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 #6

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

This document summarizes the activities and initiatives that the Southeastern Transportation Center (STC) instigated 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**. In this current UTC grant reporting period, we have maintained on-going programs and initiated strategic new activities in each of our four program areas: research, education, work force development, and technology transfer. We are especially proud of our new O&E Project initiative targeting the safety aspects of emerging advanced transportation technologies, including CAVs and CI.

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

Research

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.

MRI 1: Crash Modification Factors and the Highway Safety Manual
UT
The second year efforts during the reporting period focused on SPFs: 1) investigating spatial heterogeneity and transferability of single statewide SPFs, and 2) analyzing nonlinear dependencies between crash frequencies and key factors. By developing and applying advanced techniques to address methodological issues, more effective context-driven safety countermeasures can be evaluated to reduce transportation injuries and deaths.

HSRC
In Year 2 efforts, we compared the performance of cross-sectional regression models that make use of propensity scores with the results from before-after studies.

UK
We continued developing Kentucky specific data for Crash Modification Factors, and verified previously developed Safety Performance Functions (SPFs) along with investigating non-engineering factors affecting crash occurrences. We developed two SPFs and tested the statistical significance of associated factors. A literature review was completed on approaches evaluating non-engineering CMFs/ SPFs.

MRI 2. Integrated Simulation and Safety

UCF's team designed a driving simulator experiment to assess pedestrian-vehicle conflicts under different risk factors at both midblock crossings and intersections. The driving simulator data were extracted and analyzed. We concluded that, compared to daytime driving, nighttime driving increases maximum deceleration, but also decreases the maximum deceleration location, PET, and the minimum TTC. While marked crosswalks have nothing to do with maximum deceleration, minimum distance, and PET, they do increase the maximum deceleration location and the minimum TTC.

UK

We continued our research to develop vehicular crash models for intersections. We evaluated models based on simulations and crash data. A paper is being developed for Accident and Analysis Prevention, and a Master's report is under development on the potential use of hourly traffic counts for crash prediction and left-turn phasing changes.

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

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. 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 nor convincing explanation for regional safety performance differences. MRI 3 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 possible explanatory factors. Researchers examine the extent to which population characteristics might explain differential safety performance (dataset development and comprehensive analysis). This research includes a special focus on motorcycles and heavy vehicle safety.

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

UT

In this reporting period, we extracted, processed, and integrated data from multiple sources to generate driver feedback based on vehicle-to-vehicle and vehicle-to-infrastructure communication data. We examined instantaneous driving decisions and trip-level driving volatility at a microscopic level, generation of alerts and warnings from connected vehicle data, and analyzed location-specific volatility for developing and demonstrating a proactive safety methodology. The team is creating new analytical frameworks to extract useful information from raw data generated by CAVs.

UCF

During this reporting period, we investigated whether macroscopic data can improve the accuracy of microscopic safety modeling; performed real-time crash predictions for expressway ramps using traditional statistical models and data mining methods; and compared intersection crash frequency predictions with data based on diverse macro-level spatial units.

UK

During this period, we inventoried and assessed the expanding array of safety-related data sources, investigating scenarios for how different types of data can contribute to improving

transportation safety. We continued with an additional research component to specifically address connected vehicles. We completed the development of methods to integrate Big Data with traditional data; fused data from various sources; and identified vulnerable hotspots. We completed the data source review of Waze, HERE, and Bluetooth. To generate conflict scenarios, our research team initiated simulation (ETFOMM) of connected vehicle operating data processed by SSAM.

Opportunity and Exploratory (O&E) Grants

2017 O&E Projects
On September 20, 2016 STC issued an RFP for the 2017 O&E Grants Competition. Selected projects must directly support STC's theme of *comprehensive transportation safety*. Within this broad area, the focus is on highway, transit, and traffic safety topics. Awards will be announced by the end of December 2016.

2016 O&E Projects
During the last reporting period, new O&E grants were awarded. This solicitation specifically targeted projects addressing the safety implications of CAVs, CI, and other advanced technologies as well as projects addressing transportation security needs and deficient areas. Progress on these new projects is reported here:

UT – Asad Khattak
Connected and Automated vehicles: What are the implications of partial adoption?
During the reporting period, we explored opportunities and challenges associated with the adoption and use of CAVs. Adoption of new technologies is often messy, even if they follow the familiar S-shaped adoption curve. Among the challenges is how will partial adoption of automated technologies, characterized by levels 0 to 5, work in a transportation network? We will develop simulations to help us understand the impacts of CAVs. Our research is focused on understanding how variations in driving control will affect safety. This exploratory study is using novel tools to understand the implications of partial automation on the traffic network performance. This problem is complex because of the unpredictable nature of partial automation, where humans have different levels of involvement. The study accounts for traveler behavior under various automation scenarios and models flows at nodes in a network (merging facilities and intersections). In particular, the study is developing simulations and algorithms to better understand how variations in driving control impact safety.

UCF – Haitham Al-Deek
Evaluating the Potential of Connected Vehicles in Combating Wrong-Way Driving
Several accomplishments have been made to date in this research. The UCF research team completed the literature review task. We also completed the review of technologies to stop intentional wrong way drivers, and submitted a progress report to FHWA per the main sponsor matching contract. The UCF team designed a draft survey for notifying right way drivers about wrong way drivers then shared it with Central Florida Expressway Authority (CFX), the sponsoring agency for matching this project. UCF continues to collect data from devices installed on CFX system and evaluate the efficacy of the new technology installed to combat WWD. A modeling paper was developed from this data and submitted to TRB 2017 Annual Meeting for possible presentation and publication in the Transportation Research Record. We made two progress presentations to CFX in May and September 2016.

Framework for High Crash Risk Locations in a Connected Vehicle Environment
Our research will leverage existing V2I datasets to link high resolution traffic performance and weather information to safety performance data. This high resolution dataset will then be used to develop crash performance models to account for temporal variations in weather, geometric, and operational conditions. These models can identify alternative operational control strategies that may mitigate adverse conditions, or even send advisory information to drivers, provide alternative routing, or call for alternative vehicle operating characteristics such as following distances, to fully manage transportation systems in a fully connected V2V/V2I environment. The research team began searching for published and ongoing traffic management and safety analysis work related to vehicle to vehicle (V2V) and vehicle to infrastructure (V2I).

Other Research Activities

UT
UT has leveraged research transportation safety funding with STC projects. One example is the National Science Foundation grant, "Study of Driving Volatility in Connected and Cooperative Systems." The work of this three-year complementary study is to acquire and analyze real-world large-scale connected vehicle data, and to extract critical driving behavior information, especially driving volatility, embedded in raw BSMs. We apply the Markov Switching models to characterize driving regimes and embedded volatility during trips in connected vehicles. The vehicles' embedded intelligent systems apply inverse reinforcement learning to understand optimal choices made by drivers.

NCAT
NCA&T's proposal to the NCDOT in collaboration with the Institute for Transportation Research and Education (ITRE) at NC State University to study license plate agency (LPA) operations was selected and funded. The study will investigate customer service operations and recommend ways to reduce the number of incomplete transactions across North Carolina's LPA offices. This study is funded through the NCDOT University Research Program.

Education & Workforce Development

UT
- UT Civil & Environmental Engineering is offering a dedicated course on safety; this information is also covered in other courses from the perspectives of planning, design, and operations.
- During Fall 2016, Dr. Khattak is offering a graduate level course in Transportation Safety that defines safety from a multi-disciplinary perspective, and identifies significant challenges for transportation safety. In the course, on-campus and remote TDOT graduate students are exposed to rigorous state-of-the-art analytical techniques and advanced analytic methods for diagnosing safety issues of physical transportation infrastructure. An in-depth overview of Highway Safety Manual is provided together with training students with application of HSM tools to specific types of facilities.
- Dr. Nambisan and STC staff organized a Transportation Systems STEM Summer Academy for Teachers. This program had participation of about a dozen selected school teachers in

Eastern Tennessee. The program included brief overviews of transportation systems, logistics and supply chain management, followed by visits to a variety of real-life settings.

STC sponsored UT students were honored and awarded scholarships for their accomplishments:

1. Ziwen Ling. Tennessee Section Institute of Transportation Engineers (TSITE) Student Paper Competition Award. First Place ($500)

2. Behram Wali. TSITE Student Paper Competition Award. Second Place ($250); Intelligent Transportation Society of Tennessee (ITSTN) Student Scholarship. Second Place ($500); TSITE-T. Darcy Sullivan Scholarship ($1200).

3. Kwaku Boakye. TSITE Student Paper Competition. Third Place ($100); ITSTN Student Scholarship. First Place ($2000)

4. Bumjoon Bae. TSITE William L. (Bill) Moore, Jr. Scholarship Award ($1,200)

5. Alexandra Boggs. TSITE John R. Harper Memorial Scholarship ($2,000); Great Lakes National Scholarship ($2,500)

6. Case Offut. Volunteer Scholarship ($6,000)

HSRC
During the period of April 1 to September 30, the HSRC team finalized course materials and its roster of students for the Spring offering of Road Safety 101. The course was delivered during weekly sessions from May 5 through June 30 to a class of 17 participants. Half of the students were engineers, and the remainder represented public health agencies, law enforcement, and other organization types. In-class discussions and lectures were paired with outside of class readings, discussion board posts, and group assignments. The class was positively reviewed by students, and quiz/exam results indicated that the delivery of the material was successful.

NCAT
- The STC Education Awards went to ten undergraduates and one graduate for the fall semester. Each awardee will receive faculty mentoring through research opportunities, internships advisement and experiential learning activities. Two civil engineering students are participating in the Transportation Research Board Minority Student Research Fellow program. There are three Dwight David Eisenhower Fellows for the 2016-17 academic year, one of which is a former STC Education Award recipient.

- Seventeen students participated 2016 Summer High School Transportation Institute (STI). These high school juniors and seniors received a rigorous curriculum over the five and one half weeks. The program focuses on the modes of transportation and the safety aspect of each mode is broadly discussed. Students researched careers in each mode and lectures and presentations are delivered by university faculty, federal, state, local and corporate partners.

- Faculty members at NCA&T continue their collaboration with the Knox County School System in Knoxville, TN and the University of Tennessee, Knoxville to develop a transportation clearinghouse program. This project is funded by FHWA through the Garrett A. Morgan Technology and Transportation Education Program (GAMTTEP). The clearinghouse is a centralized organization for the collection, classification, and distribution of information; a channel for distributing assistance; and a venue for advocacy and marketing of transportation to the STEM education community. NCA&T continued its review of transportation-themed educational material for K-12 students and compiled a list

of the 2011-2014 enrollment data for the transportation, distribution, and logistics (TDL) courses by state for the United States and its territories. In addition, we created a categorical list of the TDL courses available for 9th through 10th graders by state for the United States and its territories. We developed four "When would I use this?" transportation-related scenarios for the GAMTTEP website. Additionally, two transportation lesson plans (one for middle school math classes and one for high school science classes) were developed.

UA

On June 13-24, 2016, the University of Alabama in association with the Alabama Department of Transportation West-Central Region conducted its "Advanced Transportation Institute" for 22 high school students from underrepresented groups. This year, STC funding was supplemented by National Summer Transportation Institute (NSTI) funding from the USDOT. The Institute introduces high school students to careers in transportation and STEM subjects.

UCF

- Camp Connect is a multi-year, summer engineering exploration program for students from underrepresented communities. Students return summer after summer from grades 8 through 10, and the programs gain complexity as students master STEM concepts. The students work with professional engineers, and tour local labs.
- 2016 Summer Internship Program for Civil Engineers - Two senior civil engineering students visited CATSS at UCF for a professional training program. Ms. Yasmin Chaves and Mr. Mohamed El-Agroudy came from Brazil and Canada to attend this program. The students visited the Sunrail facilities in Central Florida, a local transportation firm, and some tutorial sessions involving traffic software like VISSIM, Synchro, and SIDRA.
- PhD student Adrian Sandt and his team won second place in this national SAS shootout competition in Las Vegas this month. Adrian worked on Prof. Al-Deek's O&E grants.

1.c.   Have the results been disseminated? If so, in what ways?

UT

- UT staff created a numbering scheme to track progress on STC-funded Major Research Initiatives and Opportunity & Exploratory projects.
- Related to CAV implications for safety, three papers were published in peer-reviewed journals and seven technical papers submitted to peer-reviewed journals and Transportation Research Board. Several presentations were made nationally and internationally, based on second year activities undertaken in STC MRIs.
- On March 31 and April 1, STC hosted the 2016 University Transportation Center Conference for the Southeastern Region. The innovative and fast-paced conference brought together faculty, students, practitioners, and public agencies in the southeast to showcase recent achievements and collaborations. In particular, this event emphasized the contributions students are making to the many-faceted field of transportation.
- The Journal of Transportation Safety & Security has published a special issue on railroad grade crossing safety. Three more special issues are in preparation for the next two volume years.

- David Harkey presented the results of the Road Safety 101 course at Transportation Association of Canada 2016 Annual Conference and Exhibition (September 25 to 28, 2016), in Toronto, Canada. His presented was titled *The Need and Supply of Road Safety Learning Opportunities at HSRC and Elsewhere*, as part of a larger panel under the title of How Industry Professionals Can Apply the Science of Road Safety in Canada.
- Based on the results from year 1 from the MRI1 program, HSRC submitted a paper for review for presentation at the 2017 Annual Meeting of the Transportation Research Board.

NCAT

The results from the Teen Texting While Driving O&E project were presented at two conferences during this reporting period.

- "Texting while driving among teens: Exploring user perceptions to identify policy recommendations." Digital Government Society (dg.o 2016) Conference, Jun 8-10, 2016, Shanghai, China.
- "Teen Texting while Driving: Factors Influencing this Epidemic Behavior." Human Factors and Ergonomic Society (HFES) Annual Meeting, September 19-23, 2016, Washington, DC.

UCF

Professor Al-Deek's life-saving wrong way driving research has been a featured news story on Channel 9 News and Channel 13 News in Central Florida (July 2016) as well as FOX19 news from Cincinnati, Ohio (September 2016). The FOX19 news piece www.fox19.com/story/33130527/wrong-way-crashes-on-the-rise-in-the-tri-state shows Al-Deek's research as a successful model for the nation to follow.

UK
- The completed modules for the STC Safety Engineering Education Course were posted online and were advertised to professional organizations and groups including practitioners and academics. stc.utk.edu/STCeducation/sees-course.html
- Research results from MRIs 1, 2, and 3 were included in two state (KY) research reports for safety programs and projects and in two internal reports. Six papers and presentations arose from this work.

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

UT
- The transportation faculty will fast-track our work on safety implications of connected and automated vehicles, given the opportunities for safety in this area of inquiry.
- Transportation faculty at UT will continue the transportation seminar series, with speaker presentations available online.
- We will strengthen national and international links in order to communicate research results in Asia, Europe, and Australia.
- We will work to further strengthen the Journal of Transportation Safety & Security. Technical paper submissions to this academic journal have increased to more than 200 per year. We have prepared a proposal for this journal to be considered for listing in the Science Citation Index.

HSRC
- We plan to complete the data analysis comparing before-after and cross-sectional method for two data sets.
- During the next six months, the HSRC team will deliver the second iteration of the Road Safety 101 course (from October 6 through November 17). We will make plans for and begin marketing the Spring 2017 offering. HSRC will offer the course twice per year.

NCAT
- We will target these conferences and journals in the next reporting period to showcase the TWD study results: Applied Human Factors and Ergonomics Conference (presentation); Transportation Research – Part F (paper); and Human Factors Journal (paper).
- We will continue work on the NCDOT LPA office project with ITRE. As part of this project, we will develop and administer surveys to obtain data from the LPA office employees and customers. With assistance of a graduate student, we will evaluate the NCDOT and transfermyauto.com webpages to identify and develop processes and tools that will help customers navigate the license plate transfer process more efficiently.
- Under guidance of faculty mentors, STC students will develop research papers for TRB and other research activities. Other planned activities include proposal writing for the 2017 STI program, developing partnerships, and planning for the 25th anniversary celebration.

UCF
- We will secure final approval from the sponsoring agency on the survey for our O&E grant on Wrong Way Driving, gain IRB approval, then execute the survey. We will revise TRB paper per reviewers' comments if it is accepted for presentation.

UK
- Our MRI 1 research team expects to complete development of strategies for replacing rates/factors with SPFs, and apply before-and-after HSM procedures. We will continue to coordinate research to maximize SPF/CMF development, and explore non-engineering factors with collaborating STC universities. We plan to finalize our report addressing the influence of socio-economic variables as crash predictors as well continue developing presentations and papers.
- For MRI 2, Nick Stamatiadis plans to complete our model development and prepare a draft of final report to document our research findings.
- For MRI 4, Mei Chen, with Bryan Gibson and Reg Souleyrette, expect to complete the simulation of connected vehicle operating data. The case study will be carried out and a draft final report prepared.
- For the O&E grant *Framework for High Crash Risk Locations in a Connected Vehicle Environment*, Adam Kirk and Eric Green will identify studies that focus on operational and weather related conditions that impact safety performance. They will explore next generation V2I technology that could provide more information beyond the metrics provided by the Bluetooth data collection devices that could identify next generation datasets. The research team will begin data collection with the cooperation of the City of Lexington. Corridor Bluetooth data including vehicle speed and origin-destination is available allowing the team to determine recurring and non-recurring congestion in real-

time for the roadway network on a link-by-link basis. Site visits will be made to document corridor roadway characteristics.

## 2.	Products: What has your work produced?
## 	Publications, conference papers, and presentations
## 2.a.	Journal publications:

UT

1. Liu J., and A. Khattak, Structuring and Integrating Data to Explore Multi-Level Correlates of Driving Volatility, Under review, Transportation Research, Part F.

2. Wali, B. A. Khattak, & J. Liu, Heterogeneity in Incident Durations: A comparison of random parameter and quantile regressions. TRB 2017. (Submitted for presentation & publication)

3. Zhang M., J. Liu, A. Khattak, D. Clarke, A Comparative Study of Rail-Pedestrian and Cyclist Trespassing Crash Injury Severity at Highway-Rail Grade Crossings and Non-Crossings. TRB 2017. (Submitted for presentation & publication)

4. Xu J., Wali B. & A. Khattak, Injury Severity Analysis of Passenger Vehicle-Truck Collisions and Contributory Unsafe Pre-Crash Behaviors. TRB 2017. (Submitted for presentation & publication)

5. Li X., A. Khattak, & B. Wali, Large-Scale Traffic Incident Duration Analysis: The Role of Multi-Agency Response and Stay Times. TRB 2017. (Submitted for presentation & publication)

6. Kamrani, M. A. Khattak, & B. Wali, Can Data Generated by Connected Vehicles Enhance Safety? A proactive approach to intersection safety management. TRB 2017. (Submitted for presentation & publication)

7. Bumjoon Bae, Brandon C. Whetsel, Lee D. Han; A gray zone in isolated intersection control type selection; Transportation Research Board (TRB) 2017. (Submitted for presentation & publication)

8. Bumjoon Bae, Hyeonsup Lim, Yuandong Liu, Lee D. Han; Calibration of car-following models using a dual genetic algorithm with central composition design. TRB 2017 (Submitted for presentation & publication)

9. Nirbesh Dhakal, Christopher R. Cherry, Bruce Appleyard, William Riggs, Jeremy McKinstry, Saman Tabrizideh. New and Unique Aspects of University Campus Transportation Data to Improve Planning Methods. TRB 2017 (Submitted for presentation & publication).

10. Ling, Z., C. Cherry, J. MacArthur, J. Weinert Differences between cycling experiences and perceptions between e-bike and bicycle users in the United States. TRB 2017 (Submitted for presentation & publication).

11. Boakye K., A. Khattak, J. Liu, & S. Nambisan, How Do Smartphone and Non-Smartphone Users Access and Use Travel Information? Evidence from the 2014 Puget Sound Regional Household Travel Survey. TRB 2017. (Submitted for presentation & publication)

12. Boakye, K., S. Nambisan The Impacts of Click It-Or-Ticket Campaign and Saturation Patrol Interventions on Nighttime Seat Belt Usage. TRB 2017. (Submitted for presentation & publication)

13. Boakye, K., S. Nambisan. Influence of Passenger Presence on Driver's Seatbelt Use at Nighttime. TRB 2017. (Submitted for presentation & publication)

14. Boakye, K., S. Nambisan Nighttime Seatbelt Use of Front-Seat Passengers Based on Their Corresponding Drivers' Seatbelt Use. TRB 2017. (Submitted for presentation & publication)

NCAT

1. Carter, L., McBride, M., and Phillip, B. Integrating the theory of planned behavior and psychosocial factors to explore texting among adolescent drivers in the US. *Journal of the Association for Information Systems* (under review; federal support acknowledged).

UCF

1. Wang, L., Abdel-Aty M., Lee J., Shi Q., 2016, Analysis of Real-time Crash Risk for Expressway Ramps Using Traffic, Geometric, Land-use, and Trip Generation Predictors, World Conference on Transport Research, Shanghai. (Received best paper award by the World Conference on Transportation Research, Shanghai, July 2016.)

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

Nothing to report.

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

UT

1. Kwaku Boakye. How Smartphone and Non-Smartphone Users Access and Use Travel Information. Southern District ITE Annual Meeting. Poster Presentation. April, 2016

2. Lim, H., G. Williams, D. Abdelqader, J. Amagliani, Z. Ling, D. Priester, C. Cherry. An alternative Approach for Forecasting Parking Volumes. 14th World Conference on Transportation Research, Shanghai, July 2016

3. Wali B. Heterogeneity in Incident Durations: A comparison of random parameter and quantile regressions. TSITE Summer Annual Meeting, Gatlinburg TN. July 2016

4. Kwaku Boakye. The Impact of Click-It-Or-Ticket Campaign and Saturation Patrol Interventions on Nighttime seatbelt Usage. A Case Study in Tennessee. TSITE Summer Annual Meeting, Gatlinburg TN. July 2016.

5. Wali B. A. Khattak, & J. Liu, Heterogeneity Assessment in Incident Duration Modeling: Implications for duration prediction and countermeasure development. To be presented at 23rd World Congress on Intelligent Transportation Systems October 10-14 2016, Melbourne, Australia

6. Zhang M. & A. Khattak, Identifying and Analyzing Extreme Lane Change Events Using Basic Safety Messages in a Connected Vehicle Environment. TRB 2017. (Submitted for presentation)

7. Khattak A., M. Kamrani, A. Srinivasan, & S. Chakraborty, Applying Markov Decision Process and Inverse Reinforcement Learning to Understand Driving Decisions in Connected Vehicle Systems. TRB 2017. (Submitted for presentation review)

8. Wali B. & A. Khattak, Exploring Non-Linear Dependencies in Correlates of Roadway Crashes. TRB 2017. (Submitted for presentation review)

9. Wali B. & A. Khattak, Contributory Fault and Level of Personal Injury to Drivers Involved in Head-on Collisions: Application of copula-based bivariate ordinal models. TRB 2017. (Submitted for presentation review)

10. Khattak A., & B. Wali, Dynamics of Driving Regimes Extracted from Basic Safety Messages Transmitted Between Connected Vehicles. TRB 2017. (Submitted for presentation review)

11. Liu J., A. Khattak, & B. Wali, Do Safety Performance Functions Vary Across Space? Application of Geographically Weighted Regressions. TRB 2017. (Submitted for presentation review)

12. Boakye, K., S. Nambisan. Truthfulness of Seatbelt Usage during Daytime and Nighttime Hours: Observed and Stated Behavior. TRB 2017. (Submitted for presentation review)

NCAT

1. McBride, M., and Carter, L. (2016). Teen Texting while Driving: Factors Influencing this Epidemic Behavior. *Proceedings of the Human Factors and Ergonomic Society (HFES) Annual Meeting.*

UA

1. Ozelim, L., Zephaniah, S., Adanu, K., Smith, R., Jones, S. "Factors in Differential Safety Performance Across Different Income Levels." Road Safety on Five Continents, Rio de Janeiro, Brazil, May 17-19, 2016.

UCF

1. Abou-Senna, H., Radwan, E., Developing A Safety Prioritization Tool to Address Sidewalk and Bike Lane Gaps in Central Florida. To be presented at the 10th University Transportation Centers Spotlight Conference: Pedestrian and Bicycle Safety, to be held December 1-2, 2016, at The Keck Center in Washington, DC

2. Radwan, E., Wu, J., Abou-Senna, H., and Darius, B. Simulation of Pedestrian Safety Surrogate Measures, 27th ARRB Conference – Linking people, places and opportunities, Melbourne, Victoria, Australia November 2016.

3. Radwan, Abou-Senna, H., Wu, J., Pedestrian safety and Crash Rates Estimation. Paper to be presented at the 2nd IRF Asia Regional Congress & Exhibition October 16-20, Kuala Lumpur, Malaysia.

UK

1. Dr. Stamatiadis presented research findings at the Transport Research Area (TRA) Conference in Warsaw, Poland, April 15-18, 2016.

2. Research findings were submitted for presentation at the upcoming TRB Meeting and subsequent publication in the TRB Journal.

3. Amiridis, K., Stamatiadis, N. and Kirk, A. Safety based signalized intersection left-turn phasing decisions, Journal of the Transportation Research Board, 2016 (submitted)

4. Chen, M., O. Kazi, B. Gibson, and X. Zhang, Developing an Integrated Framework for Safety and Mobility Analysis, Year 1 STC Final Report, 2015

5. Zhang, X., M. Chen, and C. Lambert. Feasibility of Using Crowdsourced Probe Vehicle Data for Urban Arterial Performance Monitoring. (paper accepted) NATMEC 2016

6. Dr. Chen presented research findings at NATMEC (North American Traffic Monitoring Exposition and Conference), May 1-4, Miami FL.

2.d.   Websites or other Internet sites:

UT

• The STC website is the primary source of information related to the regional UTC.
  stc.utk.edu/STCconsortium/index.html

- A new website has been launched to showcase Big Data and connected and automated vehicles activities, and promote the science and engineering needed for connected and automated vehicle development and deployment. tesp.engr.utk.edu/dvcv/dvcv.php

NCAT
NCA&T Transportation Institute Website provides information on educational opportunities available to high school and college students.
www.ncat.edu/cobe/transportation%20institute/index.html

UK
www.ktc.uky.edu lists all transportation research reports issued by the UK--Kentucky Transportation Center, highlights high-value research activities and provides link to the Center's technology transfer website.

2.e.   Technologies or techniques:

UT
- UT researchers developed algorithms to learn the behaviors of drivers and their optimal choices from data generated by connected and automated vehicles. The information on regular and anomalous driving is being translated into alerts, warnings, and control assists for drivers who are approaching or in difficult situations.
- Dr. Cherry lead a team of researchers to develop *I Bike KNX*, a smart phone app for iOS and Android. It uses smart phone GPS to record routes, and allows users to report problems along their route such as potholes, contributing to improved safety and route choices for cyclists. This app was developed for the O&E grant; its data can be used to do behavior analysis from big datasets.

2.f.   Inventions, patent applications and licenses:

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

2.g.   Other products:

UT
UT faculty purchased in-vehicle, mobile, and roadside units to field test CAVs. They obtained funding for and purchased transportation laboratory software and hardware to display traffic data in real-time. The lab has modeling and simulation capabilities that include display and archiving of incoming operations feeds from TDOT, a driving simulator, and software capabilities (accident reconstruction software ARAS, TransCAD and TransModeler software).

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
Tennessee DOT	Nashville TN	Matching request & data	N/A	University of Tennessee
ORNL	Oak Ridge TN	Collaborative support		University of Tennessee

INRIX	Kirkland WA	Collaborative support	N/A	University of Tennessee
US Dept. of Energy	Washington DC	Sponsor of projects	N/A	University of Tennessee
Knoxville Regional Trans Planning Org	Knoxville TN	Collaborative support & personnel time	N/A	University of Tennessee
Social Bicycles (SoBi)	New York	Collaborative support & data match	N/A	University of Tennessee
Georgia Tech	Atlanta	Collaborative support	N/A	University of Tennessee
NURail UTC-UIUC	Champaign Urbana IL	Collaborative Support	Chris Barkan	University of Tennessee
Various Jiaotong Universities in China	Beijing, Nanjing, Guangzhou, Shenzhen, Changsha, China	Collaborative support & personnel exchanges	Dr. Xuedong Yang	University of Tennessee
Social Bicycles	New York	Data match, personnel time, & collaboration	Ryan Rzepeki	University of Tennessee
Community Action Committee	Knoxville TN	In-Kind & collaborative support	Karen Estes	University of Tennessee
East Tennessee Human Resource Agency	Knoxville TN	personnel exchanges	Aaron Bradley	University of Tennessee
Knoxville Area Transit	Knoxville TN	personnel exchanges	Melissa Roberson	University of Tennessee
e-HM consortium	Label Master, Blue Dot Solutions, etc.	Support of initiative		University of Tennessee
National Science Foundation	Washington, DC	Support of Big Data from CAVs	N/A	University of Tennessee
Knox Co Schools	Knoxville TN	Collaborative support	Dr. Jerry Everett	University of Tennessee
CURENT (an NSF Engineering Research Center)	College of Engineering, UTK	In-Kind Support, collaborative support & support for mentoring two high school students in Young Scholars Prog.	Dr. Chien-Fei Chen	University of Tennessee
National Cooperative Highway Research Program	Washington, D.C.	Collaborative match using funds from NCHRP Project 17-63: Guidance for the Development and Application of Crash Modification Factors	Raghavan Srinivasan	University of North Carolina Highway Safety Research Center
NC FHWA Division	Raleigh, NC	In-kind support- presentations, collaborative support	Lynise DeVance, Program Manager, Civil Rights Office	NCA&T
NCDOT	Raleigh, NC	In-kind Support- presentations, field trip visit Financial support- internship program	Joana McCoy, Education Initiatives Coordinator, Office of Civil Rights	NCA&T
Conference of Minority Transportation Officials (COMTO)	Washington, DC	Financial support – scholarships	Brad Mims, Interim President/CEO	NCA&T
Knox County Schools	Knoxville TN	Collaborative and financial support	Haley Holt, STEM Facilitator	NCA&T

Institute for Transportation Research and Education	Raleigh, NC	Collaborative and financial support	James Martin, Associate Director	NCA&T
USDOT	Washington, DC	Financial Support for Summer Transportation Institute for High School Students		The University of Alabama
Alabama DOT West Central Region	Tuscaloosa, AL	Collaborative support for Summer Transportation Institute for High School Students		The University of Alabama
Center for Advanced Public Safety (at Univ. of Alabama)	Tuscaloosa, AL	Collaborative Support	Dr. Randy Smith	The University of Alabama
Alabama Center for Insurance Information and Research	Tuscaloosa, AL	Collaborative Support	Dr. Lars Powell	The University of Alabama
Department of Information Systems, Statistics, Management Science	Tuscaloosa, AL	Collaborative Support	Dr. Mike Porter	The University of Alabama
City of Orlando	Orlando, FL	Provided Data Collection	Mr. Charles Ramdatt	University of Central Florida
Florida DOT	Tallahassee, FL	Provided Data Collection		University of Central Florida
For MRI 4 Central Florida Expressway Authority	Orlando, FL	Provided Data Collection		University of Central Florida
For O&E Central Florida Expressway Authority	4974 ORL Tower Road	Provided direct match for this project	Corey Quinn, P.E.	University of Central Florida
Enforcement Engineering, Inc.	Jacksonville, Florida	Has provided privileged wrong way data for analysis	Grady Carrick, Ph.D.	University of Central Florida
Kentucky Department of Highways	Frankfort, KY	Collaborative and in-kind support for multiple projects	Jason Siwula, Research and Implementation Coordinator	University of Kentucky
NURail--UTC	Champaign Urbana, IL	Collaborative Support	Ahmed Shabana	University of Kentucky
Center for Urban Transportation Research	Tampa, FL	Collaborative Support	Steve Polzin Xuehao Chu	University of Kentucky
Highway Safety Research Center	Chapel Hill, NC	Collaborative Support	Raghavan Srinivasan	University of Kentucky

3.b.   Additional collaborators:

Noteworthy safety projects underway at UT include:
- Khattak, A., S. Chakraborty & S. Nambisan, Study of Driving Volatility in Connected and Cooperative Vehicle Systems, US National Science Foundation, University of Tennessee at Knoxville, $399,793, Sept. 1, 2015-Aug 31, 2018.

- Khattak A., S. Richards & D. Chimba, Highway Safety Manual, Safety Performance Functions (SPF) and Roadway Calibration Factors, Tennessee Department of Transportation, University of Tennessee at Knoxville, $249,996, Oct. 1, 2015-Sept 30, 2017.
- Collaborations are underway with staff from the Center for Transportation Analysis, Oak Ridge National Lab, TN
- International collaborations in safety during the reporting period include Beijing Jiaotong University, Southeast University, Tongji University, Southwest Jiaotong University, Kunming University of Science and Technology, Tsinghua University, Shenzheng University, and Changsha University of Science and Technology; and COTA-Chinese Overseas Transportation Association. Utrecht University, Monash University, TU Delft, and University of Novi Sad.
- Another collaboration is the electronic Hazardous Materials (e-HM) Initiative Consortium. Label Master, Blue Dot Solutions, American Trucking Associations, CHEMTREC, Commercial Vehicle Safety Alliance, Eastman Chemical Company, FedEx, International Association of Fire Chiefs, Pilot Flying J, National Tank Truck Carriers, OmniTracs, ORNL, UPS. The goal of this consortium is to develop and demonstrate a proof-of-concept for an e-HM system. We have developed mock-ups of the envisioned system. The next step is to develop a prototype system, and eventually to conduct pilot tests to demonstrate how software, cloud computing and communications hardware. Members of the consortium have so far made contributions in the form of personnel time, travel, hardware, software, and communication resources.

HSRC

As part of the MRI1 research area, we have collaborated with the NCHRP Project 17-63 team that includes: Dr. Bhagwant Persaud, Ryerson University; Dr. James Bonneson, Kittelson and Associates; and Dr. Ezra Hauer, University of Toronto, Retired.

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.

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

UT

- The impact of safety research will be felt in multiple modes of transportation and by multiple stakeholders. We are creating new knowledge about motor vehicle driving in transportation engineering and science. The techniques developed provide theoretical and application framework that leads to understanding instantaneous driving decisions and key correlates. Practitioners and technology developers can apply the findings from this study to implement the proposed methodology by using emerging connected vehicle data.
- The activities in MRI 1 have focused on methodological concerns of the application of HSM's safety performance functions (SPFs) for diagnosing safety issues on rural two-way two-lane roads and freeways. The issue of spatial heterogeneity in crash prediction modeling is highlighted and innovative solutions are suggested by using advanced analytic methods. The key impacts of this project on principal discipline are, 1) By proposing innovative concept of L-SPFs (termed Localized SPFs), more realistic estimates of crashes can be obtained for

better identification of hazardous sites, and development of more appropriate countermeasures, 2) Compared to HSM, which uses both Empirical Bayes and SPFs for a site, the proposed methodology can potentially replace the global SPFs in HSM with L-SPFs, and 3) the practical aspects are the potential changes in current practices of HSM.

HSRC

Most of the crash modification factors in the Highway Safety Manual, the CMF Clearinghouse, and other sources are just single factors implying that the safety effect of a treatment does not depend on the characteristics of a site. The MRI1 effort from HSRC will develop crash modification functions that will provide insight into how the safety effect of a treatment may vary depending on the characteristics of a site.

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 are being used to identify the most salient factors associated with teenage drivers' decisions to TWD. These individual differences and decision factors will be used to develop customized driver training protocols.

UCF

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. This research will assist with this goal.

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

UT

- Fusing innovative analytic methods and computational power to develop and apply estimation routines for the analysis of geo-coded and multivariate crash data.
- Data science focused on connected and automated vehicles by developing and applying computational methods and algorithms for the analysis of sensor data.
- Behavioral decision science through the application of theoretical and empirical approaches used to explore instantaneous driver decisions.
- Policy and planning by examining alternatives for connected and automated vehicles.
- Enhancing social science, e.g., the role of socio-demographics in safety and analysis of spatial/geographical aspects of safety (impacting the field of geography).
- Modeling, simulation, and visualization techniques, which may be applied to safety
- Enhancing synergistic research in epidemiology and health as transportation faculty collaborate to explore ways to increase awareness of safety, e.g., young adults (not) wearing seatbelts.

NCAT

The TWD study was a multidisciplinary project, incorporating concepts from psychology, information technology, transportation, and decision sciences. Even though the study was focused on transportation safety, the methods employed in the study can be applied to research investigating industrial safety concerns and general risk taking behaviors. The protocols that will be developed based on the findings of the TWD study also have the potential to impact policy as it pertains to driver education.

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 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 work had on the development of transportation workforce development?

UT

The transportation engineering and science program at UT had 26 graduate students working toward their degrees during the reporting period. There are more than 300 undergraduate students in Civil & Environmental Engineering who will be exposed to transportation safety through their required undergraduate transportation course. UT faculty engage and mentor students from Civil & Environmental Engineering and Mechanical, Aerospace, and Biomedical Engineering Departments by developing and deploying a scientific framework for next-generation research in safety and connected and automated vehicle data collection and analytics. Students experience emerging sensor-system and wireless communications based data capture and processing, advanced analytic methods, algorithm development, optimization and implementation, and establishing interdisciplinary collaborations. Their training will lead to a workforce operating at the cutting-edge of engineering and scientific disciplines.

HSRC

We expect that the Road Safety 101 course will provide basic skills to practitioners in the traffic safety area, and encourage them to make better holistic decisions.

NCAT

The Knox County Garrett Morgan project will increase the availability of transportation curriculum information for K-12 educators through its clearinghouse. The clearinghouse will give teachers access to other educators and transportation professionals as well as training and other resources to help them incorporate transportation subject matter into their classes. By educating K-12 teachers, a larger number of students have the potential to be exposed to transportation subject matter and more of these students are likely to pursue careers in transportation in the near future.

UA

The University of Alabama Advanced Transportation Institute for underrepresented high school students provides opportunities for 22 high school students to learn about careers in transportation as well as opportunities in higher education.

UCF

MRI #2 produced one M.S. student and currently supports one Ph.D. student. The M.S. graduate is employed by a traffic engineering consulting firm, Metric Engineering, in Orlando. MRI #4 produced Dr. Ling Wang who completed her Ph.D. with the support of the STC. She is currently working as a post-doctoral research associate and continues to work on this project. O&E produced a PhD in May 2016 from the previous STC grant. He now works for FHWA in Baton Rouge, Louisiana office.

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

UT

The STC MRI projects have stimulated the development of connected and automated vehicle resources at UT, with further funding coming from VW and the National Science Foundation. UT faculty and staff have developed testing and data collection capabilities using DSRC equipment including in-vehicle, mobile and roadside units, radars, omnidirectional cameras, GPS devices, and inertial measurement units that can be mounted on a test vehicle. The platform facilitates technology development by giving the research team the opportunity to test new algorithms being developed. We are exploring the establishment of a consortium on connected and automated vehicles with the Tennessee Department of Transportation. Helped by STC grants, UT faculty have experienced substantial student and faculty interest in the emerging field of Big Data from connected and automated vehicles, serving to recruit and retain diverse and well-qualified students.

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: Department of Information Systems, Statistics, and Management Science and the Alabama Center for Insurance Information and Research.

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

UT

- During the reporting period, UT faculty worked to disseminate information about connected and automated vehicles through several media. As we enhance scientific and technological understanding of Big Data generated by CAVs, the results are simultaneously being presented to students, engineers and scientists, STEM high-school teachers, and the general public. As an example of technology transfer activities, a presentation was made to practitioners and decision makers by Dr. Nambisan at the Tennessee State Institute of Transportation Conference (in June 2016) to highlight the research efforts and preliminary findings from UT studies, as well as policy, planning, design, and operational considerations for state and municipal agencies. We are currently exploring the possibility of partnerships with new technology companies to enhance industrial applications and commercialization.
- UT faculty, staff and students are disseminating the results of research to various stakeholders in the transportation safety arena. We worked on presenting technical papers in various forums that impact diverse stakeholders, including transportation practitioners, researchers, policy makers, and the private sector. STC affiliated UT faculty have an important impact internationally through collaborations with Asian, Australian, and European countries.

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 results of the Garret Morgan project will provide K-12 teachers with the educational resources they need to effectively incorporate transportation subject matter into their classes. This is expected to lead to the development of curriculum material designed specifically to teach transportation concepts.

UA

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

UK

Impacts are most likely to begin accruing as a result of MRI-1 Crash Modification Factors research work specifically in the prioritization of safety countermeasures. Strategic site specific future roadway safety improvement investments will tend to reduce crashes and their severity. This is considered a major anticipated research benefit from our research on MRI 1 HSM/Crash Modification Factors.

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

UT

- The Big Data applications in safety consider new ways of approaching safety comprehensively by combining information from diverse databases (generated by Connected and Automated Vehicles) and developing safety tools to be used in a dynamic context.
- Safety simulations are leading to a better understanding of vehicles' interactions: why collisions occur, how to better respond to them, and their consequences. The simulations advance the knowledge and skills of people who work in the safety field, and facilitate the study of human factors. Modeling, simulation, and visualization helps formulate regulatory policies that lead to safety improvements.
- Highway Safety Manual improvements (one of the major research initiatives) is creating knowledge about reductions in hazards and application of new countermeasures that can save lives.
- Socio-demographic, attitudinal, and behavioral research on safety are improving public knowledge and provide a fundamental understanding of how to improve safety from broad social, economic, spatial, and behavioral perspective.

NCAT

- The training modules developed as a result of the TWD project are expected to encourage safer driving behaviors. The papers and presentations resulting from this project will inform the public of some of the factors that influence TWD behaviors. By brining awareness to the problem along with potential solutions, roads will be safer for all users.
- The LPA project will help improve NC DMV processes in order to make the license plate transfer process more efficient. The process changes are expected to reduce some of the aggravation experienced by customers who have to return to the LPA more than once in order to complete their transactions due to lack of knowledge and long wait times.

- The STEM transportation lesson plans developed for the Garrett Morgan project during this reporting period by Dr. Leaven will help teacher incorporate transportation-related topics into their science and math classes. This will allow students to be exposed to the transportation industry at an earlier age and encourage them to consider future careers in transportation.

UCF

Because pedestrian safety is a major issue for central Florida, the FDOT match project for this life-saving STC research initiative resulted in developing a statewide pedestrian crash fatality rate that has been publicly praised: usa.streetsblog.org/2016/08/09/streets-without-sidewalks-are-killing-florida-pedestrians/.

5.   Changes/Problems

No changes or problems to report.