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 #8

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

This document summarizes the activities that the Southeastern Transportation Center (STC) has initiated, continued, or completed during the past six months. STC is USDOT's Regional UTC representing the eight southeastern states, and is led by the University of Tennessee, Knoxville (UT). We are a strong consortium of exceptional universities striving to fulfill the mission of the University Transportation Center Program in Region 4, with a special emphasis on our programmatic theme, **comprehensive transportation safety**. As the STC grant end date approaches, we have maintained a full agenda of activities in all four of our program areas: research, education, work force development, and technology transfer.

STC faculty, staff, and students worked to accomplish the goals of our regional UTC. We participated in bi-weekly consortium member meetings, provided content social media for dissemination of information that improves safety, and we engaged in extensive research, education, and outreach activities. Work on major research initiatives resulted in publications and presentations and the development of new technology products that have far reaching impacts on transportation safety in our region and nationally. Recently, we expanded our "Comprehensive Transportation Safety" research focus area to include targeted research on advanced technologies and associated driver behavioral issues related to safety.

The full scope of our work will be reflected in more than 30 presentations on transportation safety to be made at the 2018 Transportation Research Board (TRB) annual meeting. On the education side, many students are conducting research and benefiting from experiential learning that comes with publishing their research results and participating in technical conferences and other appropriate outreach forums.

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

Major Research Initiatives (MRI)

STC has four active MRIs, all of which are multi-year, multi-university major research projects. Each MRI is led by a Coordinator or Co-coordinators, with assigned Principal Investigators overseeing the work performed by each university partner. These initiatives are continually coordinated and progress is reviewed quarterly. With the completion of each program year, all initiatives are assessed (semi-quantitatively) and refinements are made to ensure focused progress and project success.

MRI 1: Crash Modification Factors and the Highway Safety Manual

UT

Recent research focused on work zone assessment procedures in the HSM, verification of previously developed Safety Performance Functions, variations in SPFs in space, in-depth functional form and heterogeneity analysis, and performance comparison of different

calibration methodologies as well as localized SPFs focused on two-lane rural roads. The new ideas related to spatial heterogeneity, functional form analysis in development of safety performance functions, and disentangling non-linearity from unobserved heterogeneity can guide the methodological advancements related to HSM predictive methods. The aforementioned ideas related to HSM methodological advancements are accepted for publication and/or presentation in peer-reviewed journals (conferences) and which indicates the value of our work and its relevance at regional and national levels.

UK

A literature review was completed related to evaluation of non-engineering CMFs and SPFs. Databases were developed for socioeconomic and demographic factors considered relevant to predict crashes. Prior work performed as part of MRI 1 on the relationships between socio-economic variables and their effectiveness as predictors of crashes was incorporated into the current project. Analysis from the previous work as part of MRI 1 was determined to be inconclusive; however, the decision was made to continue to investigate and expand on the topic as part of the current project.

Work was completed on linking socio-economic characteristics from TIGER Census data (referenced by zip codes) with Kentucky driver crash data (includes driver's home address and zip code). Initial efforts began on modeling the two datasets in a safety performance function.

Synergistic with a project for the KY Transportation Cabinet to implement the Highway Safety Manual, a draft report was produced that included applications of the HSM and recommended processes to incorporate into standard safety analyses.

MRI 2. Integrated Simulation and Safety

UT

Simulation has evolved into a productive tool for predicting and evaluating safety on roadways and street networks. Simulation aptly defines human actions, addresses the effectiveness of roadway design and traffic operations on transportation safety, and helps to develop surrogate safety measures. Judicious and creative implementation of simulation tools holds great promise for enhancing HSM methodologies and approaches. Projects within this initiative evaluate the use of simulation in assessing and possibly predicting safety levels for roadway environments for pedestrian and bicycle conflicts with vehicular traffic; review of commonly used simulation tools and their capability to model incidents, accidents, and traffic operation under large-scale incidents requiring evacuations; and are developing vehicle-to-vehicle crash prediction models for intersections. Projects have resulted in an interim draft report that has been updated, papers and abstracts have been submitted and student theses have been initiated and completed. A substantial amount of analysis has been completed and/or nearing completion that compares real world cases with simulation scenarios. This will assist in determining the efficacy of simulation for intersection design.

UCF

This period included Year 3 of the project. Tasks 1 and 2 are accomplished, including the Literature Review and Pedestrian-Vehicle Prediction Model Development. As noted previously,

the main goal of this research effort is to evaluate the use of simulation in assessing and possibly predicting safety levels for pedestrian environments. The study objectives that contribute to this main goal include the following- 1) development of crash prediction models based on simulation for vehicle to pedestrian crashes; 2) evaluation of human centered simulation for pedestrian conflicts for roadway projects; and 3) development of incident and emergency simulation models for better understanding and management of such situations with safety considerations.

In summary, the research team used the driving simulator data to investigate the driver's avoidance behavior at the midblock crossings. Typical examples of drivers' deceleration rate associated with the distance to crosswalk were summarized, which exhibited a clear drivers' avoidance pattern during the vehicle pedestrian conflicts. This pattern was summarized into four stages, including the brake response stage, the deceleration adjustment stage, the maximum deceleration stage, and the brake release stage. These four stages show how drivers react to the pedestrian conflict. Based on the driver's avoidance behavior pattern, four key variables are extracted from the data, which include deceleration adjustment time (t_2), maximum deceleration rate (d_m), maximum deceleration time (t_3), and brake release time. Then the pedestrian-vehicle conflict prediction model is developed based on the midblock crossing experiment data. The minimum distance between the pedestrian-vehicle conflict event was selected to evaluate each conflict. The results identified the significant effects of age, gender, dressing color, initial speed, initial location, t_2, d_m, and t_3 on the minimum distance between the pedestrian and the vehicle. It is found that drivers over 40 years old have a larger minimum distance than the drivers who are under 40 years old and female drivers are more likely to have a longer minimum distance than male drivers. In addition, the pedestrians wearing dark color clothes have a smaller minimum distance than pedestrian wearing bright color clothes, indicating that pedestrian wearing dark clothes may affect the drivers' avoidance performance and lead to the pedestrian to be in a more dangerous situation. Finally, the relative absolute error was used to validate the prediction model and the results indicated highly acceptable prediction performance.

UK

In the current report period, we completed data for crash and conflict models; developed crash prediction models; submitted papers to TRB and Transport Research Arena conference.

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

USF

The southeastern US has the highest roadway incident and injury rates in the country. While this disparity in roadway safety has been explored numerous times, these studies most often investigate the physical design characteristics of the transportation infrastructure. Some studies focus on the weather, government policies (e.g., speed limits, seat belt law), and the role of human factors in designing the infrastructure or vehicles. When socio-demographic characteristics are considered, they are typically limited to gender, age, and race or ethnicity. The results have not provided a comprehensive picture or convincing explanation for regional safety performance differences.

The research effort underway with this initiative expands this limited set of characteristics to include socio-demographic characteristics, risk-taking and health characteristics, land use patterns, and other measures that consider the culture and values of the population as potential explanatory factors. Specific projects now underway include the determination of the extent to which population characteristics might explain differential safety performance (dataset development and comprehensive analysis). Research work includes a special focus on motorcycles and heavy vehicle safety. Multiple papers are in various stages of submission and review that includes publication in a major peer reviewed journal. This program area was developed from the beginning with a multi-year progressive research intent. Significant products, outcomes and impact are anticipated.

During the current reporting period, the USF team completed the final report for MRI3 Year 1 and Year 2 research efforts, which documents and summarizes our work undertaken to address the above described objective.

For the Directed MRI Grant: 2017-2018, Probability of Pedestrian Deaths and the Role of Socioeconomic Factors – A Disaggregated Approach, we did a literature review, assembled the data from various sources, and identified key explanatory variables. We obtained all crash data from the Crash Analysis Reporting (CAR) System of the Florida Department of Transportation from 2011 through 2015 and obtained 2011-2015 five-year estimates of socioeconomic and demographic data at the census tract level from the American Community Survey. We merged the ACS data into the crash data through working with the location coordinates of individual crashes and started cleaning the merged data based on the identified key variables.

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

Along with the potential benefits of big data come issues related to large data volumes, high data velocities, varied data types and formats, and the veracity of the data's accuracy and reliability, thus making big data and the proactive applications that rely upon it vulnerable to interruption, overload, and misuse. As part of MRI 4, the STC is exploring many of these issues.

UT

The UT MRI 4 research team continued work on multiple tasks including the following: assessing and investigating data sources and scenarios for how different data types can contribute to improving safety; macroscopic safety analysis and real-time crash risk analysis (including pedestrians); analyzing real-time travel time data quality collected from license plate readers, Bluetooth readers, probe vehicles, INRIX database, NAVTEQ, Remote Traffic Microwave Sensors (RTMS).

UCF

UCF has completed their MRI 4 tasks. No work was underway during the current report period.

UK

During the current reporting period, the simulation model UK's team built tested the application of BSM data on intersection safety analysis.

Opportunity and Exploratory (O&E) Grants

O&E Grants are typically awarded to a single university, are one year long, and have one PI. Oftentimes, graduate students receive some support for participation in the research.

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 is a work is currently in progress with 2 graduate Civil Engineering students and an ORNL researcher (Dr. Rios-Torres) contributing to the project. The research activities undertaken in this O&E has resulted in a research article that was accepted for presentation in the 2018 TRB Annual Meeting:

Can You Hear It Now? A Study of Personal Listening Devices and Pedestrian Safety. Maranda McBride, PI

The STC O&E study titled "Can You Hear It Now? A Study of Personal Listening Devices and Pedestrian Safety" was initiated in April 2017. One graduate student and one undergraduate student worked on the project. Equipment was purchased and a pilot study was conducted. The pilot study gave the students an opportunity to become familiar with the equipment and procedures that must be followed during the course of the experiments. A preliminary analysis of the data was performed to identify areas of the procedure that may need to be modified.

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

Two major activities were completed on this projects as follows. First, we developed a method to assess the efficiency of social media communication during disasters and identify the contributing factors leading to effective disaster communication strategies. Second, we developed a methodology and an algorithm that can detect extreme events and measure mobility resilience metrics from geo-located social media data.

Evaluating the Potential of Connected Vehicles in Combating Wrong-Way Driving. Haitham Al-Deek, PI.

Several accomplishments have been made to date. Specifically, 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. Several journal papers were submitted to TRB 2018 for

possible presentation and publication in TRR. We made two progress presentations to CFX, the matching fund sponsor of this research, in May and September 2017.

Education & Workforce Development

UT

The UT transportation program graduated six Masters and two Ph.D. students during this reporting period.

Clemson

Clemson University students won the Southern District ITE Traffic Bowl and were invited to Toronto to compete in the International ITE Traffic Bowl. Four students and Dr. Jennifer Ogle made the trip to Toronto to represent the STC and the Southern District. The students won their first match and made it to the finals, but were ultimately defeated. While in Toronto, the students presented posters and spent some time sightseeing in Canada.

Several research projects that have been under development over the course of the last year were completed and submitted as TRB papers for TRB 2018 as shown in Journal Publications.

The last bit of funding was used to have students collect data for a student accessibility services application on the Clemson Campus. Students used GIS, smart levels, and wheelchairs to determine the difficulty level for traversing campus – particularly between accessible parking and building access. Recommendations were made for accessible parking changes, sidewalk and ramp upgrades, and development of an online portal to house all of the grade and slope data that was collected.

HSRC

During the period from April 1, 2017, to September 30, 2017, the UNC Highway Safety Research Center completed two rounds of its Road Safety 101 course and prepared to launch a third. The two completed courses reached a total of 55 students from a variety of backgrounds, including planning, engineering, public health and law enforcement.

As noted during the previous reporting period, HSRC launched one round of course delivery in March 2017. This course ended in April 2017, and reached a total of 28 students – a larger group than previous classes. Despite the larger than normal group size, the course ran very well and we anticipate increasing the class size in the future.

While the March/April course was wrapping up, HSRC was collecting applications for another round of training set to begin in May 2017. We successfully completed that course offering, which enrolled a total of 27 students from a similarly diverse background. This course wrapped up in June 2017, and was followed by a break in course offerings during the Summer.

During this time period, HSRC also opened applications for its next offering of Road Safety 101, which is scheduled to take place from October to November 2017. By the end of this reporting period, HSRC had already held its Orientation with the new students. More information about this course offering will be included in the next progress report.

Fourteen undergraduates were granted the Southeastern Transportation Center (STC) Education Award in the fall semester. Two freshman supply chain and former Summer High School Transportation Institute (STI) participants were granted the STC Incentive Award. This award goes to an incoming freshman who meets the SAT/ACT score requirements as well as the high school GPA requirement. Students who have attended the STI program are given first priority in the selection process. Each awardee will receive faculty mentoring through research opportunities, internships advisement and experiential learning activities. This fall there is one civil engineering student participating in the **Transportation Research Board Minority Student Research Fellow** program. He is responsible for writing and submitting a research paper for presentation at TRB. Additionally, we were approved to administer the Dwight David Eisenhower Fellows for the 2017-18 academic year. A former STC Education Award recipient has applied for this Fellowship.

Workforce Development and Outreach:

This year marked the 25th anniversary of the STI at North Carolina A&T State University. Twenty-seven students applied to the 2017 Summer High School Transportation Institute (STI). Sixteen were selected, nine girls and seven boys. The program focused on the modes of transportation and the safety aspect of each mode. Students researched careers in each mode and attended lectures and presentations by university faculty, federal, state, local and corporate partners. The highlight of the summer was the Washington, DC field trip where the participants learned about intercity travel with the Washington Area Metropolitan Area Transit Authority (WAMATA) Metro service. They learned to map their trip and plan a route using the system's color coded subway lines. Additionally, they visited the Turner-Fairbank Highway Research Center, participated in an intermodal trip to Baltimore which demonstrates how to move from city to city without the use of a car, WMATA Emergency Response Training Facility, National Air and Space Museum and the National Museum of American History, which houses an exhibit on the history of transportation in the United States. They also visited the Norfolk Port system on the way to Washington, DC.

The work with the Garrett A. Morgan Technology and Transportation Education Program (GAMTTEP) Clearinghouse continued with Knox County. From April through September, six Transportation Blogs were developed for the Knox County Garrett A. Morgan Technology and Transportation Education Clearinghouse Project. The topics for the transportation blogs were: (1) Transportation Plays a Vital Role in Supply Chain Management, (2) Certain Systems Greatly Help the Transportation Industry, (3) There are Transportation Models that Save the Environment, (4) Technology has Significantly Impacted Modern Transportation, (5) Third Party Logistics Providers are Valuable in Transportation, and (6) Transportation is Important in the Healthcare Industry. In addition to the transportation blog development, two lesson plans were created. The first lesson plan designed for Middle School Algebra courses and is *Minimizing Transportation Costs (Warehouse to Retailers) Using Mathematical Analysis*. The second lesson plan, *Analyzing the Carbon Dioxide Levels in Multiple Gas Sources,* will be used in High School Chemistry courses.

One PhD student was supported with STC funding during the current funding period, working on projects related to the Highway Safety Manual. One PhD student working on an STC-funded Project (MRI 3) graduated in August 2017.

UK

A new STC-supported MS student started working on modeling connected vehicle in simulated environment. Synergistic with a project for the Kentucky Transportation Cabinet on incident management data assessment.

1.c.   Have the results been disseminated? If so, in what way(s)?

Most results have been in the form of papers and presentations; these are listed in Section 2.

UT

UT hosts "Engineering Day" each year to give university students and faculty time with high school students interested in pursuing engineering degrees. The 2017 Engineers day will have approximately 1,500 students from various high schools and even home schoolers.

We participated in the Fall 2017 Freshmen Engineering Fair sponsored and hosted by the UT College of Engineering. We also participated in the Transit Day at Knox County Schools. In this unique and productive outreach activity, students learn about the transit system in Knoxville while being able to board one of the trolleys.

We also participated in the STEMpunk Reverse Science Fair. This Fair is for high school students who want to pursue engineering as a major. This event allows students to get a hands-on experience of research activities being conducted at the university. Some of the research being exposed include: transportation efficiency through electric bicycles and autonomous and connected vehicle technology through a driving simulator.

Clemson

Collegiate Traffic Bowl Story submitted for SDITE Newsletter. Accessibility data provided to Clemson University Offices of Access and Equity and Parking and Transportation Services.

NCAT

The 25th STI Anniversary celebration was communicated through invitation to parents, local, state, and federal officials, program partners, university news media, and word of mouth. This resulted in more than 130 attendees present to learn about the accomplishments of the Summer High School Transportation Institute over the past 25 years.

GAMTTEP lesson plans and blog postings were disseminated via the internet reaching countless interested readers.

Dr. McBride presented the results of the Texting While Driving study at the Applied Human Factors and Ergonomics Conference on July 19, 2017 in Los Angeles, California.

Lemuria Carter presented the results of the Texting While Driving study to approximately 25 professors and doctoral students in the School of Information Systems and Technology Management in the University of New South Wales in Sydney, Australia on September 26, 2017.

UCF

Based on the results of the O&E Disaster Analytics project, two articles have been submitted to TRB Annual Meeting and a poster presentation will be made at the Midwest Big Data Hub All-Hands Meeting on Oct. 2-3 at Omaha, Nebraska.

The O&E Wrong Way Driving project produced several journal papers that were submitted to TRB 2018 for possible presentation and publication in TRR. In addition, UCF made two presentations to CFX in May and September 2017.

UK

Results from case study applications of HSM methods for design projects were documented in draft report form and delivered to KYTC representatives. Analyses were performed to evaluate safety countermeasures (implemented as part of Kentucky's Highway Safety Improvement Program and disseminated by documentation in the online annual report) with application of HSM benefit-cost methods.

USF

The final report for MRI3 Year 1 and Year 2 research efforts was completed and disseminated through STC/UTC channels. Results were presented at the STC research conference.

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

HSRC

The next offering of Road Safety 101 is scheduled to take place from October to November 2017. More information about this course offering will be included in the next progress report.

NCAT

Several STC students will be participating in developing research papers for TRB and the TRB minority research fellows program. Faculty mentors will support these students during the next reporting period. The Center for Advanced Transportation Mobility (CATM) will host its annual symposium on October 17th. STC and CATM students will participate in the student poster session as well as serve as ambassadors to the symposium guest. Other planned activities will involve participation in the Southeast Regional Conference, the Transportation Research Board Meeting, and planned site visits to transportation/supply chain entities that will broaden students' knowledge and perspective to the discipline.

The graduate student working on the STC O/E project is expected to present a poster during the Poster Exhibit at the Southeast Regional Conference. Other students working on research projects within CATM may also be presenting posters at the regional conference. Additionally, developing partnerships and proposal writing for 2018 STI will occur during the October-March performance period.

Revisions will be made to the Texting While Driving manuscript so it can be resubmitted to the Transportation Research Record: Part F during the next reporting period. The reviewer comments will guide the authors as they strive to improve the article for publication.

Work on the Pedestrian Safety study will continue. The graduate student is expected to propose her thesis based on this project during the next reporting period. The method will be adjusted based on the results of the pilot study and additional participants will be recruited to participate in the experiment.

UCF

MRI#2 -The plan is to develop a model that can combine field data, microsimulation data, and simulator data to predict pedestrian-vehicle conflicts. Consolidate the significant parameters from the three approaches and determine the best way forward in order to maximize gains. UCF team will develop a framework and identify means to accomplish this task complementing prior experience from respective efforts from Years 1 and 2.

O&E (DA) - During the next reporting period, we plan to submit two journal articles and develop an advanced text mining algorithm to detect different phases of disaster management: preparation, response and recovery.

O&E (WWD) - We plan to revise the TRB papers once we receive the results of the reviews and resubmit again by the new deadline of November 15, 2017. Also, the plan is to continue collecting data about the WWD countermeasures and analyzing it.

UK

Efforts on MRI 1 will focus on analysis and development of SPFs to predict crashes based on socio-economic and demographic factors. Initial work will begin on drafting a report to summarize the literature review and analysis results. We will evaluate models developed and synthesize research findings for MRI 2. We will continue with the simulation modeling for MRI 4.

USF

We plan to complete the Directed MRI Grant: 2017-2018, Probability of Pedestrian Deaths and the Role of Socioeconomic Factors – A Disaggregated Approach. Research publications and presentations are planned. One research paper is planned to possible publication in a scholarly journal, which will depend on the results. The research will be presented, at a minimum, through the CUTR Webcast series.

2.   Products: What has your STC work produced?
2.a.   Journal publications:

UT

Relevant papers from MRI 1 published or (accepted to be) presented:

- Wali. B., Khattak, A.J., Waters, J., Chimba, D., Li, X. (forthcoming) (2018). Development of Safety Performance Functions for Tennessee: Unobserved Heterogeneity & Functional Form Analysis. Accepted for publication in Transportation Research Record: Journal of the Transportation Research Board. STC/Federal support acknowledged.

- Liu, J., Khattak, A.J., Wali, B. Do Safety Performance Functions Vary Across Space? Applying Geographically Weighted Regressions to Account for Spatial Heterogeneity. Accident Analysis and Prevention (2017). DOI: https://doi.org/10.1016/j.aap.2017.10.012. STC/Federal support acknowledged.
- Liu J., & A. Khattak, Gate-Violation Behavior at Highway-Rail Grade Crossings and the Consequences: Using Geo-Spatial Modeling Integrated with Path Analysis, Forthcoming in Accident Analysis & Prevention, 2017. STC/Federal support acknowledged.
- Boakye K., A. Khattak, & S. Nambisan, Correlates of Front-Seat Passengers' Non-Use of Seatbelts at Night, 18-00405, To be 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, To be 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, To be 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, To be 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, To be presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.

Relevant papers from MRI 2 published or (to be) presented:

- 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 https://doi.org/10.1016/j.ijdrr.2017.09.013.
- 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.

Relevant papers from MRI 4 published or (to be) presented:

- 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? 18-00089, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.

Relevant papers from O&E Grants published or (to be) presented:

- Arvin R., M. Kamrani, & A. Khattak, & J. Rios-Torres, Safety Impacts of Automated Vehicles in Mixed Traffic, 18-00088, To be presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.

Clemson

- McCubbin, J. A., Switzer, F. S., LaDue, M. N., Ogle, J. H., & Bendigeri, V. (2016). Cardiovascular Emotional Appraisal and Risk Behavior: Resting Blood Pressure Predicts Risky Driving in Women. Psychometric Medicine, Vol. 78, No. 3, pp. A150-A150, Philadelphia, PA: Lippincott Williams and Wilkins.

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; submitted; acknowledgement of federal support (yes).

UCF

- Wu, J., Radwan, E, & Abou-Senna, H. Use of a Driving Simulator to Evaluate Pedestrian-vehicle Conflicts with Different Potential Risk Factors at Signalized Intersections. 17th COTA conference International Conference of Transportation Professionals, 8 July 2017.
- 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, (accepted).
- 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, accepted; acknowledgement of federal support (yes).

UK

- Amiridis, K., Stamatiadis, N., and Kirk, A. 2017 "Safety Based Signalized Intersection Left-Turn Phasing Decisions," accepted for publication to the Journal of the Transportation Research Board.
- Amiririds, K.*, Stamatiadis, N., and Kirk, A. 2017 "Safety-Based Decisions for Left-Turn Phasing," Proceedings of the Road Safety and Simulation 2017 Conference, Deft, Netherlands, October 2017.
- Stamatiadis, N., Sallee, T. and Kirk, A. 2016 "Left turn guidance based on crossing conflict analysis," Advances in Transportation Studies, Vol. 2, pp. 17-26.

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

Clemson

Chhetri, N.; Impact Assessment of Universal Helmet Law Repeal in South Carolina; 2017; Thesis Presented to the Graduate School of Clemson University. Published and federal support acknowledged.

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

UT

- Khattak, A.J. (Host), Wali, B (Presenter). The Role of Connected & Automated Vehicles: How Can Urban Areas Use the Data They Create? U.S. DOT ITS Professional Capacity

Building Program, Talking Technology and Transportation in Education (T3e) Webinars Series, October 11, 2017.
https://www.pcb.its.dot.gov/t3/s171011_Role_of_Connected_and_Automared_Vehicles.asp

- Khattak, A.J., Wali, B. Analysis of Volatility in Driving Regimes Extracted from Basic Safety Messages Transmitted Between Connected Vehicles. To be presented at the Intelligent Transportation Systems World Congress (October 29 - November 2, 2017), Montreal, Canada.
- Kamrani M., R. Arvin, & A. Khattak, What measures of driving volatilities best explain crash frequency at intersections? 18-00089, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be 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, To be presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Weber, J., Azad, M., Riggs, W., and Cherry, C., The Convergence of Smartphone Apps and Competition to Increase Cycling, 18-02631, to be presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Hezaveh, A., Azad, M., and Cherry, C., Pedestrian Crashes in Tennessee; A Data Mining Approach, 18-01507, To be presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Boayke, K. Some Impacts of Enforcement and Community-based Outreach & Education Programs on Nighttime Seatbelt Use, Presentation at the 2017 Lifesavers conference held March 26-28 in Charlotte, NC.
- Boggs A., Truck Parking Facilities and Ramp Parking: Role of Supply, Demand, and Ramp Characteristics, Presentation at the 2017 Lifesavers conference held March 26-28 in Charlotte, NC.
- Boggs, A. Shortage of Commercial Vehicle Parking Influence on Interstate Ramp Crashes in Tennessee, Presentation at the TSITE Summer Meeting held July 29-31 in Gatlinburg, TN.
- Wali, B. Exploring Non-Linear Dependencies in Correlates of Rural Two-Way Two-Lane Road Crashes: A Hybrid Statistical-Machine Learning Approach, Presentation at the TSITE Summer Meeting held July 29-31 in Gatlinburg, TN.
- Bae B., Gray Areas in Isolated Intersection Control Type Selection: A Complementary Decision Support Tool, Presentation at the TSITE Summer Meeting held July 29-31 in Gatlinburg, TN.

NCAT

- Carter, L.; Texting While Driving: The Role of Personality, Protection Motivation and General Deterrence Theory; presented to the School of Information Systems and Technology Management in the University of New South Wales in Sydney, Australia; September 26, 2017; acknowledgement of federal support (yes).

- McBride, M.; Exploring Adolescent Texting While Driving Behaviors using the Theory of Planned Behavior and Psychosocial Factors; Applied Human Factors and Ergonomics Conference; Los Angeles, California, July 19, 2017; acknowledgement of federal support (yes).

UCF

- Wu, J., Radwan, E., Abou-Senna, H. Assessment of pedestrian-vehicle conflicts with different potential risk factors at midblock crossings: A driving simulator study Transportation Research Board 96th Annual Meeting.
- Radwan, E., Darius, B., Wu, J., & Abou-Senna, H. (2016, November). Simulation of pedestrian safety surrogate measures. In ARRB Conference, 27th, 2016, Melbourne, Victoria, Australia.
- Wu, J., Radwan, E., Abou-Senna, H. Analysis of driver's avoidance behavior at mid-block crossings based on driving simulation experiment. Roadway Safety and Simulation, Netherlands, 2017. (Accepted).
- 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. Submitted to the 97th Transportation Research Board Annual Meeting.

UK

- Stamatiadis, N. and Kirk, A. 2016. "Operational Efficiency and Left Turn Phasing," *Proceedings of the Transport Research Arena*, Warsaw, Poland, 18-21 April 2016.

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

The STC website (stc.utk.edu) is the primary source of information related to the regional UTC.

2.e.   Technologies or techniques:

UT

"I Bike KNX" smart phone app for iOS and Android has been developed by Dr. Cherry and several other researchers. It uses smart phone's GPS to record routes and allows users to report problems along their route such as potholes and so on. It contributes to safety improvement and route choice optimization for cyclists. This app was developed for the O&E grant, focusing on behavior analysis from big datasets.

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

UT

Patent application under review: "Device for level bicycle at-grade crossing of rail tracks."

2.g.   Other products:

UT

Faculty installed ARADA Technologies in-vehicle, mobile, and roadside units for field testing of Connected and Automated Vehicles (CAVs). Traffic and incident data from INRIX and TDOT are being obtained. The CAV units were successfully tested. Results of the testing include:

- Evaluating the communication reliability of safety-critical applications using Dedicated Short Range Communication, with work on the following paper:
  - 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, To be presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Development of safety applications for signalized intersections using signal timing data:
  - 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, To be presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.
- Development of freeway merge assist system:
  - Ahmed M., M. Hoque, J. Rios-Torres, & A. Khattak, A Cooperative Freeway Merge Assistance System using Connected Vehicles, 18-05614, To be presented at Transportation Research Board annual meeting, National Academies, Washington, D.C., 2018.

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 board membership 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 (NSF) and VW. In this regard, the UTK faculty has started a seminar series devoted to the creation of Southeastern Smart Mobility Consortium (http://tesp.engr.utk.edu/ssmc/ssmc.php), with potential for TDOT and USDOT support.

UTK faculty have successfully obtained funding for transportation laboratory software and hardware for research and education projects, e.g., they 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.

Clemson

Clemson students have collected a vast database to report cross-slope and grade of pedestrian facilities on Clemson University. This data is being prepared for widespread use on the university web as an interactive portal for accessibility services.

MRI#2 - The FDOT match project for this STC initiative developed a safety prioritization tool (SPT) for pedestrian sidewalks and bicyclist bike lanes. It also developed a pedestrian crash rate methodology along with statewide averages for pedestrian crash rates that would give transportation planners and engineers a barometer indicating how the regions (or Districts) compare against other areas, thus evaluating locations that are operating beyond statewide averages and therefore emphasizing mitigation improvements. The FDOT match project won the 2017 ITE best project award by the standing committee on Pedestrian and Bicycle Safety in the annual ITE meeting in August in Toronto, Canada.

USF

As part of the MRI3 Year 1 and Year 2 research, a state-level panel dataset was developed for the period from 2001 through 2014, including a large number of variables for the following categories:

- Crash outcomes
- Exposure
- Infrastructure
- Laws
- Land use and system conditions
- Weather
- Socio-demographic and economic
- Risk-taking behavior

Details of the variable assessments are described in the Final Report for MRI3 Year 1 and Year 2, and additional information can be provided to interested parties.

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	N/A	UT
Tennessee DOT	Nashville TN	Matching request & data	N/A	UT
ORNL	Oak Ridge TN	Collaborative support		UT
INRIX	Kirkland WA	Collaborative support	N/A	UT
US Dept. of Energy	Washington DC	Sponsor of projects	N/A	UT
Knoxville Regional Trans Planning Org	Knoxville TN	Collaborative support & personnel time	N/A	UT
Social Bicycles (SoBi)	New York	Collaborative support & data match	N/A	UT
Georgia Tech	Atlanta	Collaborative support	N/A	UT
NURail------UIUC	Champaign Urbana IL	Collaborative Support	Chris Barkan	UT
Various Jiaotong Universities in China	Beijing, Nanjing, Guangzhou, Shenzhen, Changsha, China	Collaborative support & personnel exchanges	Dr. Xuedong Yang	UT

Social Bicycles	New York	Data match, personnel time, and collaboration	Ryan Rzepeki	UT
Community Action Committee	Knoxville TN	In-Kind Support, collaborative support	Karen Estes	UT
East Tennessee Human Resource Agency	Knoxville TN	personnel exchanges	Aaron Bradley	UT
Knoxville Area Transit	Knoxville TN	personnel exchanges	Melissa Roberson	UT
e---HM consortium – see info below	Label Master, Blue Dot Solutions, etc.	Support of initiative		UT
National Science Foundation	Washington DC	Support of Big Data from CAVs	N/A	UT
CURENT (an NSF Engineering Research Center)	College of Engineering, UTK	In---Kind Support, collaborative support and nominal stipend for a graduate student to mentor two high school students in the Young Scholars Program	Dr. Chie---Fei Chen	UT
MKT 466: Capstone Design course	Haslam College of Business, UTK	In---Kind Support for 42 students to develop a marketing campaign to increase seat belt usage during nighttime hours	Cindy Raines	UT
Office of Access and Equity	Clemson, SC	Accessibility Data Publication	Priscilla Harrison	Clemson
Parking and Transportation Services Office	Clemson, SC	Funding for Accessible Parking Spaces	Dan Hoffman	Clemson
NC FHWA Division	Raleigh, NC	In-kind support-presentations, collaborative support	Lynise DeVance, Program Manager, Civil Rights Office	NCAT
NCDOT	Raleigh, NC	In-kind Support-presentations, field trip visit Financial support-internship program	Joana McCoy, Education Initiatives Coordinator, Office of Civil Rights	NCAT
Conference of Minority Transportation Officials (COMTO)	Washington, DC	Financial support – scholarships	Brad Mims, Interim President/CEO	NCAT
Center for Transportation Workforce Development	Washington, DC	Financial and in-kind support	Virginia Tsu	NCAT
Knox County School System	Knoxville, TN	Collaborative Support	Brianna Fisher	NCAT
Institute for Transportation Research and Education (ITRE)	Raleigh, NC	Financial support, collaborative support – research collaboration	James Martin, Associate Director	NCAT
Savannah State University	Savannah, GA	Collaborative Support	Suman Niranjan	NCAT

University of Alabama - Birmingham	Birmingham, AL	Collaborative Support	David Schwebel Despina Stavrinos	NCAT
Virginia Tech Transportation Institute	Blacksburg, VA	Collaborative Support Facilities	Jon Antin	NCAT
Embry-Riddle Aeronautical University	Daytona Beach, FL	Collaborative Support	Dahai Liu	NCAT
Center for Advanced Public Safety	Tuscaloosa, AL	Collaborative Support	Dr. Randy Smith	UA
Alabama Center for Insurance Information and Research	Tuscaloosa, AL	Collaborative Support	Dr. Lars Powell	UA
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
UA College of Engineering	Tuscaloosa, AL	Collaborative support	Shashi Nambisan	USF
Kentucky Transportation Center	Lexington, KY	Collaborative support	Reginald Souleyrette	USF
Vanasse, Hangen, Brustlin, Inc (VHB)	Weedsport, NY	Collaborative Support	Frank Gross	UK

3.b.   Additional collaborators:

UT

Noteworthy new collaborations include UT's role as a partner with the new national UTC, **Collaborative Sciences Center for Road Safety (CSCRS)**, led by University of North Carolina at Chapel Hill's Highway Safety Research Center. With Dr. Asad Khattak as an associate director of CSCRS, UT is a key contributor to the new Center. CSCRS unites leading programs in transportation research, planning, public health, data science, and engineering, with UNC, UT, Duke University, Florida Atlantic University, and the University of California, Berkeley all taking part. The UT Center for Transportation Research and the Department of Civil and Environmental Engineering will head UT's efforts at the new center. Dr. Chris Cherry's project "Completing the Picture of Traffic Injuries: Understanding Data Needs and Opportunities for Road Safety," has been chosen as one of eight Quick Start Project to receive year one funding. Dr. Khattak is co-PI on the Quick Start Project "Advanced Analytics for Vulnerable Road User Scenarios."

UA

In a non-STC safety project, UA is working with Cambridge Systematics on writing the Strategic Highway Safety Program for the State of Alabama. This project is funded by the Alabama DOT.

UCF

Two new collaborators on the O&E Disaster Analytics project are Dr. Arif M. Sadri, Rose-Hulman Institute of Technology, and Dr. Manuel Cebrian, MIT Media Lab.

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

UT

STC's "Comprehensive Transportation Safety" integrated approach addresses issues from a broad, interdisciplinary perspective. We do this by researching and developing engineering and behavioral solutions to safety problems. This approach develops a knowledge-base that can lead to reductions in injuries and fatalities. The UT team has worked individually and collaboratively with consortium members on research issues related to the Southeastern US, and we have engaged stakeholders and professional community through technology transfer. Our work improves safety through research on Highway Safety Manual (HSM) procedures, safety simulations, big data applications, and the role of socio-demographics in safety. These activities are creating the knowledge-base and foundation needed for innovations in safety countermeasures and methodological advances in safety modeling, simulation, and visualization.

As an example of stakeholder involvement, the Tennessee Department of Transportation has bought into our approach and invested matching funds in adopting and calibrating Highway Safety Manual. During the reporting period, the UT research team worked on the following research papers related to the HSM project, which were accepted by TRB:

- Wali B., A. Khattak, D. Chimba, J. Waters, & X. Li, Development of Safety Performance Functions for Tennessee: Unobserved Heterogeneity & Functional Form Analysis, 18-00065, To be 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, To be 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. Forthcoming in Accident Analysis & Prevention, 2017.

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, To be 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.

NCAT

The data from the texting while driving (TWD) surveys provide evidence of individual differences that impact teenager TWD behavior. The results from this study is being used to identify the most salient factors associated with teenage drivers' decisions to TWD. These individual differences and decision factors are the basis upon which customized driver training protocols will be developed.

The data from the pedestrian study is expected to reveal that potential hazards could potentially be eliminated through the use of a different type of listening device. Using a listening device that does not cover the ear canal is expected to increase situation awareness for pedestrians; thus increasing overall safety by reducing traffic-related pedestrian accidents.

UCF

MRI #2 - This 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.

O/E Disaster Analytics - This research provides significant insights on social media uses in disasters. Using the methods developed in this project, disaster management agencies dealing with major hurricanes can make significant changes on how to communicate during disasters.

MRI#4 - This 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.

UK

Advances in the level of knowledge related to the Highway Safety Manual has impacted the safety analysis methods of the Kentucky Transportation Cabinet, with decision making supported with science-based approaches.

The findings will allow transportation agencies to employ a more systematic and cohesive approach in selecting left-turn phasing options at signalized intersections based on operational and safety considerations.

USF

Exposure measures for pedestrian fatality risks should account for both vehicle and pedestrian activities. A reasonable metric appears to be the square root of the product of vehicle and pedestrian activities. For frequent measurement, a reasonable choice would be to use VMT for vehicle activities and the product of resident population and the share for walking for commuting from the American Community Survey (ACS) as pedestrian activities.

While socio-demographic factors and other included variables being controlled for, a 10% drop in average speed at the state level could reduce the risk of pedestrian deaths by 3.135 percentage points.

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

UT

UT's research team is engaging a wide spectrum of disciplines. Specifically, in terms of research impact, UT's safety work underway is relevant to social sciences; e.g., findings from the study of sociodemographic 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. Engineering faculty at UT also collaborated with the Haslam College of Business faculty on educational efforts.

Clemson

Researchers collaborated with psychology professors to study effects of risky driving behavior on health metrics. These findings were published in Psychometric Medicine.

NCAT

Both the TWD and pedestrian study are multidisciplinary projects, incorporating concepts from psychology, information technology, transportation, and decision sciences. Even though these studies focus on transportation safety, the methods employed in the studies can be applied to research investigating industrial safety concerns, general risk taking behaviors, and communication devices.

UCF

MRI #2 - 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 the development of transportation workforce development?

UT

Our "Comprehensive Transportation Safety" approach is now well-integrated into relevant transportation courses taught at UT. We have made substantial efforts to include relevant transportation safety issues in all transportation courses. Currently, the University of Tennessee Transportation Engineering and Science Program has 18 graduate students. In the Fall and Summer months, there were 8 graduate students who graduated from the program with two of them doctoral students. Also there are 236 undergraduates (sophomore –seniors) in Civil and

Environmental Engineering that will be exposed to transportation safety through their required undergraduate transportation course.

Additionally, the UT faculty has presented extensively at various conferences attended by students and practitioners. For example, Khattak presented in plenary sessions at the CICTP conference in Shanghai, China and Research Day Celebration at University of Aveiro in Portugal on new approaches to comprehensive transportation safety and using connected and automated vehicles generated data to develop innovative solutions for safety problems.

Clemson

Numerous students have received funding to pursue both undergraduate research related to transportation engineering as well as graduate degrees. All of these students have been positively impacted by the funding and intent to purse transportation careers.

HSRC

The Road Safety 101 course has been well received. We hope that the students who took this course will be able this knowledge in their work.

NCAT

The blogs created for the Knox County Garrett Morgan project provide opportunities for K-12 students and teachers to learn more about transportation through stories and information that is relatable to these target groups. The blog posts enable youth to learn about the importance of transportation in all areas of life and will aid in developing a pipeline of future transportation professionals.

UCF

MRI #2 produced one Ph.D student with the support of the STC. He is currently working as a post-doctoral research associate and continues to work on this project.

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

UT

The STC consortium of eight universities representing Southeastern states has fostered valuable collaborations and established strong links between UT 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.

Clemson

Recommendations were made for accessible parking changes, sidewalk and ramp upgrades, and development of an online portal to house all of the grade and slope data that was collected.

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

MRI #2 - The recruitment of students and other participants in the driving simulator experiment provided further exposure and raised more awareness on campus for pedestrian safety.

MRI#4 - We will share our experiences in collecting, processing, analyzing Big Data, and developing an integrated model using Big Data with other colleagues at our university.

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

NCAT

The TWD study is likely to have an impact on the current driver training practices. Now that the data analyses have been completed, psychosocial profiles of young drivers are being identified based on their TWD behaviors and customized training protocols will be developed. These protocols are expected to be more effective at deterring young drivers from texting while driving. The training protocols will be used to develop training modules that can be implemented in driver training classes.

The pedestrian study may result in the development of a different type of communication device that will enable persons to communicate and/or enjoy listening to their personal media devices without sacrificing their safety.

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

MRI #2 - 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?

UT

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, 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

MRI # 2 - 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 and deadly problem. This research supported by the O&E Grant will save lives.

UK

Applications of the Highway Safety Manual have improved the processes for identification and prioritization of locations on KY highways with the greatest potential for crash reductions. Impacts are the longer-term, fundamental changes intended as a result of your activities, such as:

- Safer driver behavior;
- Increased travel time reliability;
- Increased intermodal transportation operations;
- Reduction in carbon and other harmful emissions from transportation sources.

5.   Changes/Problems

Nothing to report in these categories.

6.   Additional information regarding Products and Impacts
6.a.   Outputs:

Clemson

- Brown, K., W. Sarasua, J. Ogle, and S. Sperry, "A Spatial Investigation Into Teen Driver Crash Involvement In South Carolina Public High School Attendance Zones Using Geocoded Nine-Digit Driver Residential Zip Codes" Transportation Research Record, Transportation Research Record, TRB/NAS, Washington D.C., 2017, submitted.
- Rajabi, M., J. Ogle, J., and P. Gerard, "Highway Safety Manual Calibration: Assessing Alternate Definitions of the Calibration Factor" Transportation Research Record, Transportation Research Record, TRB/NAS, Washington D.C., 2017, submitted.
- Ogle, J., S. Islam, K. Brown, W. Davis, and W. Sarasua, "Impacts of State Specific Policy and Legislation on Safety Advancement by Departments of Transportation" Transportation

Research Record, Transportation Research Record, TRB/NAS, Washington D.C., 2017, submitted.

- Ogle, J., P. Alluri, C. Zhang, M. Rajabi, W. Sarasua, and V. Bendigeri, "Methods to Define Homogeneous Segments and Assign Crashes for Highway Safety Manual Applications" Transportation Research Record, Transportation Research Record, TRB/NAS, Washington D.C., 2017, submitted.
- Reed, F., Ogle, J., and B. Putman, "GIS Integrated Methodology for Identifying Pavement Preservation Candidates in South Carolina" Transportation Research Record, Transportation Research Record, TRB/NAS, Washington D.C., 2017, submitted.

UCF

- Wu, J., Radwan, E, & Abou-Senna, H. Pedestrian-Vehicle Conflict Analysis at Signalized Intersection with a Concurrent Pedestrian Phasing. Submitted for presentation at the Transportation Research Board 97th Annual Meeting, Washington, D.C.
- Wu, J., Radwan, E, & Abou-Senna, H. Comprehensive Analysis of Conflict Pattern Between Pedestrians and Vehicles at Midblock Crossing Based on Driving Simulator Experiment. Submitted for presentation at the Transportation Research Board 97th Annual Meeting, Washington, D.C.
- Wu, J., Radwan, E, & Abou-Senna, H. Pedestrian-Vehicle Conflicts Prediction Model Based on Driver's Avoidance Pattern at Midblock CROSSINGS. Submitted for presentation at the Transportation Research Board 97th Annual Meeting, Washington, D.C.
- 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. (Submitted).
- Roy, K.C., and Hasan, S. "Quantifying Human Mobility Resilience to Extreme Events Using Geo-located Social Media Data". Submitted to TRB Annual Meeting 2018.
- Roy, K.C., Hasan, S. Sadri, A.M., and Cebrian, M. "Understanding the Effectiveness of Social Media based Crisis Communication during Hurricane Sandy". Submitted to TRB Annual Meeting 2018.

6.b.   Outcomes:

UCF

MRI # 2

- 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.

O&E (WWD)

- Safer travel on high speed roads.
- Combating a dangerous behavior of wrong way driving.

6.c.   Impacts:

UCF

MRI # 2

- 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.

Part I

University Transportation Centers Program Performance Indicators

UTC Name:	Southeastern Transportation Center
University:	The University of Tennessee
Grant #:	DTRT13-G-UTC-34
Reporting Period:	September 30, 2016 - September 30, 2017

Performance Indicators	Consortium Total	Consortium Member 1 UT	Consortium Member 2 UK	Consortium Member 3 NCA&T	Consortium Member 4 UNCCH	Consortium Member 5 Clemson	Consortium Member 6 UA	Consortium Member 7 UAB	Consortium Member 8 UCF	Consortium Member 9 USF
1. Number of transportation-related courses offered during the reporting period that were taught by faculty and/or teaching assistants who are associated with the UTC										
Undergraduate courses	35	3	5	17	2	0	3	0	5	0
Graduate courses	26	6	6	3	0	0	3	0	6	2
2. Number of students participating in transportation research projects during the reporting period funded by this grant										
Undergraduate students in research	68	5	1	1	55	0	0	0	6	0
Graduate students in research	43	24	6	2	0	0	1	0	7	3
3. Number of transportation-related advanced degree programs that utilize grant funds during the reporting period to support graduate students										
Masters level programs	8	2	1	1	0	0	0	0	2	2
Doctoral level programs	22	17	2	0	0	0	1	0	1	1
4. Number of students supported by this grant during the reporting period										
Undergraduate students	13	4	1	7	0	0	0	0	1	0
Masters students	11	3	3	1	0	0	0	0	1	3
Doctoral students	18	12	4	0	0	0	1	0	1	0
5. Number of students supported by this grant who received degrees during the reporting period										
Undergraduate degrees	15	2	1	12	0	0	0	0	0	0
Masters degrees	4	2	1	1	0	0	0	0	0	0
Doctoral degrees	5	3	1	0	0	0	0	0	1	0
6. Number and total dollar value of research projects selected for funding during the reporting period using UTC grant funds (Federal and/or Recipient Share) that you consider to be applied research and advanced research										
Number of applied research projects	18	7	6	1	0	0	2	0	2	0
Dollar value of applied research projects	$ 1,520,747	$ 152,500	$ 625,000	$ 100,202	$ -	$ -	$ 44,045	$ -	$ 599,000	$ -
Number of advanced research projects	3	2	0	0	0	0	0	0	0	1
Dollar value of advanced research projects	$ 160,000	$ 85,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 75,000

Part II – UTC-Specific Indicators

In Part II, you must report the annual performance metrics that you identified in your application for each category below. Include the description of the indicator(s) and report the corresponding metrics for the grant year.

UTC Name:	**Southeastern Transportation Center**
University:	**The University of Tennessee**
Grant #:	**DTRT13-G-UTC-34**
Reporting Period:	**September 30, 2016 - September 30, 2017**

Performance Indicators	Consortium Total	Consortium Member 1 UT	Consortium Member 2 UK	Consortium Member 3 NCA&T	Consortium Member 4 UNCCH	Consortium Member 5 Clemson	Consortium Member 6 UA	Consortium Member 7 UAB	Consortium Member 8 UCF	Consortium Member 9 USF
1. Research Capability										
· Number of STC research projects funded	13	4	3	1	0	0	1	0	1	1
· Dollar amount of STC research projects funded	$ 691,500	$ 210,534	$ 187,500	$ 99,994	$ -	$ -	$ 6,202	$ -	$ 112,271	$ 74,999
· Number of competitive proposals submitted	16									
· Number of universities participating in funded projects	6									
· Number of peer reviewed journal articles, reports, conference presentations and awards resulting from STC-funded research projects.	65	39	10	2	0	0	0	0	12	2
· Number of students and faculty engaged in STC funded research	69	31	13	4	0	0	2	0	14	5
· Amount of matching funds (and new funds leveraged) for STC research	$ 799,000	$ 237,500	$ 375,000	$ -	$ -	$ -	$ -	$ -	$ 111,500	$ 75,000
· Number of outside (non-STC) collaborations on STC research	36	28	4	0	0	0	2	0	2	0
· Listing of outside (non-STC) collaborations on STC research *see below										
2. Leadership										
· Measures of high standing										
number of publications (STC or other)	48	23	11	0	0	0	4	0	10	0
number of committees served on	26	7	7	2	0	0	3	0	7	0
· Measure of contributing to solving regional problems:										
Identification of key regional safety problems (previous surveys)	yes					0				
Problems specifically addressed by programs (research, etc.)	yes					0				
· Measure of developing future leaders										
number of STC graduate students	42	24	7	1	0	0	1	0	6	3
number of STC undergraduate students	16	2	1	7	0	0	0	0	6	0
number of in-service professionals	36	32	0	0	0	0	0	0	4	0
number of K-12 students impacted by STC	171	150	0	16	0	-	0	0	5	0
3. Education and Workforce Development										
· Number of transportation related courses that have a safety component.	18	7	4	2	2	0	1	0	2	0
· Number of students attending these safety courses.	566	186	160	65	0	0	130	0	25	0
· Number of professionals who take the online continuous education course	83	18	0	0	55	0	0	0	10	0
· Number of continuing education credits awarded.	214	214	0	0	0	0	0	0	0	0
· Track the first job of graduating students placed in a transportation related field. Note which field they enter (see list following).										
government	5	4	0	0	0	0	0	0	1	0
industry	10	4	0	3	0	0	0	0	3	0
academic (teaching)	1	0	1	0	0	0	0	0	0	0
academic (advanced degree)	5	0	5	0	0	0	0	0	0	0
· Number of transportation outreach events conducted for pre-college students.	4	2	0	1	0	0	0	0	1	0
· Number of K-12 students participating in outreach events.	186	150	0	16	0	-	0	0	20	0

Performance Indicators	Consortium Total	Consortium Member 1 UT	Consortium Member 2 UK	Consortium Member 3 NCA&T	Consortium Member 4 UNCCH	Consortium Member 5 Clemson	Consortium Member 6 UA	Consortium Member 7 UAB	Consortium Member 8 UCF	Consortium Member 9 USF
4. Technology Transfer										
· Number of peer-reviewed transportation research publications listed on the website (searchable database)	294									
· Number of STC newsletters	3									
other periodicals published	16	15	0	0	0	0	0	0	1	0
number of issues produced	1	1	0	0	0	0	0	0	0	0
total circulation of issues produced	Electronic	0	0	0	0	0	0	0	0	0
· Number of JTSS papers cited in other scholarly works;	23									
· Increase in international representation within the JTSS editorial board;	1									
· Number of licenses, patents, new processes, new businesses arising from STC research;	2	2	0	0	0	0	0	0	0	0
· Number of new LTAP safety-related training courses developed and delivered;	1	1	0	0	0	0	0	0	0	0
· Number of transportation technology safety-oriented products deployed.	3	2	0	0	0	0	0	0	1	0
5. Collaboration										
· Number of program area collaborations within the consortium and among the states of the region	24	20	2	1	0	0	0	0	1	0
· Number of collaborations that link research to technology transfer	24	22	0	1	0	0	0	0	1	0
· Number of program area collaborations with other entities, including private sector	31	28	1	1	0	0	0	0	1	0
· Number of program area collaborations that involve other UTCs that have safety initiatives	14	7	1	5	0	0	0	0	1	0
· Number of Executive Board Meetings	1									

* UT: Knox Co Schools, National Science Foundation, Tennessee DOT, ORNL, INRIX, US Dept. of Energy, Knoxville Regional Trans Planning Org, Social Bicycles (SoBi), Georgia Tech, Various Jiaotong Universities in China, Community Action Committee, East Tennessee Human Resource Agency, Knoxville Area Transit, e---HM consortium, National Science Foundation CURENT (an NSF Engineering Research Center), Old Dominion University, East Tennessee State University, Tennessee State University, Virginia Department of Transportation,

*UK: Kentucky Transportation Cabinet Federal Highway Administration Kentucky State Police TRB SHRP2 Program

*UA: Center for Advanced Public Safety (at Univ. of Alabama), Alabama Center for Insurance Information and Research

*UCF: Central Florida Expressway Authority (CFX)

Annual Receipt Share Report
The University of Tennessee
Grant No. DDTRT13-G-UTC34
September 30, 2016–September 30, 2017
Total Recipient Share = $2,218,412

State Department of Transportation (TN)
$96,178 - 5%

LTAP
$333,828 - 15%

University
$1,788,406 - 80%