is titled: *Comparison of Crash Modification Factors for Engineering Treatments Estimated by Empirical Bayes and Propensity Score Methods*, Bo Lan and Raghavan Srinivasan.

#### UK

Between October 2017 and March 2018, we accomplished these things for MRI 1:

- Compiled database of 5 socio/economic and demographic factors, which have been aggregated to the segment level. Currently, we are only using Unit 01 drivers (with the assumption of 01 at-fault); however, more research will be done on this per Dr. Stamatiadis' suggestion. Initial SPFs (using only ADT) have been created using R-Studio to run a negative binomial regression. SPFs will soon be developed using the various socio/economic factors to dampen omitted variable bias. In regards to the dataset, only 2-lane rural roads are being examined, and crash records without zip-codes have been eliminated.
- Some SPFs were generated based on socio-economic factors. This needs more tinkering to develop an accurate model.
- We re-evaluated the project's scope and goals. New work plan developed including roles and timelines. Will use Generalized Linear Models and Negative Binomial regression models instead of developing Safety Performance Functions to correlate socioeconomic/demographic factors with at-fault drivers in KY crashes.

- New database created for Demographic and socio/economic factors that includes indicators for Education, Employment, Poverty, Income, Population, and Marital Status aggregated to the Zip Code Tabulation Area. Terrain Index created for each zip code by comparing the straight-line length to the total length of all road segments in a zip code. This will allow for analysis of the general terrain that a driver is used to compared to where they crashed. Finally, crashes were queried for KY drivers over four years, including only at fault drivers (based on human factor code). Some preliminary maps and descriptive statistics have been done for the demographics. All of this will need to be rolled up to the zip code level and analyzed further with regressions.
- Found top zip codes by number of crashes recorded. Compared demographics across these zip codes to determine variable sensitivity and identify notable demographic/socioeconomic trends.

## **MRI 2. Integrated Simulation and Safety**

### *UCF*

This period included Year 3 of the project. Tasks 3 and 4 are accomplished, which includes Field Data, Driving Simulator and Microsimulation Framework as well as the final report. In summary, this period focused on developing a framework to consolidate the significant parameters from the three legged approach which included field data, micro-simulation data, and driving simulator data and determine the best way forward in order to maximize gains. The evaluation process concerning pedestrian safety using one or more type of data was investigated to predict conflicts, propose countermeasures and test it before implementation. A progress report has been submitted.

### *UK*

We have been trying to finalize the MRI2 concepts attempting to combine the safety and operational guidance we have developed. This could also be the foundation for PhD work. The operational approach has been well received by the research community and KYTC.

## **MRI 3. Exploring Socio-Demographic Characteristics and Culture Factors in Differential Safety Performance across Geography**

### *USF*

We created an initial cleaning set of data from merging the American Community Survey and pedestrian crashes in the State of Florida from 2011 through 2015 and started preliminary regression analyses of the probability of pedestrian deaths and the role of socioeconomic factors.

We experienced some challenges in identifying the role of socioeconomic factors beyond the age and gender of pedestrians and drivers. Both the age and gender of involved individual pedestrians and drivers are available at the disaggregated level for each pedestrian crash. Other socioeconomic factors, however, are available only at the aggregated level of census tracts from the American Community Survey. For involved pedestrians, the socioeconomic characteristics of a census tract may reasonably represent the characteristics of the walking population living in that census tract. The literature has shown that most pedestrian crashes occur in areas close to their residences. For involved drivers, however, the socioeconomic characteristics of a census tract may not represent the characteristics of the driving population living in that census tracts. This is simply because the range of most driving trips is much longer than walking trips.

Facing these difficulties, we started exploring a range of options, particularly in terms of model specifications. These include what and how socioeconomic factors are included in a model. They include

what and how characteristics of pedestrian crashes are included as control variables. They can also include alternative forms of the statistical model used.

## **MRI 4 Big Data for Safety Monitoring, Assessment, and Improvement**

### **UT**

Emerging sensor and communication technologies have made traffic, mobility, safety, and other information available ubiquitously and in real-time with appreciable temporal resolution and spatial accuracy. Some of the real time and dynamic data come from infrastructural investments by government agencies for traditional traffic monitoring, some come from private enterprises for logistical operations, and still other data come from crowd-sourced personal electronics, e.g., smartphone and Bluetooth equipped units. All these and other increasingly available data can be collected, fused, and mined to help monitor, assess, and improve transportation safety in real-time as well as after the fact. Projects have resulted in several presentations at the 2018 Transportation Research Board Annual meeting in Washington, D.C. This research is at a critical stage of data assessment and scenario building that will determine the strategic potential of large amounts of data and data integration. The efforts undertaken in this MRI have helped in investing resources in analysis and processing of new kinds of data, e.g., vehicle trajectories, and images, generated by connected and automated vehicles being tested in the field.

### **UK**

For MRI 4 we worked on building models to simulate connected vehicle and safety measures with integrated SSAM module. It is ongoing.

## **Opportunity and Exploratory (O&E) Grants**

### **Connected and Automated vehicles: What are the implications of partial adoption?**

#### **Asad Khattak, PI**

With increasing attention focused on connected and automated vehicles (CAVs), this study explores the opportunities and challenges associated with the adoption and use of such systems. CAVs represent the opportunity to greatly enhance safety. Among the challenges is how will partial adoption of automated technologies, characterized by levels 0 to 5, work in a transportation network? We developed simulations to help us understand the impacts of CAVs in transportation networks. Specifically, our research has focused on developing network simulations and algorithms to understand how variations in driving control will impact safety and congestion. Substantial progress was made in developing an ad-hoc behaviorally-based modeling framework in SUMO simulator, which allows flexibility to changing the car-following models and to account for vehicle crashes. This work is currently in progress with 2 graduate Civil Engineering students and an ORNL researcher (Dr. Rios-Torres) contributing to the project, along with participation from East Tennessee State University. The research activities undertaken in this O&E are reflected in technical presentations 2018 TRB Annual Meeting:

### **Can You Hear It Now? A Study of Personal Listening Devices and Pedestrian Safety.**

#### **Maranda McBride, PI**

The manuscript describing the results of the Texting While Driving study was resubmitted to the Transportation Research Record – Part F on February 18, 2018.

The STC O/E study titled “Can You Hear It Now? A Study of Personal Listening Devices and Pedestrian Safety” is in the data collection phase. The graduate student conducting the study gave a poster presentation at the STRIDE conference in November and defended her proposal in January.

#### **Disaster Analytics: Disaster Preparedness and Management through Online Social Media. Samiul Hasan, PI.**

Under this project three accomplishments have been made to date.

- Successfully gathered large-scale datasets of hurricanes from social media.
- Developed algorithms to analyze social media data for understanding various patterns.
- Participated data for climate action challenge where one of these algorithms has been applied over mobile phone data.

#### **Evaluating the Potential of Connected Vehicles in Combating Wrong-Way Driving.**

##### **Haitham Al-Deek, PI.**

The UCF research team submitted a progress report to FHWA per the main sponsor matching contract. UCF continues to collect data from devices installed on CFX system and evaluate the efficacy of the new technology installed to combat WWD. Five journal papers were presented at TRB 2018 and accepted for publication in TRR. We made two progress presentations to CFX, the matching fund sponsor of this research, in November 2017 and February 2018.

## **Education & Workforce Development**

### **UTK**

The UT transportation program is on target to graduate eight Masters and two Ph.D. students in engineering by the end of Spring 2018 semester. Other related activities include:

- Students participated in the Tickle College of Engineering Engineer’s Day for high school students who are interested in pursuing a degree in an engineering discipline. This tradition brings in more than 1,500 students from various high schools in Tennessee, Florida, Georgia, and Kentucky who participate in events around the college. UTK students created an event called “Using Transportation Technology to Improve Safety, Mobility, Efficiency, and Sustainability,” which gave the high schoolers an introduction on transportation engineering and career opportunities in transportation. The attendees rode electric bikes, used real time license plate recognition devices, used the driving simulator, and visited our traffic management center.
- Students showcased their research in transportation efficiency in the Tickle College of Engineering STEMpunk Reverse Science Fair. High school seniors learned about electric bikes and their impact on countries with congestion issues, such as China.
- Students volunteered in the OpenStreets Knoxville hosted by the Bike Walk Knoxville, Knoxville Regional Transportation Planning Organization, and City of Knoxville. This event was an opportunity to walk, ride bikes, rollerblade, etc. in a safe and fun environment. This event encourages people to use active transportation for healthy living and to reconsider our streets as public space.

- Students assisted in hosting Transit Day at local elementary schools including Emerald Academy, Green Magnet Academy, and Bearden Elementary School to encourage ridership on Knoxville Area Transit (KAT). Students were able to hop on and learn about the trolley.
- Students assisted in the Seatbelt Convincer, which simulates a low speed crash of approximately 5 to 7 miles per hour and demonstrates the benefits of wearing seatbelts even at a low speed. The convincer has been used by more than 2,000 people throughout Tennessee. Some events include Austin East High School, Knoxville Ice Bear Hockey Team games, Tickle College of Engineering Homecoming Barbeque, Teen Rodeo, LN Stem Academy, UT Welcome Week, and Knoxville Healthy Living Expo.
- Students showcased transportation engineering and technologies and assisted in the Tennessee Regional Future City Competition that was held at UTK. Middle school students from across Tennessee competed and were challenged to design a virtual city in SimCity, write a 1,500 word essay on the city, build a scale model that had at least one moving part, using recycled materials, develop a project plan, and give a 7-minute project presentation.

### NCAT

The STC Education program supported eight undergraduates for the Fall 2017 semester along with two freshmen Incentive Award students for the 2017-18 academic year. These STC Education Awardees received research mentorship, internship opportunities, and opportunities to engage in experiential learning activities such as the Annual UTC Conference for the Southeastern Region and Transportation Research Board Meeting. The Incentive Award is given to incoming freshmen who have declared transportation/supply chain management as an undergraduate major. Additionally, one student received the TRB Minority Student Transportation Research Fellowship. One student was selected as the Dwight David Eisenhower Transportation Fellow.

#### *Workforce Development and Outreach:*

The application process for the 2018 Summer High School Transportation Institute is underway during this reporting period. Applications are sent out to high schools in a four-county area. Students take a for-credit English course during the second session of summer school, participate in lectures and interactive presentation that support academic and career choices in transportation, SAT preparation and personal development sessions, and field trips to support classroom experience. They study a different mode of transportation each week along with career choices in each mode.

### UK

UK has worked to train and educate staff at the Kentucky Transportation Cabinet on Highway Safety Manual techniques. In particular, we have worked with the KYTC Planning and Design Divisions.

#### **1.c. Have the results been disseminated? If so, how?**

### UTK

STC and Collaborative Sciences Center for Road Safety (CSCRS) jointly sponsored a successful, well-attended event at the 2018 TRB annual meeting, where TRB attendees interacted on important safety topics.

UT hosts “Engineers Day” each year for high school students interested in pursuing engineering degrees. The 2017 Engineers Day hosted approximately 1,500 students, including home-schoolers. We participated in the Fall 2017 Freshman Engineering Fair. Another outreach activity includes Transit

Day at Knox County Schools. Students learn about the transit system in Knoxville while being able to board one of the trolleys.

## NCAT

### *Education*

All scholarship opportunities are emailed to our supply chain and civil engineering majors. An announcement is placed on our communications network throughout our building and hard copies are available in the Transportation Institute office. Students who are fortunate enough to receive STC funding are highlighted at TRB through the STC Spotlight program, the Eisenhower Showcase and the TRB Fellows paper presentations.

### *Workforce Development/Outreach*

Applications for the 2018 Summer High School Transportation Institute are distributed through Guidance Counselors' offices at all of the schools within the targeted four-county area. Also, the application is available on the Transportation Institute website, and hardcopies are available in the Transportation Institute. Applications are emailed directly to students upon request. Student who are selected are showcased throughout the program via news articles, the opening and closing program, COMTO conference attendance, etc.

### *Research*

The Pedestrian Safety and Personal Listening Devices pilot study results were disseminated during a poster presentation session at the STRIDE conference in November.

## UCF

Based on the results of this project, two articles were presented at the 97<sup>th</sup> TRB Annual Meeting in January 2018 and a poster was presented at the Midwest Big Data Hub All-Hands Meeting on Oct. 2-3, 2017 at Omaha, Nebraska. Five journal papers were presented at TRB 2018 and accepted for publication in TRR. In addition, UCF made two presentations to CFX in November 2017 and February 2018.

## UK

UK presented a workshop on calibrating safety performance models at the annual meeting of the TRB.

### **1.d. What do you plan to do during the next reporting period to accomplish the goals and objectives?**

## NCAT

### *Education*

During the next reporting period students will be selected to participate in the 2018 Summer High School Transportation Institute. Scheduling the five and one-half week program will begin. Other activities planned involve the application process for the Dwight David Eisenhower Fellowship program, developing partnerships and continued planning for the 2018 STI. Students participating in the TRB Minority Student Fellows programs will be selected along with their faculty mentors.

### *Research*

The Pedestrian Safety and Personal Listening Devices pilot study results will be presented at the Institute of Industrial and Systems Engineering conference in May. The graduate student working on the STC O/E project is expected to complete the data collection and defend her thesis during the summer.

## UCF

Our work on MRI#2 has come to an end and we are preparing the final report. For O&E (DA) we will develop machine learning models to infer evacuation behavior from social media data. For O&E (WWD) we plan to submit more papers to TRB and or other journals. We plan to wrap up this project and write draft final report.

## UK

We plan to complete all work on MRIs and O&E grants during the next reporting period, as well as to publish papers and make conference presentations as appropriate.

## USF

Plan to complete the Directed MRI Grant: 2017-2018, Probability of Pedestrian Deaths and the Role of Socioeconomic Factors – A Disaggregated Approach in the next quarter.

## 2. Products: What has your STC work produced?

### 2.a. Journal publications:

## UTK

- Liu, J., A. Khattak, and B. Wali, Do safety performance functions used for predicting crash frequency vary across space? Applying geographically weighted regressions to account for spatial heterogeneity, Presented at the TRB annual meeting. Published in *Accident Analysis & Prevention*, Volume 109, 2017, pp. 132–142. STC/Federal support acknowledged.
- Wali, B., A. Khattak, D. Chimba, J. Waters, & X. Li, Development of Safety Performance Functions for Tennessee: Unobserved Heterogeneity & Functional Form Analysis, Presented at the TRB annual meeting, Forthcoming in *Transportation Research Record: Journal of the Transportation Research Board*, 2018. STC/Federal support acknowledged.
- Wali B., A. Khattak, & X. Li, Exploring Non-Linear Dependencies in Correlates of Roadway Crashes: Application of Generalized Additive and Piecewise Linear Count Data Models, 18-00064, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018. STC/Federal support acknowledged.
- Robinson RM, A. Collins, C. Jordan, P Foytik, & A. Khattak, Modeling the Impact of traffic incidents during Hurricane Evacuations using a large scale microsimulation, Forthcoming, *International Journal of Disaster Risk Reduction*, 2017
- Li, X., A.J. Khattak, and B. Wali, Large-Scale Traffic Incident Duration Analysis: The Role of Multi-agency Response and On-Scene Times. *Transportation Research Record: Journal of the Transportation Research Board*, 2017 (TRR 2616) p. 39–48. STC/Federal support acknowledged.
- Wali, B. and A. Khattak, Analysis of Volatility in Driving Regimes Extracted from Basic Safety Messages Transmitted Between Connected Vehicles. *Transportation Research, Part C: Emerging Technologies* 84, 2017 p. 48-73. STC/Federal support acknowledged.
- Liu, J., A. Khattak, and X. Wang, A comparative study of driving performance in metropolitan regions using large-scale vehicle trajectory data: Implications for sustainable cities. *International Journal of Sustainable Transportation*, 2017. 11(3): p. 170-185. STC/Federal support acknowledged.
- Kamrani, M., A.J. Khattak, and B. Wali, Can Data Generated by Connected Vehicles Enhance Safety? Proactive Approach to Intersection Safety Management. *Transportation Research Record: Journal of the Transportation Research Board*, 2017 (TRR 2659). STC/Federal support acknowledged.
- Kamrani M., R. Arvin, & A. Khattak, What measures of driving volatilities best explain crash frequency at intersections? Forthcoming, *Transportation Research Record*, Paper #: 18-00089, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018. STC/Federal support acknowledged.
- Khattak A., B. Wali, & H. Bozdogan, How is Driving Volatility Related to Intersection Safety in a Connected Vehicles Environment? 18-00058, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018. STC/Federal support acknowledged.



- Wali B., A. Khattak, & T. Karnowski, How Driving Volatility in Time to Collision Relates to Crash Severity in a Naturalistic Driving Environment? 18-00060, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018. STC/Federal support acknowledged.
- Zhang M. & A. Khattak, Identifying and Analyzing Extreme Lane Change Events Using Basic Safety Messages in a Connected Vehicle Environment, 18-04734, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018. STC/Federal support acknowledged.
- Hoque A., M. Ahmed, J. Rios-Torres, A. Khattak, & R. Arvin, Impact of Vehicle-to-Vehicle Communication Reliability on Safety Applications: An Experimental Study, 18-05532, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Kamrani M., A. Khattak, & T. Li, A Framework to Process and Analyze Driver, Vehicle and Road infrastructure Volatilities in Real-time, 18-00979, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Ahmed M., A. Hoque, & A. Khattak, Intersection Approach Advisory Through V2X Technology Using Signal Phase and Timing (SPaT) Information at Fixed-Time Signalized Intersection, 18-05804, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Arvin R., M. Kamrani, & A. Khattak, & J. Rios-Torres, Safety Impacts of Automated Vehicles in Mixed Traffic, 18-00088, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018. STC/Federal support acknowledged.
- Ahmed M., M. Hoque, J. Rios-Torres, & A. Khattak, A Cooperative Freeway Merge Assistance System using Connected Vehicles, 18-05614, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Boakye K., A. Khattak, S. Nambisan, & J. Everett, Correlates of Front-Seat Passengers' Non-Use of Seatbelts at Night, Forthcoming in Accident Analysis and Prevention, 2018.
- Kamrani M., R. Arvin, & A. Khattak, What measures of driving volatilities best explain crash frequency at intersections? Forthcoming Transportation Research Record: Journal of the Transportation Research Board, 2018.
- Zhang, M., A. Khattak, J. Liu, & D. Clarke, A Comparative Study of Rail-Pedestrian and Cyclist Trespassing Crash Injury Severity at Highway-Rail Grade Crossings and Non-Crossings. Forthcoming in Accident Analysis & Prevention, 2018.
- Wali, B., A. Khattak, J. Xu, Contributory Fault and Level of Personal Injury to Drivers Involved in Head-on Collisions: Application of copula-based bivariate ordinal models, Accident Analysis & Prevention, 110, 2018, pp. 101-114.
- Liu J., & A. Khattak, Gate-Violation Behavior at Highway-Rail Grade Crossings and the Consequences: Using Geo-Spatial Modeling Integrated with Path Analysis, Accident Analysis & Prevention, Volume 109, 2017, pp. 99-112.
- Liu, J., A. Khattak, and B. Wali, Do safety performance functions used for predicting crash frequency vary across space? Applying geographically weighted regressions to account for spatial heterogeneity, Accident Analysis & Prevention, Volume 109, 2017, pp. 132-142.
- Wali, B., A. Khattak, D. Chimba, J. Waters, & X. Li, Development of Safety Performance Functions for Tennessee: Unobserved Heterogeneity & Functional Form Analysis, Forthcoming in Transportation Research Record: Journal of the Transportation Research Board, 2018.
- Dhakal, N., C. Cherry, Z Ling, M. Azad (2018) Using CyclePhilly Data to Assess Wrong-Way Riding of Cyclist in Philadelphia. Journal of Safety Research (In Review).
- Lu, X., H. Yang, C. Cherry, X. Liu (2017) Spatial Variations in Active Mode Volume at Intersections: A Local Analysis Utilizing Geographically Weighted Regression Approach. Journal of Transport Geography. 64 pg 184-194.
- Langford, B.C., C. Cherry, D. Bassett, E. Fitzhugh, N. Dhakal (2017) Comparison of Walking, Conventional Bicycles, and Pedal Assist Electric Bikes: Effects on Physical Activity and Travel Time. Journal of Transport & Health.
- Ling, Z., C. Cherry, N. Dhakal (2017) Factors influencing single-bicycle crashes at skewed rail grade crossings. Journal of Transport & Health. DOI: 10.1016/j.jth.2017.01.004.

## Clemson

- Zhao, Xi; Dawson, Douglas; Sarasua, Wayne; Birchfield, Stanley; Multiple Hypothesis Tracking with Kinematics and Appearance Models on Traffic Flow for Wide Area Traffic Surveillance; *Journal of Computing in Civil Engineering*; under review; federal support acknowledged.

## NCAT

- McBride, M., Carter, L., and Phillips, B.; Integrating the Theory of Planned Behavior and Behavioral Attitudes to Explore Texting among Adolescent Drivers in the US; *Transportation Research Part F: Psychology and Behaviour*; under review; federal support acknowledged.

## UA

- Adanu, K., Hainen, A., Jones, S. Latent class analysis of factors that influence weekday and weekend single-vehicle crash severities. *Accident Analysis and Prevention*, 113, 2017, 187-192. NO
- Adanu, K. and Jones, S. Effect of human-centered factors on crash injury-severities. *Journal of Advanced Transportation*, ID 1208170, 2017, 1-11. YES
- Adanu, K., Smith, R., Powell, L., Jones, S. Multilevel analysis of the role of human factors in sub-regional disparities in crash outcomes. *Accident Analysis and Prevention*, 109, 2017, 10-17. YES

## UCF

- Wu, J., Radwan, E., & Abou-Senna, H. Pedestrian-Vehicle Conflict Prediction Model Based on Drivers Avoidance Pattern at Midblock Crossings. Presented at the Transportation Research Board 97th Annual Meeting, 2018. Washington, D.C.
- Abou-Senna, H, Radwan, E., & Mohamed, A. Safety Prioritization Tool for Sidewalk and Bike-Lane Gaps. Presented at the Transportation Research Board 97th Annual Meeting, 2018. Washington, D.C.
- Wu, J., Radwan, E., & Abou-Senna, H. Assessment of pedestrian-vehicle conflicts with different potential risk factors at midblock crossings based on driving simulator experiment. *Journal of Advances in Transportation Studies*. (Accepted, awaiting publication).
- Wu, J., Radwan, E., & Abou-Senna, H. (2017). Determine if VISSIM and SSAM could estimate pedestrian-vehicle conflicts at signalized intersections. *Journal of Transportation Safety & Security*, (Published).
- Wu, J., Radwan, E., and Abou-Senna, H. Assess pedestrian-vehicle conflicts at signalized intersection with a concurrent pedestrian phasing – A driving simulator study. *Journal of Transportation Research Part F: Psychology and Behaviour*. (Submitted).
- Wu, J., Radwan, E., and Abou-Senna, H. Assessment of pedestrian-vehicle conflicts with different potential risk factors at midblock crossings based on driving simulator experiment. *Journal of Advances in Transportation Studies*. (Accepted and waiting publication).
- Sandt\*, A., and AL-DEEK+, H., “A Wrong-Way Driving Crash Risk Reduction Approach for Cost-Effective Installation of Advanced Technology Wrong-Way Driving Countermeasures,” published in the Transportation Research Board 97th Annual Meeting Compendium of Papers AMOnline, Washington D.C., January 7-11, 2018
- Kayes, I., AL-DEEK+, H., Sandt\*, A., Rogers, J., and Carrick, G. “Analysis of Performance Data Collected from Two Wrong-Way Driving Advanced Technology Countermeasures and Results of Countermeasures Stakeholder Surveys,” published in the Transportation Research Board 97th Annual Meeting Compendium of Papers AMOnline, Washington D.C., January 7-11, 2018.
- Al-Sahili, O., AL-DEEK+, H., Sandt\*, A., Mantzaris, A., Rogers, J., and O. Faruk., “Investigating and Modeling the Illegal U-turn Violations at Medians of Limited Access Facilities,” published in the Transportation Research Board 97th Annual Meeting Compendium of Papers AMOnline, Washington D.C., January 7-11, 2018.
- Wertanen, S., Staves, C., AL-DEEK+, H., Sandt\*, A., Carrick, G., and Rogers, J., “Evaluating Wrong-Way Driving Characteristics, Countermeasures, and Alert Dissemination Methods through Driver and Law Enforcement Surveys,” published in the Transportation Research Board 97th Annual Meeting Compendium of Papers AMOnline, Washington D.C., January 7-11, 2018.

- Faruk, O., AL-DEEK+, H., Sandt\*, Rogers, J., and Shamma, A., “Wrong-Way Driving: A Regional Transportation Systems Management and Operations Approach to A Regional Problem,” published in the Transportation Research Board 97th Annual Meeting Compendium of Papers AMOnline, Washington D.C., January 7-11, 2018.
- Wang, L., Abdel-Aty, M., Lee, J., & Shi, Q. (2017). Analysis of real-time crash risk for expressway ramps using traffic, geometric, trip generation, and socio-demographic predictors. *Accident Analysis & Prevention*, awaiting publication; acknowledgement of federal support (yes).

## UK

- Amiririds, K, Stamatiadis, N., and Kirk, A. 2018 “Safety-Based Decisions for Left-Turn Phasing,” submitted for publication to *Advances in Transportation Sciences*.
- Stamatiadis, N., Cafiso, D. and Pappalardo, G. 2017 “Use of Technology to Improve Bicycle Mobility in Smart Cities,” accepted for publication *Procedia*
- Stamatiadis, N. and Kirk, A. 2017 “Overcoming Practical Design Implementation Issues,” *Advances in Transportation Studies*, Vol. 39, pp. 5-14.
- Stamatiadis, N. and Psarianos, B. 2017 “Impacts of Design Exceptions on Highway Safety,” *International Journal of Transportation*, Vol. 5 (1), pp. 1-14.

### **2.b. Books or other non-periodical, one-time publications:**

Nothing to report.

### **2.c. Other publications, conference papers and presentations:**

## UTK

- Liu J. & A. Khattak, et al., Revisiting Hit-and-Run Crashes: A Geo-Spatial Modeling Method, 18-03009, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Kamrani M., R. Arvin, & A. Khattak, What measures of driving volatilities best explain crash frequency at intersections? 18-00089, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Khattak A., B. Wali, & H. Bozdogan, How is Driving Volatility Related to Intersection Safety in a Connected Vehicles Environment? 18-00058, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Boakye K., A. Khattak, & S. Nambisan, Correlates of Front-Seat Passengers’ Non-Use of Seatbelts at Night, 18-00405, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Wali B., A. Khattak, & T. Karnowski, How Driving Volatility in Time to Collision Relates to Crash Severity in a Naturalistic Driving Environment? 18-00060, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Wali B., A. Khattak, & X. Li, Exploring Non-Linear Dependencies in Correlates of Roadway Crashes: Application of Generalized Additive and Piecewise Linear Count Data Models, 18-00064, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Wali B., A. Khattak, D. Chimba, J. Waters, & X. Li, Development of Safety Performance Functions for Tennessee: Unobserved Heterogeneity & Functional Form Analysis, 18-00065, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Liu J., & A. Khattak, Mapping Location-Based Driving Volatility for Connected and Automated Vehicles, 18-00825, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Zhang M., A. Khattak, & E. Shay, Analysis of Crashes Involving Pedestrians across the United States: Implications for Connected and Automated Vehicles, 18-04721, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.

- Zhang M. & A. Khattak, Identifying and Analyzing Extreme Lane Change Events Using Basic Safety Messages in a Connected Vehicle Environment, 18-04734, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Hoque A., M. Ahmed, J. Rios-Torres, A. Khattak, & R. Arvin, Impact of Vehicle-to-Vehicle Communication Reliability on Safety Applications: An Experimental Study, 18-05532, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Kamrani M., A. Khattak, & T. Li, A Framework to Process and Analyze Driver, Vehicle and Road infrastructure Volatilities in Real-time, 18-00979, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Wali B., A. Khattak, & M. Zhang, Injury Severity Analysis of Pedestrian and Bicyclist Trespassing Crashes at Non-Crossings: Application of Predictive Text Analytics, 18-00209, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Ahmed M., A. Hoque, & A. Khattak, Intersection Approach Advisory Through V2X Technology Using Signal Phase and Timing (SPaT) Information at Fixed-Time Signalized Intersection, 18-05804, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Arvin R., M. Kamrani, & A. Khattak, & J. Rios-Torres, Safety Impacts of Automated Vehicles in Mixed Traffic, 18-00088, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Ahmed M., M. Hoque, J. Rios-Torres, & A. Khattak, A Cooperative Freeway Merge Assistance System using Connected Vehicles, 18-05614, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Kamrani, M., R. Arvin, & A. Khattak Analyzing Highly Volatile Driving Trips and Associated Factors, 18-00980, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Boakye K., A. Khattak, B. Wali, S. Nambisan, Are Education and Enforcement Strategies Effective in Increasing Night-Time Seat Belt Use? Evidence from a Large-Scale Before-After Observational Study, 18-06451, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Cherry, C., J. MacArthur (2017) Are E-bikes Unsafe? A review of European and North American Studies. International Cycling Safety Conference. Davis CA. Sept 21-22, 2017.
- Ling, Z., C. Cherry, N. Dhakal (2017) Avoiding Railroad Crossing Hazards to Cyclists. International Cycling Safety Conference. Davis CA. Sept 21-22, 2017.
- Azad, M., C. Cherry (2017) Do e-bikes matter for bikeshare safety? Early evidence from Baltimore Bikeshare system. International Cycling Safety Conference. Davis CA. Sept 21-22, 2017.
- Light Electric Vehicles: Asian and North American experiences. Africa Clean Mobility Week, UNEP. Nairobi Kenya. March 12-16, 2018. (invited).
- New Probe Data Sources to Measure Cycling Behavior and Safety. Queensland University of Technology CARRS-Q March 6, 2018.
- New Probe Data Sources to Measure Cycling Behavior and Safety. Portland State University TREC Seminar Series. Dec 1, 2017 .
- E-bikes and their role in shared and connected mobility. Korean Research Institute for Human Settlements Workshop. Seoul South Korea. October 12, 2017. (invited)
- The Latest Electrifying Research on eBikes and their Health and Transportation Impacts. Interbike Electric Theater. Las Vegas, NV. September 20, 2017. (invited)
- China's Motorization Wave and the Place of Emerging Technologies. Portland State University TREC Seminar. Portland OR. June 2, 2017. (invited)

- Keynote: E-bikes and motorization – The importance of new technology and behavior on safety. International Symposium on Frontiers of Road and Airport Engineering (iFRAE). Shanghai, China May 26-28, 2017. (invited)

## UCF

- Wu, J., Radwan, E., & Abou-Senna, H. (2018). Pedestrian–Vehicle Conflicts Prediction Model Based on Driver’s Avoidance Pattern at the Midblock Crossings. Presented at the 97th TRB Annual Meeting 2018.
- Wu, J., Radwan, E., and Abou-Senna, H. Analysis of driver’s avoidance behavior at mid-block crossings based on driving simulation experiment. Presented at the International Conference on Road Safety and Simulation (RSS), Netherlands, 17-19 October 2017.
- Abou-Senna, H, Radwan, E., & Mohamed, A. Developing a Safety Prioritization Tool for Pedestrian Sidewalk and Bicyclist Bike-Lane Gaps in Central Florida. Presented at the International Conference on Road Safety and Simulation (RSS), Netherlands, 17-19 October 2017.
- Roy, K., Hasan, S., Sadri, A.M., and Cebrian, M. Understanding the Effectiveness of the Social Media Based Crisis Communication During Hurricane Sandy. Accepted in Transportation Research Board 97th Annual Meeting, Washington D.C., January, 2018.
- Roy, K. and Hasan, S. Quantifying human mobility resilience to extreme events using geolocated social media data. Accepted in Transportation Research Board 97th Annual Meeting, Washington D.C., January, 2018.
- Lee, J., Abdel-Aty, M., Cai, Q., Wang, L., & Huang, H. (2017). Integrated Modeling Approach for Non-Motorized Mode Trips and Crashes in the Framework of Transportation Safety Planning. Presented at the 97th Transportation Research Board Annual Meeting, 2018.

## UK

- Amiridis, K., Stamatiadis, N., and Kirk, A. 2017 “Safety-Based Decisions for Left-Turn Phasing,” Proceedings of the Road Safety and Simulation 2017 Conference, Delft, Netherlands, October 2017.
- Amiridis, K., Stamatiadis, N., and Kirk, A. 2017 “Safety-Based Signalized Intersection Left-Turn Phasing Decisions,” Proceedings of the 97th Annual Meeting of the Transportation Research Board, Washington, DC, January 7-10, 2018.
- Blackden, C., Green, E., R. Souleyrette and W. Staats, “Automating Safety Performance Function Development to Improve Regression Models” Proceedings of the 97th Annual Meeting of TRB, Washington, DC, Jan. 2018. 14 pages.
- E. Green, N. Stamatiadis and R. Souleyrette, “Segment Length and Highway Safety Analysis: Does it matter?” RSS 2017, The Hague, Netherlands, October 19, 2017. Proceedings, 11 pages.
- Blackden, C., Green, E., R. Souleyrette and W. Staats, “Automating Safety Performance Function Development to Improve Regression Models,” poster presented at the 97th Annual Meeting of TRB, Washington, DC, Jan. 2018.
- N. Stamatiadis, “Safety-Based Decisions for Left-Turn Phasing,” Road Safety and Simulation 2017 Conference, Delft, Netherlands, October 2017. Presentation.
- E. Green, “Segment Length and Highway Safety Analysis: Does it matter?” RSS 2017, The Hague, Netherlands, October 19, 2017. Presentation.
- Mei Chen and students, “A Data Driven Approach for Quantifying the Impact of Crashes,” TRB 2018. Presentation.
- R. Souleyrette, “Safety Implications of the Transition to CAVs: KY CAV Crash Savings Demonstrator,” Northwestern University Transportation Seminar, February 22, 2018. Invited talk.
- R. Souleyrette, “Data Analytics in the Policy Process,” Session 525 at the 97th Annual Meeting of TRB, Washington, DC, Jan. 2018. Discussant.
- R. Souleyrette, “Data Analysis and Methodologies” SHRP2 Safety Summit, National Academies Transportation Research Board, Washington, DC, October 6, 2017. Moderator.

#### **2.d. Website(s) or other Internet site(s):**

There were no new websites created during this reporting period.

#### **2.e. Technologies or techniques:**

##### **UTK**

During the reporting period, we tested various connected and automated vehicle technologies in the field, on the UT Knoxville campus and the East Tennessee State University campus in Johnson City, TN. Dedicated Short Range Communications (DSRC) technology is being used along with new algorithms and applications for signal phasing at intersections, freeway merging systems at on-ramps, and for testing the reliability of DSRC on rural two-way two-lane roads. The work is reflected in the following papers (under submission to IEEE journals) and presentations at the 2018 Transportation Research Board annual meeting:

- A Cooperative Freeway Merge Assistance System using Connected Vehicles, Poster Session 392, Md Salman Ahmed, Mohammad Hoque, Jackeline Rios-Torres, Asad Khattak
- Intersection Approach Advisory Through V2X Technology Using Signal Phase and Timing (SPaT) Information at Fixed-Time Signalized Intersection , Poster Session 572, Md Salman Ahmed, Mohammad Hoque, Asad Khattak
- Impact of Vehicle-to-Vehicle Communication Reliability of Safety Applications: An Experimental Study, Lectern Session 755, Mohammad Hoque, Md Salman Ahmed, Jackeline Rios-Torres, Asad Khattak, Ramin Arvin

#### **2.f. Inventions, patent applications and/or licenses:**

Nothing to report.

#### **2.g. Other products:**

##### **UTK**

UTK faculty has installed ARADA Technologies in-vehicle, mobile, and roadside units for field testing of Connected and Automated Vehicles (CAVs), with assistance from computer science faculty at East Tennessee State University. Traffic and incident data from TDOT was obtained. The CAV units were successfully tested. The testing has resulted in several research papers presented at the 2018 TRB annual meeting. The relate to the following topics:

- Evaluating the communication reliability of safety-critical applications using Dedicated Short Range Communication.
- Development of safety applications for signalized intersections using signal timing data.
- Development of freeway merge assist system.

UTK professional service activity, peer-recognition, and enhanced visibility for the STC is reflected in editorships of high-quality refereed scholarly journals by UTK faculty. Dr. Khattak served as Editor-in-Chief of Journal of Intelligent Transportation Systems, Impact Factor = 1.769, & Associate Editor of International Journal of Sustainable Transportation; IF = 2.548), and as special advisor to the UTK-based Journal of Transportation Safety & Security (cites per document, 2016=0.668) and as editorial board member of AMAR-a safety journal.

UTK Civil & Environmental Engineering Department is well-positioned to take advantage of Connected and Automated vehicle technologies and worked collaboratively with faculty from Electrical Engineering & Computer Science Department as well as Mechanical Aerospace and Biomedical

Engineering toward research sponsored from various sources that include the National Science Foundation and Volkswagen.

UTK faculty have successfully obtained funding for transportation laboratory software and hardware for research and education projects, e.g., they have installed display equipment for traffic data in real-time and created a well-functioning transportation laboratory. The lab has modeling and simulation capabilities that include display and archiving of incoming operations feeds from Tennessee Department of Transportation, a driving simulator, and software capabilities, e.g., Accident reconstruction software ARAS, TransCAD, and TransModeler software.

UTK has access to several safety databases that include the SHRP-2 Naturalistic Driving Study data and the Tennessee Department of Transportation TITAN and E-TRIMS databases.

### 3. Participants and Other Collaborating Organizations

#### 3.a. Table of Collaborating Organizations

Organization Name	Location of the Organization	*Partner's Contribution to the Project	Name (First and Last)	University
National Science Foundation	Washington DC	Sponsor of projects; Support of Big Data from CAVs	Dr. Cynthia Chen	UTK
Tennessee DOT	Nashville TN	Matching project (HSM calibration) & data	Mr. Jim Waters; Mr. P.B. Freeze	UTK
ORNL	Oak Ridge TN	Collaborative support	Dr. Jacky Rios-Torres	UTK
INRIX	Kirkland WA	Collaborative support	N/A	UTK
US Dept. of Energy	Washington DC	Sponsor of projects	N/A	UTK
Knoxville Regional Trans Planning Org	Knoxville TN	Collaborative support & personnel time	N/A	UTK
Social Bicycles (SoBi)	New York	Collaborative support & data match	N/A	UTK
Georgia Tech	Atlanta	Collaborative support	N/A	UTK
CSCRS UTC	UNC-Chapel Hill, NC	Collaborative Support	Dr. Laura Sandt	UTK
Various Jiaotong Universities in China	Beijing, Nanjing, Guangzhou, Shenzhen, Changsha, China	Collaborative support & personnel exchanges	Dr. Xuedong Yang	UTK
Social Bicycles	New York	Data match, personnel time, and collaboration	Ryan Rzepeki	UTK
Community Action Committee	Knoxville TN	In---Kind Support, collaborative support	Karen Estes	UTK
East Tennessee Human Resource Agency	Knoxville TN	personnel exchanges	Aaron Bradley	UTK

Knoxville Area Transit	Knoxville TN	personnel exchanges	Melissa Roberson	UTK
e---HM consortium – see info below	Label Master, Blue Dot Solutions, etc.	Support of initiative		UTK
CURRENT (an NSF Engineering Research Center)	College of Engineering, UTK	In---Kind Support, collaborative support.	Dr. Chie---Fei Chen	UTK
TennSMART	Knoxville, TN	Collaborative support	Dan Miller	UTK
Center for Advanced Public Safety (at Univ. of Alabama)	Tuscaloosa, AL	Collaborative Support	Dr. Randy Smith	UA
Alabama Center for Insurance Information and Research	Tuscaloosa, AL	Collaborative Support	Dr. Lars Powell	UA
University of Alabama - Birmingham	Birmingham, AL	Collaborative Support	David Schwebel Despina Stavrinou	NCAT
Conference of Minority Transportation Officials (COMTO)	Washington, DC	Collaborative Support-Garett Morgan Youth Symposium and financial support - NCA&T Scholarship	Brad Mims, President/CEO of COMTO	NCAT
NC Department of Transportation	Raleigh, NC	In-kind support-presentations, financial support-internship program	JoAna McCoy, Director of Education Initiatives	NCAT
NC FHWA Division	Raleigh, NC	In-kind support-presentations, collaborative support	Lynise DeVance, Program Manager, Civil Rights Office	NCAT
Central Florida Expressway Authority (CFX)	4974 ORL Tower Road Orlando, FL 32807	Provided direct match for this project	Corey Quinn, P.E.	UCF
Enforcement Engineering, Inc.	Jacksonville, Florida	Has provided privileged wrong way data for analysis	Grady Carrick, Ph.D.	UCF
Department of Civil and Environmental Engineering	Terre Haute, IN	Collaborative research	Arif M. Sadri	UCF
MIT Media Lab	Cambridge, MA	Collaborative research	Manuel Cebrian	UCF
Vanasse, Hangen, Brustlin, Inc (VHB)	Weedsport, NY	Collaborative Support	Frank Gross	UK

**3.b. Additional collaborators:**



## NCAT

New collaborators this reporting period include Savannah State University, Institute for Transportation Research and Education (ITRE), Virginia Tech Transportation Institute, and Embry-Riddle Aeronautical University.

### 4. Impact

#### 4.a. What impact has your STC work had on the principal disciplines of the program?

## UTK

The “Comprehensive Transportation Safety” theme adopted by STC is addressing issues from a broad interdisciplinary perspective by researching and developing engineering (infrastructure and technological) as well as behavioral solutions to safety problems. The impact of our approach is in terms of developing a knowledge-base that can lead to reductions in injuries and fatalities. The UT team has worked individually and collaboratively with consortium members on conducting research issues related to the Southeastern United States and engaging a wide variety of stakeholders and the professional community through technology transfer. The work undertaken at UT is improving safety through research on Highway Safety Manual (HSM) procedures, safety simulations, big data applications, and exploring the role of socio-demographics in safety. These multi-disciplinary research activities underway with diverse consortium partners is creating the knowledge-base and foundation needed for innovations in safety countermeasures and making methodological advances in safety modeling, simulation, and visualization. Notably, the impact of safety research and development should be felt in multiple modes of transportation and by multiple stakeholders.

Stakeholder involvement is reflected in the Tennessee Department of Transportation buy-in of the safety approach and investing matching funds in adoption and calibration of the Highway Safety Manual. During the reporting period, the UT research team has worked on the following research papers related to the HSM project:

- Wali B., A. Khattak, D. Chimba, J. Waters, & X. Li, Development of Safety Performance Functions for Tennessee: Unobserved Heterogeneity & Functional Form Analysis, 18-00065, Presented at *Transportation Research Board annual meeting*, National Academies, Washington, D.C., 2018. Accepted for publication in *Transportation Research Record*, TRB.
- Wali B., A. Khattak, & X. Li, Exploring Non-Linear Dependencies in Correlates of Roadway Crashes: Application of Generalized Additive and Piecewise Linear Count Data Models, 18-00064, Presented at *Transportation Research Board annual meeting*, National Academies, Washington, D.C., 2018.
- Boakye K., A. Khattak, B. Wali, S. Nambisan, Are Education and Enforcement Strategies Effective in Increasing Night-Time Seat Belt Use? Evidence from a Large-Scale Before-After Observational Study, 18-06451, Presented at *Transportation Research Board annual meeting*, National Academies, Washington, D.C., 2018.
- Wali B., A. Khattak, & T. Karnowski, How Driving Volatility in Time to Collision Relates to Crash Severity in a Naturalistic Driving Environment? 18-00060, Presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.

During this time, the UT team worked on a methodological paper related to the project that was accepted for publication in a premier safety journal:

- Liu, J., A. Khattak, and B. Wali, Do Safety Performance Functions Vary Across Space? Application of Geographically Weighted Regressions. *Accident Analysis & Prevention*, Volume 109, 2017, pp. 132–142.

As another example, findings from the STC Big Data major research initiative are creating new metrics of driving volatility. These can be used in real-time to support instantaneous driving decisions. This work is providing new analytics (driving volatility) using big data coming in from sensors to enhance safety. During the reporting period, the UT research team worked on the following research paper related to the big data project, which was accepted for presentation at the TRB annual meeting:

- Kamrani M., R. Arvin, & A. Khattak, What measures of driving volatilities best explain crash frequency at intersections? 18-00089, Presented at *Transportation Research Board annual meeting*, National Academies, Washington, D.C., 2018.

Overall, by leveraging the resources available through the STC, the on-going research activities are expected to produce a strong impact on the principal disciplines of the program.

#### HSRC

We hope that our work will lead to a better understanding of pros and cons of different methods for developing CMFs.

#### NCAT

The texting while driving (TWD) study has generated interest by other researchers at institutions such as Savannah State University. They are currently building on our research study to identify additional factors that may impact teenage driver safety.

The data from the pedestrian study has already provided some evidence illustrating the negative effects of personal listening devices on pedestrian safety. It is expected that the larger study will provide support for the use of alternative listening devices that will lessen the effects of walking while listening to music.

#### UCF

Our MRI#2 research provides an added dimension for using driving simulator to analyze pedestrian safety from the driver's point of view. The lack of pedestrian safety data has been a major hurdle for researchers to better quantify pedestrian crash rates. In addition, this research provided a 3-legged stool summarizing three different kinds of data to evaluate pedestrian safety, including field data, simulation data, and driving simulator data.

The work on our O&E grant will have an impact on disaster management by an effective use of social media. This project provides new algorithms to analyze social media data for disaster management applications. It will also provide critical insights on social media communication during disasters.

Our MRI#4 research proves the potential of using Big Data for the integration of transportation planning and traffic safety analysis. The application of Big Data from multiple sources enables to provide valuable insights and research direction in the field.

#### USF

Two potential outcomes from this research could be useful to the study of pedestrian crashes in general. It is well established that speed kills. We try to extend that knowledge by exploring how speed may impact pedestrian crashes differently in areas with different socioeconomic factors. It is common for statistical analyses of pedestrian crashes to use more aggregated measures of socioeconomic factors in much less aggregated crash analyses. Any lessons learned from this research would contribute to this common practice.

#### **4.b. What impact has your STC work had on other disciplines?**

## UTK

UT's research team is engaged in a wide spectrum of disciplines. UT's safety work underway is relevant to public health and social sciences; e.g., findings from the studies on injury creates new knowledge for the public health field. Studies on the role of socio-demographics in safety creates a new social science-based knowledge. Analysis of spatial/geographical aspects of safety impacts the field of geography. Another example is the application of modeling, simulation, and visualization techniques to safety. These can improve transportation operations (e.g., incident/accident management), transportation planning and sustainability (e.g., by considering the costs of injuries and death and potential improvements in facility design) and link with epidemiology and health.

## HSRC

Cross-sectional and before-after methods are used in other fields as well. We hope our work will provide insights that other fields can benefit from.

## NCAT

The TWD study has already piqued the interest of other business school researchers and the methods employed in the study are currently being used to expand the study. The pedestrian study has a strong focus on communications thus allowing the results to potentially impact on the types of communication devices that will be developed in the future. The results of the study are likely to encourage headset designers to develop new headsets that will further decrease the deterioration of situation awareness that typically occurs when these devices are in use.

## UCF

The research conducted on pedestrian safety and how to utilize different safety measures using field data together with microsimulation and driving simulators has shed the light on the challenges and opportunities researchers and practitioners face when dealing with pedestrian safety. The outcome of this research will help us rethink how to design research experiments and what to take into consideration to secure credible data.

### **4.c. What impact has your STC work had on transportation workforce development?**

## UTK

Our "Comprehensive Transportation Safety" approach is integrated into relevant transportation courses taught at UT. Currently, the University of Tennessee Transportation Engineering and Science Program has 18 graduate students. Nine graduate students recently completed their degree requirements, quite a few of whom were doctoral students.

There are above 240 undergraduates (sophomore –seniors) in Civil and Environmental Engineering that are exposed to transportation safety through their required undergraduate transportation course.

The Civil & Environmental Engineering faculty offered 10 transportation courses during Spring 2018 and Fall 2017: Transportation Engineering I and II; Transportation Engineering II Lab; Transportation Seminar; Traffic Engineering Characteristics; Geometric Design; Transportation Planning; Transportation Safety; Analysis Techniques for Transportation Planning System II; and Intelligent Transportation Systems.

Additionally, the UT faculty has presented extensively at various conferences attended by students and practitioners. For example, Dr. Khattak and collaborators presented upward to 20 technical papers

at the 2018 TRB annual meeting in Washington, D.C. Asad Khattak attended the 5th Annual UTC Conference for the Southeastern Region in Gainesville, FL., in November 2017. Four of his graduate students presented posters at the conference. Other student/workforce development opportunities include

- Nearly 30 students traveled to TRB.
- Students were able to attend the 7th Annual Transportation Camp at George Mason University before the Transportation Research Board Conference. This event has over 400 attendees in the field of transportation and technology allowing students to network.
- Supported eight students from the UTK Institute of Transportation Engineers (ITE) chapter to travel and present at the Regional Southern District ITE Conference. They presented technical research and competed in the regional Traffic Bowl Competition.
- Supported nine UTK ITE Student Chapter meetings in the Fall and Spring Semester. The meetings were held to promote further learning and career development into the transportation engineering realm. Presenters include employees of Tennessee Department of Transportation (TDOT), City of Knoxville, Knoxville TPO, Federal Highway Administration, and local consulting firms.
- Students were able to attend the Tickle College of Engineering's WomEngineers, a dinner in Neyland Stadium for incoming and transfer female engineering students to meet and network with UT faculty and students.
- Students established a Women's Transportation Seminar Student Chapter at the University of Tennessee in the Fall 2017 semester.

#### NCAT

The pedestrian study has enabled us to reach students outside of the typical disciplines that focus on transportation in order to pique the interest of students in other disciplines. The student who is conducting the study as well as several of those who have participated in the study have expressed an interest in the work.

#### UCF

Produced one PhD student with the support of the STC. He is currently working as a post-doctoral research associate and continues to work on this project. Two of our MS thesis graduates joined the industry and both worked on this project.

#### **4.d. What impact has your STC work had on physical, institutional and information resources at your university or partner institutions?**

#### UTK

The STC consortium has fostered fruitful collaborations and established strong links between UTK and different consortium universities and within the UT system. This federal grant has helped build bridges across disciplines and also allowed UT to acquire new laboratories, equipment, and space needed for growth of our offerings in transportation.

#### UA

STC work has been the basis of new collaborative relationships between the Department of Civil, Construction, and Environmental Engineering and two entities within the business school at UA (Alabama Center for Insurance Information and Research)

## UCF

The recruitment of students and other participants in the driving simulator experiment provided further exposure and raised more awareness on Campus for pedestrian safety. We are planning to share our experiences in collecting, processing, analyzing Big Data, and developing an integrated model using Big Data with other colleagues at our university.

## USF

STC resources have allowed us to enhance our overall reputation and work program in transportation safety. This has included supporting students.

### **4.e. What impact has your STC work had on technology transfer?**

## NCAT

The TWD study has the potential to lead to the development of customized training protocols to discourage teenagers from texting while driving. The pedestrian study has the potential to lead to the development of a communication device that will enable enjoy listening to their personal media devices without significantly decreasing their situational awareness.

## UA

Work related to MRI 3 (socio-economic factors affecting crashes) has been applied to the recently published Alabama Strategic Highway Safety Plan for the State of Alabama funded by the Alabama DOT.

## UCF

This research will help in sharing the methodology of collecting traffic related data from multiple sources for safety analysis and building safety models, with colleagues at other universities. A model that can combine field data, microsimulation data, and simulator data and predict conflicts will be shared as well as a framework to accomplish this task complementing prior experience from respective efforts.

### **4.f. What impact has your STC work had on society beyond science and technology?**

## UTK

Socio-demographic, attitudinal, and behavioral research on safety are improving public knowledge and providing a fundamental understanding of how to improve safety from broad social, economic, spatial, health, and behavioral perspectives. Highway Safety Manual improvements is leading to knowledge about reductions in hazards and application of new countermeasures that can save lives. The Big Data applications in safety inspires innovation and new ways of approaching safety by combining information from diverse databases, which are increasingly generated by Connected and Automated Vehicles. Safety simulations are leading to a better understanding of vehicles' interactions, why collisions occur, how to better respond to them, and their consequences. Simulations advance the knowledge and skills of people who work in the safety field, and facilitate the study of human factors. Our efforts in modeling, simulation, and visualization provide inputs to help formulate regulatory policies that lead to safety improvements.

## UCF

Because pedestrian safety is a major issue in central Florida, the FDOT match project for this STC initiative resulted in developing a safety prioritization tool (SPT) for pedestrians and bicyclists which

prioritizes locations with missing sidewalks and bike lanes that have significant safety impacts. Wrong way driving is a serious problem. This research will save lives.

## **5. Changes/Problems**

### **5.a. Changes in approach and reasons for change**

#### **USF**

As noted above, the analysis modeling for MRI 3 is being driven by both data availability and early results of data analysis. The challenges associated with fully understanding pedestrian safety have perplexed transportation safety analyses for years, thus, the extent extremely deliberate and careful approach being used here should help inform methodologies with respect to safety studies.

## **6. Additional information regarding Products and Impacts**

### **6.a. Outputs:**

#### **UTK**

Weekly Transportation Safety Seminar Series (Led by UTK)

Fall 2017 Seminars at UTK:

- September 7 - Dissertation Overview, Bumjoon Bae and Meng Zhang, UTK PhD Candidates
- September 14 - Studying the Impacts of Connected and Automated Vehicles, Dr. Jackie Rios-Torres, Oak Ridge National Laboratory Research Scientist
- September 21 - Monitoring Drivers' Vital Signs during Driving, Dr. Aly Fathy, UTK Electrical and Computer Engineering Professor
- September 28 - Predicting Traffic Flows in the North American Railway Network, Dr. David Clarke, UTK Civil and Environmental Engineering Professor
- October 12 - Big Data Approaches to Understanding the Intersection of Bikesharing and Public Transit, Dr. Candace Brakewood, UTK Civil and Environmental Engineering Assistant Professor
- October 19 - Automotive Vehicle Safety: Lessons Learned from Aerospace Systems, Dr. Mark Whorton, University of Tennessee Space Institute Director
- November 2 - Transportation Infrastructure Management: From Policy to Technology, Dr. Shuai Li, UTK Civil and Environmental Engineering Assistant Professor
- November 9 - The Buckle Up Tonight to See Tomorrow Campaign, Dr. Jerry Everett and Christine Waxstein, UTK Center for Transportation Research
- November 16 - Freight in Tennessee, Daniel Pallme, Tennessee Department of Transportation

Spring 2018 Seminars at UTK:

- February 1 - 2018 Transportation Research Board Conference Experiences, UTK Graduate Students
- February 8 - Challenges of Roadway Construction in Area with Sulfur-Bearing Formations: Investigation and Mitigation Techniques, Jim Ozment
- February 15- Social Media and Crowd-Sourced Data in Transportation, Dr. Christa Brelsford, Oak Ridge National Laboratory

- February 22 - Transportation Infrastructure: Data to Pave the Way Forward, Pat Hu, US DOT Bureau of Transportation Statistics
- March 8 - Some Creative Thinkings in Mobility Data Analytics, Dr. Ho-Ling Hwang, Oak Ridge National Laboratory

### UCF

We have applied an approach (developed in this project) over mobile phone data collected in Senegal. The mobile phone data was given to the team by Orange mobile company as part of “Data for Climate Action Challenge (D4CA)”. Our submission has been recognized as an honorable mention in the challenge.

#### **6.b. Outcomes:**

### UCF

- Driver’s avoidance behavior pattern was investigated during the pedestrian-vehicle conflict.
- Driver’s characteristics variables (age and gender) and potential risk factors (time of day, marking, roadway type, and dressing color) were studied.
- Pedestrian-vehicle conflict prediction model is developed based on the midblock crossing experiment data. The model has a reliable prediction performance and can be tested in connected vehicles as a vehicle alert system.
- A framework for the process of the pedestrian safety evaluation based on the field data, micro-simulation data, and driving simulator data will be developed.
- A Safety Prioritization Tool (SPT) for sidewalk/bike lane gaps was developed through the FDOT match project.
- Improved understanding of social media use during hurricanes.
- Safer travel on high speed roads.

#### **6.c. Impacts:**

### UCF

- More accurately predict potential conflicts leading to pedestrian crashes through microscopic data.
- Effective countermeasures resulting from the driving simulator experiment could be implemented in the field.