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 #10

1. Accomplishments

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

At this point in the life of our 2013 USDOT Regional UTC grant, STC work is yielding results from its research, education, and technology transfer activities in the context of our theme, *Comprehensive Transportation Safety*. Therefore, the summary of our efforts over the past six months reflects many outputs from the work on our four Major Research Initiatives and Opportunity & Exploratory Grants:

- valuable datasets and final reports from research efforts;
- clearly defined research areas for future grants;
- new collaborations with industry partners;
- raised public awareness of transportation safety concerns;
- scholarly output reaching a wider, international audience;
- improved impact factor and citation rate for the Journal of Transportation Safety & Security;
- a large number of scholarly publications and presentations;
- student involvement in wrapping up research work;
- graduation of transportation students with advanced degrees;
- well-trained graduates entering the field;
- workforce improvement programs;
- safety awareness outreach to communities; and
- programs for pre-college education.

To advance comprehensive transportation safety in the Southeastern region, STC strove to understand its sociology and safety cultures; gather and curate relevant data; integrate human factors with infrastructure use; implement and enrich the Highway Safety Manual and similar tools; and apply these to a variety of operations related to moving people and goods. We helped the transportation sector improve its existing workforce while we developed the next generations of educators, professionals, technical specialists, and practitioners to create and sustain our nation's safe transportation systems. We devised a technology transfer program to implement the outcomes of our research program and disseminate research results, with their implications and significance, to practitioners, decision makers, students, educators, and other transportation researchers.

The work of achieving comprehensive transportation safety is never finished. We will continue to contribute to the goals of the University Transportation Centers Program by building upon the successes our consortium achieved under this grant.

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

UT

- Research accomplishments: UT faculty worked on STC's major research initiatives that resulted in publications and presentations at prestigious conferences and the development of new technology products that can have far reaching impacts on safety. Through our research, we continued to enhance our "Comprehensive Transportation Safety" approach, which is based on technological innovations, roadway safety measures, and behavioral issues related to safety. The full scope of our work will be reflected at the 2019 Transportation Research Board (TRB) annual meeting.
- Educational accomplishments: On the education side, many of the students are involved in conducting research and benefiting from experiential learning that comes with publishing and attending conferences. They were exposed to a curriculum that offers courses on safety and intelligent transportation systems. The UT transportation program graduate 11 Masters and three Ph.D. students during the reporting period.
- Outreach accomplishments:
    - **Crash Scene Investigation Camp**
      Sixteen rising 8th and 9th graders attended the inaugural CSI: Crash Scene Investigation Summer camp held in early July. Attendees learned an overview of vehicular dynamics that allow crashes to be reconstructed. Students were able to pick apart evidence through actual dashcam videos, determine speed of vehicle on impact by the vehicle's crush, and utilize crash reconstruction equipment (i.e., total station, drones, conventional and heavy vehicle event data recorders). The Southeastern Transportation Center Seatbelt Convincer was used to emphasize the importance of wearing a seatbelt when a motor vehicle is motion. In addition, accelerometers were placed on the convincer for students to learn about low speed (i.e., 5-7 mph) crash forces and compare to forces of higher speeds. One of the primary goals of the camp was to illustrate the statistics of motor vehicle crashes, especially distracted driving, for the soon-to-be young drivers. This camp is set to become an annual summer with exportable lesson plans, supply lists, and other helpful information for use in other locations.
    - **#GetConvinced Teen Outreach Program -** *Not buckled up? What's holding you back?*
      With the end of the CDC Nighttime Seatbelt pilot study drawing near, CTR Associate Director Dr. Jerry Everett wanted to sustain the grant's focus of increasing seatbelt use by young people. His solution was to request and obtain funding from Tennessee Highway Safety Office, whose primary mission is reducing fatalities on our roads. Dr. Everett and his team developed the #GetConvinced outreach program, aimed at teens aged 15-19. Studies show that car crashes are the leading cause of death for this age group. This grant allows CTR to bring the Arrive Alive with The Seatbelt Convincer program to area schools and events at no cost.

      The #GetConvinced program has brought the **STC Seatbelt Convincer** to more than 5,000 young people. The convincer simulates a 5-7 mph crash, demonstrating just how jolting even a low-speed impact is and how effective seatbelts can be. During this reporting period, CTR staff brought the convincer to area events attended by 16-32 year olds in Blount, Knox, Loudon, Roane, and Sevier counties. The Convincer made appearances at the Luke Bryan Farm Tour Concert at Maple Lane Farms in Greenback; UT Police Department's Blue Light Special awareness campaign; local high school driving classes; law enforcement community events such as Blount and Alcoa's law enforcement **National Nights Out**; and the press conference for Tennessee Highway Safety Office's **Seatbelts Are for Everyone** launch.
- Dr. Khattak was plenary session speaker at the 18th COTA International Conference of Transportation Professionals (CICTP) conference in Beijing, China, July 2018. He presented work sponsored by US DOT on using connected and automated vehicle data to develop innovative solutions for safety problems.

NCAT

- The STC Education Program supported two freshman Incentive Award students for the 2017-2018 academic year. The Incentive Award was given to freshman who declared Transportation/Supply Chain Management as

their undergraduate major. They have received research mentorship, internship opportunities, and they will attend the Annual UTC Conference for the Southeastern Region in October 2018 at Clemson University.

- The selection process for the 2018 Summer High School Transportation Institute (STI) began in May 2018. Sixteen high school juniors and seniors were selected to participate in the 2018 STI which started on June 27 and ended on August 3. Stipends for eight of these students were funded through the STC grant. A team of university faculty, private and public sector professionals from diverse disciplines and areas of transportation utilized a variety of educational activities, including lectures and presentations, group projects and field trips to meet program objectives. Participants were enrolled in and successfully completed a freshman college-level English course. Successful completion earned the students an English credit at the college of their choice. Other components of the enhancement program were SAT Preparation, Library/Research Instruction and a Financial Planning Workshop.

  Evaluations were administered after each scheduled session, guest presenter, and site visit. Pre/posttests were also administered. Student projects were presented at the Closing Ceremony on August 3. Projects were well researched and delivered. Topics included Air Safety, Rail Safety, Bridge Safety, and NC Ports. The students' newly acquired knowledge of the field of transportation was made visually evident with creatively designed PowerPoint presentations. Each participant received a weekly stipend through the STC grant and a Certificate of Completion at the end of the program.

- Data collection for the STC O/E Pedestrian Safety project was completed during the reporting period.

UK

- Final reports for MRI 1 and MRI 2 have been submitted.
- A master student finished his thesis, *Quantifying Non-Recurrent Delay using Probe-Vehicle Data*.
- Completed summary of connected vehicle applications, implementation (benefits/costs), and barriers to implementation.

Research Accomplished under Program Goals

Major Research Initiatives (MRI)

MRI 1. Crash Modification Factors and the Highway Safety Manual Reginald Souleyrette, University of Kentucky, Coordinator Participating schools: UTK, UK, HSRC, UA

UT

Relevant papers published, presented, or under review during the reporting period:

- Wali, B., A. J. Khattak, J. Waters, D. Chimba, and X. Li. Development of Safety Performance Functions: Incorporating Unobserved Heterogeneity and Functional Form Analysis. Transportation Research Record, 2018.
- Behram Wali, Numan Ahmad, Zachary Jerome Asad J. Khattak. Untangling Systematic and Random Heterogeneity in Safety Performance Functions for Multilane Rural Highways. Safe Systems Summit" April 23-24, 2019 in Durham, North Carolina) Accepted for presentation.
- Kamrani M., R. Arvin & A. Khattak. The Role of Aggressive Driving and Speeding in Road Safety: Insight from SHRP2 Naturalistic Driving Study Data. TRB Paper 19-01980, Under Review, 2019.
- Arvin R., M. Kamrani & A. Khattak. Examining the Role of Speed and Driving Stability on Crash Severity Using SHRP2 Naturalistic Driving Study Data. TRB Paper 19-01981, Under Review, 2019.

MRI 2. Integrated Simulation and Safety Essam Radwan, University of Central Florida Nikiforos Stamatiadis, University of Kentucky; Co-Coordinators Participating schools: UTK, UK, UCF

UT

Relevant papers published, presented, or under review during the reporting period:

- Robinson RM, A. Collins, C. Jordan, P Foytik, & A. Khattak, Modeling the Impact of traffic incidents during Hurricane Evacuations using a large scale microsimulation, International Journal of Disaster Risk Reduction, Volume 31, October 2018, pp. 1159-1165.
- Collins A., R.Robinson, C. Jordan & A. Khattak, Development of a traffic incident model involving multiple municipalities for inclusion in large microscopic evacuation simulations, International Journal of Disaster Risk Reduction, Volume 31, October 2018, pp. 1223-1230.

UCF

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: 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.

This period included Year 3 of the project. Tasks 3 and 4 are accomplished which included field data, driving simulator and microsimulation framework as well as the final report.

In summary, this period focused on developing a framework to consolidate the significant parameters from the three legged approach, which included field data, micro-simulation data, and driving simulator data, and determining the best way forward to maximize gains. The evaluation process concerning pedestrian safety using one or more type of data was investigated to predict conflicts, propose countermeasures, and test it before implementation. The final report was submitted on June 30.

Relevant publication during the reporting period:

- Wu, J., Radwan, E., & Abou-Senna, H. (2018). Assessment of pedestrian-vehicle conflicts with different potential risk factors at midblock crossings based on driving simulator experiment. Journal of Advances in Transportation Studies, Vol 44, pp 33-46.
- Wu, J., Radwan, E., & Abou-Senna, H. (2018). Determine if VISSIM and SSAM could estimate pedestrian-vehicle conflicts at signalized intersections. Journal of Transportation Safety & Security, 10 (6), 572-585.

MRI 3. Exploring Socio-Demographic Characteristics and Culture Factors in Differential Safety Performance across Geography; Shashi Nambisan, University of Tennessee; Steve Polzin, University of South Florida; Co-Coordinators Participating schools: UTK, USF, UA

This project is complete and final reports have been submitted.

MRI 4. Big Data for Safety Monitoring, Assessment, and Improvement Asad Khattak, University of Tennessee, Coordinator Participating schools: UTK, UK, UCF

Relevant publication during the reporting period:

- Wali, B., A. J. Khattak, H. Bozdogan, and M. Kamrani. How is driving volatility related to intersection safety? A Bayesian heterogeneity-based analysis of instrumented vehicles data. Transportation Research Part C: Emerging Technologies, Vol. 92, 2018, pp. 504-524.
- Kamrani, M., R. Arvin, and A. J. Khattak. Extracting useful information from Basic Safety Message Data: an empirical study of driving volatility measures and crash frequency at intersections. Transportation Research Record, 2018, https://doi.org/10.1177/0361198118773869.
- Shay, E., A. J. Khattak, and B. Wali. Walkability in the Connected and Automated Vehicle Era: A US Perspective on Research Needs. Transportation Research Record, 2018, https://doi.org/10.1177/0361198118787630.
- Kamrani M., A. R. Srinivasan, S. Chakraborty & A. Khattak. Applying Markov Decision Process to Understand Driving Decisions in Connected Vehicle Systems. Transportation Research Part C: Emerging Technologies, Under Review, 2019.
- Mussah, AR., B. Wali, A. Khattak, Using Driving Volatility As a Leading Predictor of Unsafe Events Involving Vulnerable Road Users - A Naturalistic Driving Environment Study, TRB Paper 19-02947, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Wali B., A. Khattak, & T. Karnowski, Exploring Intentional Driving Volatility in Naturalistic Driving Environment Prior to Involvement in Unsafe Events, TRB paper 19-05116, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Boggs, A., A. Khattak, & B. Wali, Analyzing Automated Vehicle Crashes in California: Application of a Bayesian Binary Logit Model, TRB paper 19-05567, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Shay E., A. Khattak, A. Boggs, Safety in the Connected and Automated Vehicle Era: A U.S. Perspective on Research Needs, TRB Paper, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.
- Arvin R., M. Kamrani & A. Khattak. Instantaneous Driving Behavior at Intersections: Insights on Rear-end and Head-on Crash Frequencies Using Connected Vehicle Data. TRB Paper 19-00602, Accident Analysis and Prevention, Under Review, 2019.
- Hoque M., M. Kamrani, C. Davis & A. Khattak. Real-time Alerting of Hazardous Driving Behavior Using Internet of Things (IOT) and Connected Vehicles. TRB Paper 19-04684, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.
- Hosseinzadeh N., R. Arvin, A. Khattak & L. Han. Incorporating Route Safety in the Pathfinding Problem Using Big Data. TRB Paper 19-01433, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.
- Khattak, A., Wali, B., Ahmed, N., A Taxonomy of Naturalistic Driving Errors and Violations and Its Variations Across Different Land-Use Contexts – A Path Analysis Approach, TRB Paper 19-05054, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.
- Zhang M. A. Khattak, S. Chakraborty, The Role of "Gossip" In Instantaneous Driving Decisions: Evidence of Behavior Propagation Using Instrumented Vehicle Data, In preparation, 2019.
- Kamrani M., A. Khattak, H. Bozdogan, Harnessing Instrumented Vehicles Data for Real-Time Crash Risk Prediction: A Comparison of Machine Learning Classifiers, In preparation, 2019.

Opportunity & Exploratory Grants (O&Es)

UT

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

Publications from this O&E project:

- Arvin R., A. Khattak, J. Rios-Torres, Evaluating Safety with Automated Vehicles at Signalized Intersections: Application of Adaptive Cruise Control in Mixed Traffic, 19-05063, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.
- Mohammadi S., M. Kamrani & A. Khattak. Social Influence on Driver Decisions Using Modeling and Gossip Algorithm. TRB Paper 19-01424, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.

UCF

Disaster Analytics: Disaster Preparedness and Management through Online Social Media

Under this project three accomplishments have been made to date.

- Developed models to infer individual evacuation behaviors from Twitter data and compared relative performance of each model.
- Developed models to predict evacuation traffic based on Twitter data and
- Develop models to predict short-term traffic speed based on traffic sensor data.

Based on the results of this project, one article has been accepted for presentation at the TRB Annual Meeting in January 2019 and one article has been accepted for presentation at IEEE International Conference on Intelligent Transportation Systems in November 2018.

Publications from this O&E project:

- Sadri, A. M., Hasan, S., Ukkusuri, S. V., & Cebrian, M. (2018). Crisis Communication Patterns in Social Media during Hurricane Sandy. Transportation Research Record, 0361198118773896.

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

This project was completed in August 2018, and the project final report was submitted to STC on July 24, 2018. 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 the CFX system and evaluate the efficacy of the new technology installed to combat WWD. Three journal papers were submitted for presentation at the Transportation Research Board (TRB) annual meeting in Washington, D.C. in January 2019. All three papers were accepted for presentation and they are being evaluated for possible publication in the Transportation Research Record: Journal of the Transportation Research Board. Five previously accepted papers for publication have all been published online in TRR. We made two progress presentations to CFX, the matching fund sponsor of this research, in May 2018 and September 2018.

Publications from this O&E project:

- Sandt*, A., and AL-DEEK+, H., "A Wrong-Way Driving Crash Risk Reduction Approach for Cost-Effective Installation of Advanced Technology Wrong-Way Driving Countermeasures," published in the *Transportation Research Board* 97th Annual Meeting Compendium of Papers AMOnline, Washington D.C., January 7-11, 2018.
- Kayes, I., AL-DEEK+, H., Sandt*, A., Rogers, J., and Carrick, G. "Analysis of Performance Data Collected from Two Wrong-Way Driving Advanced Technology Countermeasures and Results of Countermeasures Stakeholder Surveys," published in the *Transportation Research Board* 97th Annual Meeting Compendium of Papers AMOnline, Washington D.C., January 7-11, 2018.

- Al-Sahili, O., AL-DEEK+, H., Sandt*, A., Mantzaris, A., Rogers, J., and O. Faruk., "Investigating and Modeling the Illegal U-turn Violations at Medians of Limited Access Facilities," published in the *Transportation Research Board* 97th Annual Meeting Compendium of Papers AMOnline, Washington D.C., January 7-11, 2018.
- Wertanen, S., Staves, C., AL-DEEK+, H., Sandt*, A., Carrick, G., and Rogers, J., "Evaluating Wrong-Way Driving Characteristics, Countermeasures, and Alert Dissemination Methods through Driver and Law Enforcement Surveys," published in the *Transportation Research Board* 97th Annual Meeting Compendium of Papers AMOnline, Washington D.C., January 7-11, 2018.
- Faruk, O., AL-DEEK+, H., Sandt*, Rogers, J., and Shamma, A., "Wrong-Way Driving: A Regional Transportation Systems Management and Operations Approach to A Regional Problem," published in the *Transportation Research Board* 97th Annual Meeting Compendium of Papers AMOnline, Washington D.C., January 7-11, 2018.
- Sandt*, A., AL-DEEK+, H., and Kayes, I., "Responding to the Wrong-Way Driving Problem with Limited Resources by Optimizing the Placement of Wrong-Way Driving Countermeasure Technologies on Limited Access Facilities," accepted for presentation at the Transportation Research Board (TRB) 2019 Annual meeting, Washington, D.C., January 2019, and under revision for possible publication in the Transportation Research Record: Journal of the Transportation Research Board, September 2018.
- Kayes, I., Sandt*, A., AL-DEEK+, H., Uddin, N., Rogers, J., and Carrick, G., "Modeling Wrong-Way Driving Entries at Limited Access Facility Exit Ramps in Florida," accepted for presentation at the Transportation Research Board (TRB) 2019 Annual meeting, Washington, D.C., January 2019, and under revision for possible publication in the Transportation Research Record: Journal of the Transportation Research Board, September 2018.
- Kayes, I., AL-DEEK+, H., Sandt*, A., Carrick, G., Staves, C., Gamaleldin, G., Faruk, Md. O., and Al-Sahili, O.,"Characteristics of Law Enforcement Response to Wrong-Way Driving Events in Florida," accepted for presentation at the Transportation Research Board (TRB) 2019 Annual meeting, Washington, D.C., January 2019, and under revision for possible publication in the Transportation Research Record: Journal of the Transportation Research Board, September 2018.
- Sandt*, A., and AL-DEEK+, H., "An Optimization Approach for Deployment of Intelligent Transportation Systems Wrong-Way Driving Countermeasures," submitted for publication in the Journal of Intelligent Transportation Systems (J-ITS), September 2018.

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

UT

- Preparations are underway for UTK's *Engineers Day*. The 2018 Engineers Day will be on October 25 (http://www.engr.utk.edu/engineers-day/) with approximately 1,500 students attending from various high schools as well as a number of home-schoolers. Attendees will be able to ride the STC Seat Belt Convincer. This simulates a low-speed crash that shows the importance of wearing a seatbelt.
- We participated in the Fall 2018 Freshman Engineering Fair. Another outreach activity includes Transit Day at Knox County Schools. Students learn about the transit system in Knoxville while being able to board one of the trolleys.
- STEMpunk Reverse Science Fair is for high school students who want to pursue engineering as a major. This event allows students to get hands-on experience of research activities being conducted at the university. Some of the research includes: transportation efficiency through electric bicycles, and autonomous and connected vehicle technology through a driving simulator.

USF

Our most recent research report led to a story in the Tampa Bay Business Journal as well as a follow-up televised interview for our local NBC affiliate. *USF research arm determines what makes pedestrians more likely to die in auto crashes - Tampa Bay Business Journal*

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

All consortium members will be wrapping up the research projects, educational activities, outreach and professional development activities for the Southeastern Transportation Center.

2. Products: What has your STC work produced? (Publications, conference papers, and presentations)

2.a. Journal publications:

Publications relevant to STC's various research initiatives are listed under the specific projects above.

UT

- Liu, J., and A. J. Khattak. Are gates at rail grade crossings always safe? Examining motorist gate-violation behaviors using path analysis. Transportation research part F: traffic psychology behaviour, Vol. 55, 2018, pp. 314-324.
- Wali, B., A. J. Khattak, H. Bozdogan, and M. Kamrani. How is driving volatility related to intersection safety? A Bayesian heterogeneity-based analysis of instrumented vehicles data. Transportation Research Part C: Emerging Technologies, Vol. 92, 2018, pp. 504-524.
- Boakye, K. F., A. Khattak, J. Everett, and S. Nambisan. Correlates of front-seat passengers' non-use of seatbelts at night. Accident Analysis Prevention, 2018.
- Wali, B., A. J. Khattak, and A. J. Khattak. A heterogeneity based case-control analysis of motorcyclist's injury crashes: Evidence from motorcycle crash causation study. Accident Analysis Prevention, Vol. 119, 2018, pp. 202-214.
- Wali, B., A. J. Khattak, and J. Xu. Contributory fault and level of personal injury to drivers involved in head-on collisions: application of copula-based bivariate ordinal models. Accident Analysis Prevention, Vol. 110, 2018, pp. 101-114.
- Zhang, M., A. J. Khattak, J. Liu, and D. Clarke. A comparative study of rail-pedestrian trespassing crash injury severity between highway-rail grade crossings and non-crossings. Accident Analysis Prevention, Vol. 117, 2018, pp. 427-438.
- Kamrani, M., R. Arvin, and A. J. Khattak. Extracting useful information from Basic Safety Message Data: an empirical study of driving volatility measures and crash frequency at intersections. Transportation Research Record, 2018, p. 0361198118773869.
- Shay, E., A. J. Khattak, and B. Wali. Walkability in the Connected and Automated Vehicle Era: A US Perspective on Research Needs. Transportation Research Record, 2018.
- Wali, B., A. J. Khattak, J. Waters, D. Chimba, and X. Li. Development of Safety Performance Functions: Incorporating Unobserved Heterogeneity and Functional Form Analysis. Transportation Research Record, 2018.
- Arvin R., M. Kamrani, A. Khattak & J. Rios-Torres. Safety Impacts of Instrumented Vehicles in Mixed Traffic. Transportation Research Part C: Emerging Technologies, Under Review, 2019.
- Kamrani M., A. R. Srinivasan, S. Chakraborty & A. Khattak. Applying Markov Decision Process to Understand Driving Decisions in Connected Vehicle Systems. Transportation Research Part C: Emerging Technologies, Under Review, 2019.

Clemson

- Zhao, X., D. Dawson, W. Sarasua, "Multiple Hypothesis Tracking with Kinematics and Appearance Models on Traffic Flow for Wide Area Traffic Surveillance," Journal of Computing in Civil Engineering, American Society of Civil Engineers, New York, accepted for publication.

NCAT

- McBride, M., Carter, L., and Phillips, B.; Integrating the Theory of Planned Behavior and Behavioral Attitudes to Explore Texting among Young Drivers in the US; Transportation Research Part F: Psychology and Behaviour; submitted but not accepted; acknowledgement of federal support (yes).

UA

- Adanu, K., Penmetsa, P., Jones, S., Smith, R. 2018. Gendered Analysis of Fatal Crashes Among Young Drivers in Alabama, USA. Accepted by *Safety,* 4(3), 29. YES

UK

- Amiridis, K., Stamatiadis, N., and Kirk, A. 2 "Safety-Based Decisions for Left-Turn Phasing," accepted Advances in Transportation Sciences. (accepted, awaiting publication)
- Amiridis, K., Stamatiadis, N., and Kirk, A. "Safety Based Signalized Intersection Left-Turn Phasing Decisions," Journal of the Transportation Research Board, 2619, 2017 pp.13-19. (published)

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

NCAT

- Horton, J.; Pedestrian Safety with Personal Listening Devices; Thesis; awaiting publication; acknowledgement of federal support (yes).

UK

- Brashear, Jacob D. K., Quantifying Non-Recurrent Delay using Probe-Vehicle Data, 2018, thesis, University of Kentucky. https://doi.org/10.13023/etd.2018.305

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

UT

- Khattak, A., Wali, B., Ahmed, N., A Taxonomy of Naturalistic Driving Errors and Violations and Its Variations Across Different Land-Use Contexts – A Path Analysis Approach, TRB Paper 19-05054, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.
- Mussah, AR., B. Wali, A. Khattak, Using Driving Volatility As a Leading Predictor of Unsafe Events Involving Vulnerable Road Users - A Naturalistic Driving Environment Study, TRB Paper 19-02947, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Boggs, A., A. Khattak, & B. Wali, Analyzing Automated Vehicle Crashes in California: Application of a Bayesian Binary Logit Model, TRB paper 19-05567, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Eteifa S. & A. Khattak, Understanding Factors Contributing to Rising Fatal Crashes: A Social Network Analysis Approach, TRB Paper19-03744, Under Review 2019.
- Zhang M. A. Khattak, S. Chakraborty, The Role of "Gossip" In Instantaneous Driving Decisions: Evidence of Behavior Propagation Using Instrumented Vehicle Data, In preparation, 2019.
- Wali B., A. Khattak, & T. Karnowski, Exploring Intentional Driving Volatility in Naturalistic Driving Environment Prior to Involvement in Unsafe Events, TRB paper 19-05116, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.

- Arvin R., A. Khattak, J. Rios-Torres, Evaluating Safety with Automated Vehicles at Signalized Intersections: Application of Adaptive Cruise Control in Mixed Traffic, 19-05063, Under Review, 2019.
- Wali B. & A. Khattak, A Heterogeneity Based Case-Control Analysis of Motorcyclist's Injury Crashes: Evidence from Motorcycle Crash Causation Study, 19-05159, Under Review, 2019.
- Wali B., A. Khattak, & N. Ahmad, Modeling Injury Severity Score as a More Precise Measure of Motorcyclist Injuries: A Correlated Random Parameter Corner Solution Framework, TRB Paper 19-05185, Under Review, 2019.
- Kamrani M., A. Khattak, H. Bozdogan, Harnessing Instrumented Vehicles Data for Real-Time Crash Risk Prediction: A Comparison of Machine Learning Classifiers, In preparation, 2019.
- Shay E., A. Khattak, A. Boggs, Safety in the Connected and Automated Vehicle Era: A U.S. Perspective on Research Needs, TRB Paper, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Arvin R., M. Kamrani & A. Khattak. Instantaneous Driving Behavior at Intersections: Insights on Rear-end and Head-on Crash Frequencies Using Connected Vehicle Data. TRB Paper 19-00602, Accident Analysis and Prevention, Under Review, 2019.
- Kamrani M., R. Arvin & A. Khattak. The Role of Aggressive Driving and Speeding in Road Safety: Insight from SHRP2 Naturalistic Driving Study Data. TRB Paper 19-01980, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Arvin R., M. Kamrani & A. Khattak. Examining the Role of Speed and Driving Stability on Crash Severity Using SHRP2 Naturalistic Driving Study Data. TRB Paper 19-01981, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Mohammadi S., M. Kamrani & A. Khattak. Social Influence on Driver Decisions Using Modeling and Gossip Algorithm. TRB Paper 19-01424, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Hoque M., M. Kamrani, C. Davis & A. Khattak. Real-time Alerting of Hazardous Driving Behavior Using Internet of Things (IOT) and Connected Vehicles. TRB Paper 19-04684, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.
- Hosseinzadeh N., R. Arvin, A. Khattak & L. Han. Incorporating Route Safety in the Pathfinding Problem Using Big Data. TRB Paper 19-01433, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.
- Han J., J. Rios-Torres, R. Arvin & A. Khattak. Optimal Coordination Control Systems for Connected Vehicles at Highway On-Ramps: Safety, Traffic Flow, and Fuel Consumption Impacts. (In preparation), 2019.

Chris Cherry made the following presentations:

- *Do e-bikes belong in a city? Evidence-Base for answers to FAQs*. Presented at Interbike Electric Theater on September 19, 2018
- *New Probe Data Sources to Measure Cycling Behavior and Safety*. Queensland University of Science and Technology Monash University, Institute of Transport Studies. April 18 and May 15, 2018.
- *Light Electric Vehicles: Asian and North American experiences*. Africa Clean Mobility Week, UNEP. Nairobi Kenya. March 12-16, 2018. (invited).

NCAT

- Horton, J.; Pedestrian Safety with Personal Listening Devices; Presentation at the Institute of Industrial and Systems Engineering (IISE) Conference; May 22, 2018.

UCF

- Wu, J., Radwan, E., & Abou-Senna, H. (2018). Pedestrian–Vehicle Conflicts Prediction Model Based on Driver's Avoidance Pattern at the Midblock Crossings. Presented at the 97th TRB Annual Meeting 2018.

- Wu, J., Radwan, E., and Abou-Senna, H. Analysis of driver's avoidance behavior at mid-block crossings based on driving simulation experiment. Presented at the International Conference on Road Safety and Simulation (RSS), Netherlands, 17-19 October 2017.
- Abou-Senna, H, Radwan, E., & Mohamed, A. Developing a Safety Prioritization Tool for Pedestrian Sidewalk and Bicyclist Bike-Lane Gaps in Central Florida. Presented at the International Conference on Road Safety and Simulation (RSS), Netherlands, 17-19 October 2017.
- Roy, K. and Hasan, S. Modeling the Dynamics of Hurricane Evacuation Decisions from Real-time Twitter Data. Accepted in *Transportation Research Board 98th Annual Meeting,* Washington D.C., January, 2019.
- Rahman, R. and Hasan, S. Short-Term Traffic Speed Prediction for Freeways During Hurricane Evacuation: A Deep Learning Approach. Accepted in IEEE International Conference on Intelligent Transportation Systems, Hawaii, November, 2018.

UK

- Stamatiadis, N. and Kirk, A. 2018 "Left-Turn Phasing Decisions for Improved Intersection Safety," Proceedings Transport Research Arena Conference, Vienna, Austria, April 16-19, 2018.
- 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.
- "Left-Turn Phasing Decisions for Improved Intersection Safety," Transport Research Arena Conference, Vienna, Austria, April 16-19, 2018 (Stamatiadis)
- "Safety-Based Signalized Intersection Left-Turn Phasing Decisions," 97th Annual Meeting of the Transportation Research Board, Washington, DC, January 7-10, 2018 (Amiridis).
- "Safety-Based Decisions for Left-Turn Phasing," Road Safety and Simulation 2017 Conference, Deft, Netherlands, October 2017.

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

UT

- Weekly Transportation Safety Seminar Series (Led by UTK): http://mediasite.utk.edu/UTK/Catalog/catalogs/transportation-seminar-series

The UTK ITE Student Chapter

- created a new, more user-friendly website (https://utkite.weebly.com/)
- updated the Facebook page (https://www.facebook.com/BigOrangeITE/)
- created a Twitter (https://twitter.com/UTKITE), and
- obtained a University of Tennessee email address (ite@utk.edu).

NCAT

- https://www.ncat.edu/cobe/transportation-institute/eduprog.html: Webpage where the STI program is described and the application is accessible.
- https://www.ncat.edu/cobe/transportation-institute/images/The%20STI%20Experience.pdf: Webpage highlighting where pictures of some of the STI activities are posted.
- https://www.ncat.edu/cobe/transportation-institute/Files2013/catmpages/sti.html: Webpage with additional information about the STI program.
- https://www.ncat.edu/cobe/transportation-institute/Files2013/catmpages/transportation_conf.html: Webpage highlighting STC Award recipients who attended the 2018 TRB Annual Meeting.
- https://www.facebook.com/groups/627756624232070/: STI program Facebook page

2.e. Technologies or techniques:

UT

During the reporting period, we were awarded a competitive project by the Tennessee Department of Transportation:

Research on Connected and Automated Vehicles Investment and Smart Infrastructure in Tennessee, Tennessee Department of Transportation, The University of Tennessee at Knoxville, $300,000, Oct. 1, 2018-Sept. 31, 2020. Asad Khattak, PI; L. Han & S. Chakraborty, Co-PIs.

It is based on previous STC tests and work on various connected and automated vehicle technologies in the field, on the UT Knoxville campus, and the East Tennessee State University campus in Johnson City, TN. Dedicated Short Range Communications (DSRC) technology is being used along with new algorithms and applications for signal phasing at intersections, freeway merging systems at on-ramps, and for testing the reliability of DSRC on rural two-way two-lane roads. The work is reflected in the following papers (under submission to IEEE journals) and a presentation at the 2019 Transportation Research Board annual meeting:

- Hoque M., M. Kamrani, C. Davis & A. Khattak. Real-time Alerting of Hazardous Driving Behavior Using Internet of Things (IOT) and Connected Vehicles. TRB Paper 19-04684, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.
- A Cooperative Freeway Merge Assistance System using Connected Vehicles, Poster Session 392, Md Salman Ahmed, Mohammad Hoque, Jackeline Rios-Torres, Asad Khattak
- Intersection Approach Advisory Through V2X Technology Using Signal Phase and Timing (SPaT) Information at Fixed-Time Signalized Intersection , Poster Session 572, Md Salman Ahmed,Mohammad Hoque, Asad Khattak
- Impact of Vehicle-to-Vehicle Communication Reliability of Safety Applications: An Experimental Study, Lectern Session 755, Mohammad Hoque, Md Salman Ahmed, Jackeline Rios-Torres, Asad Khattak, Ramin Arvin

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

None

2.g. Other products:

The UTK-based *Journal of Transportation Safety & Security* achieved an Impact Factor of 0.736 during Volume Year 10.

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

NC Department of Transportation	Raleigh, NC	In-kind support- presentations, financial support- NCA&T Scholarship	JoAna McCoy, Director of Education Inititives	NCAT
NC FHWA	Raleigh, NC	In-kind support- presentations, collaborative support	Lynise DeVance, Program Manager, Civil Rights Office	NCAT
Department of Psychology	University of Alabama - Birmingham	Collaborative support	David Schwebel, Despina Stavrinos	NCAT
Department of Accounting	Greensboro, NC	Collaborative support	Brandis Phillips	NCAT
Department of Information Systems	Virginia Commonwealth University Fredericksburg, VA	Collaborative support	Lemuria Carter	NCAT
UNC Highway Safety Research Center	Chapel Hill, NC	Collaborative support	Caroline Mozingo	NCAT
Humans and Autonomy Lab	Duke University Durham, NC	Collaborative support	Missy Cummings	NCAT
Center for Advanced Public Safety (at Univ. of Alabama)	Tuscaloosa, AL	Collaborative Support	Dr. Randy Smith	UA
Alabama Center for Insurance Information and Research	Tuscaloosa, AL	Collaborative Support	Dr. Lars Powell	UA
Central Florida Expressway Authority (CFX)	4974 ORL Tower Road Orlando, Fl 32807	Provided direct match for this project	Corey Quinn, P.E.	UCF
Enforcement Engineering, Inc.	Jacksonville, Florida	Has provided privileged wrong way data for analysis	Grady Carrick, Ph.D.	UCF
Department of Civil and Environmental Engineering	Rose-Hulman Institute of Technology Terre Haute, IN	Collaborative research	Arif M. Sadri	UCF
MIT Media Lab	MIT Cambridge, MA	Collaborative research	Manuel Cebrian	UCF

3.b. Additional collaborators:

UT

CTR is partnering with Vessul Creative (https://vessul.co) to develop a three-part virtual reality film for students who are 14-18 years old. See project details under 4.f.

UK

- TRIMARC (http://www.trimarc.org/site/pages/Index.html) provided incident data;
- KYTC (https://transportation.ky.gov/Pages/Home.aspx) provided highway inventory data

4. Impact

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

UT

Stakeholder involvement is reflected in TDOT's buy-in of the safety approach and their investment of matching funds in adoption and calibration of the Highway Safety Manual. During the reporting period, the UT research team has worked on research papers and presentations described under MRI 1. Also, as mentioned above, UT obtained a new TDOT project testing Connected and Automated Vehicles (CAVs). This new project will enable different units in UT (Knoxville, Chattanooga, and Tullahoma) and East Tennessee State University to work collaboratively on establishing technology testbeds.

NCAT

The results of the pedestrian safety study provided additional knowledge on the potential impacts of using personal listening devices while crossing intersections. The results confirmed the belief that the use of personal listening devices while crossing streets can indeed impact various types of street crossing behavior metrics such as wait time, hit rate, missed opportunities, etc. They did not, however, suggest any differences in these metrics based on the two types of headset that were tested (air conduction earbuds versus bone conduction transducers).

UCF

MRI #2

This research provides an added dimension for using a 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 three-legged stool summarizing three different kinds of data to evaluate pedestrian safety, including field data, simulation data, and driving simulator data.

Disaster Analysis O&E

The work will have an impact on disaster management by an effective use of social media and machine learning models and algorithms. This project provides new algorithms to analyze social media data for disaster management applications. It will also provide critical insights on social media communication during disasters.

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 us to provide valuable insights and research direction in the field.

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

NCAT

The pedestrian safety study uncovered some unexpected results associated with the differences in the street crossing behavior metrics between males and females as well as differences in associated with the genre of the music to which participants were listening. It also indicated associations between performance using the virtual reality software and the participants familiarity with video gaming. Further studies will be conducted to investigate these results more thoroughly.

UCF

The research for MRI #2, conducted on pedestrian safety and how to utilize different safety measures using field data together with microsimulation and driving simulators, has shed 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

Nine graduate students, many of whom are doctoral students, recently completed their degree requirements from the UT Civil & Environmental Engineering program. The recent graduates and their dissertation titles are:

- Wali B., Harnessing Big Data for Characterizing Driving Volatility in Instantaneous Driving Decisions – Implications for Intelligent Transportation Systems (completed), The University of Tennessee, Knoxville, 2018.
- Zhang M., Understanding Micro-Level Lane Change and Lane Keeping Driving Decisions: Harnessing Big Data Streams from Instrumented Vehicles, Unpublished Ph.D. Dissertation (completed), The University of Tennessee, Knoxville, 2018.
- Li X., Analysis of Large-Scale Traffic Incidents and En Route Diversions due to Congestion, Unpublished Ph.D. Dissertation (completed), The University of Tennessee, Knoxville, 2018.

This dissertation will be defended in October, 2018:

- Kamrani M., A Framework to Process and Analyze Driver, Vehicle and Road Infrastructure Volatilities in Real-time, Unpublished Ph.D. Dissertation (in-preparation), The University of Tennessee, Knoxville, 2018.

Fifteen UTK students prepared papers submitted and submitted them to TRB for review. The students include:

Alexandra Boggs, Mojdeh Azad Disfany, Mohsen Kamrani, Ramin Arvin, Rashid Mussah Abdul, Behram Wali, Numan Ahmad, Xiaobing Li, Hoseinzadeh Nima, Yuandong Liu, Meng Zhang, Zhihua Zhang, Amin Mohamadi-Hezaveh, Russell Graves, David Harris.

These papers were prepared for TRB presentation and publication:

- Khattak, A., Wali, B., Ahmed, N., A Taxonomy of Naturalistic Driving Errors and Violations and Its Variations Across Different Land-Use Contexts – A Path Analysis Approach, TRB Paper 19-05054, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.

- Mussah, AR., B. Wali, A. Khattak, Using Driving Volatility As a Leading Predictor of Unsafe Events Involving Vulnerable Road Users - A Naturalistic Driving Environment Study, TRB Paper 19-02947, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Boggs, A., A. Khattak, & B. Wali, Analyzing Automated Vehicle Crashes in California: Application of a Bayesian Binary Logit Model, TRB paper 19-05567, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Eteifa S. & A. Khattak, Understanding Factors Contributing to Rising Fatal Crashes: A Social Network Analysis Approach, TRB Paper19-03744, Under Review 2019.
- Wali B., A. Khattak, & T. Karnowski, Exploring Intentional Driving Volatility in Naturalistic Driving Environment Prior to Involvement in Unsafe Events, TRB paper 19-05116, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Arvin R., A. Khattak, J. Rios-Torres, Evaluating Safety with Automated Vehicles at Signalized Intersections: Application of Adaptive Cruise Control in Mixed Traffic, 19-05063, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Wali B. & A. Khattak, A Heterogeneity Based Case-Control Analysis of Motorcyclist's Injury Crashes: Evidence from Motorcycle Crash Causation Study, 19-05159, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Wali B., A. Khattak, & N. Ahmad, Modeling Injury Severity Score as a More Precise Measure of Motorcyclist Injuries: A Correlated Random Parameter Corner Solution Framework, TRB Paper 19-05185, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Shay E., A. Khattak, A. Boggs, Safety in the Connected and Automated Vehicle Era: A U.S. Perspective on Research Needs, TRB Paper, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Arvin R., M. Kamrani & A. Khattak. Instantaneous Driving Behavior at Intersections: Insights on Rear-end and Head-on Crash Frequencies Using Connected Vehicle Data. TRB Paper 19-00602, Accident Analysis and Prevention, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Kamrani M., R. Arvin & A. Khattak. The Role of Aggressive Driving and Speeding in Road Safety: Insight from SHRP2 Naturalistic Driving Study Data. TRB Paper 19-01980, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Arvin R., M. Kamrani & A. Khattak. Examining the Role of Speed and Driving Stability on Crash Severity Using SHRP2 Naturalistic Driving Study Data. TRB Paper 19-01981, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Mohammadi S., M. Kamrani & A. Khattak. Social Influence on Driver Decisions Using Modeling and Gossip Algorithm. TRB Paper 19-01424, Accepted for Presentation at the TRB Annual Meeting, National Academies, 2019.
- Hoque M., M. Kamrani, C. Davis & A. Khattak. Real-time Alerting of Hazardous Driving Behavior Using Internet of Things (IOT) and Connected Vehicles. TRB Paper 19-04684, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.
- Hosseinzadeh N., R. Arvin, A. Khattak & L. Han. Incorporating Route Safety in the Pathfinding Problem Using Big Data. TRB Paper 19-01433, Accepted for Presentation at TRB Annual Meeting, National Academies, 2019.
- Kamrani M., A. R. Srinivasan, S. Chakraborty & A. Khattak. Applying Markov Decision Process to Understand Driving Decisions in Connected Vehicle Systems. Transportation Research Part C: Emerging Technologies, Under Review, 2019.

Additionally, the UT faculty presented papers at conferences attended by students and practitioners at the plenary session of CICTP conference in Beijing, China, July 2018.

- Supported four students from UTK ITE Student Chapter to attend the Tennessee Institute of Transportation Engineers (TSITE) Summer Meeting. Students were able to present research reported in their papers of the annual student paper competition.
- Supported 2 UTK ITE Student Chapter meetings in the Spring and Fall semesters thus far. The meetings were held to promote further learning and career development into the transportation engineering realm for undergraduates and graduates students.
- Students planned and assisted in the inaugural weeklong camp, Crash Scene Investigation (CSI) Camp, for rising eighth and ninth graders. Sixteen students attended the camp to examine motor vehicle crashes by picking apart evidence and using mathematics. Some activities that students learned include measuring vehicle crush to determine speed of vehicle on impact, examining dashcam footage of vehicles involved in crashes, and determining the cause of the crashes in different scenarios.

Clemson

Dr. Jennifer Ogle had one PhD student, Mahdi Rajabi, and two MS Thesis students, Hind Ali and Nancy Chhetri, graduate on UTC funds.

NCAT

The STI program introduced several high schoolers to the various disciplines of transportation. Several of the students expressed increased interest in pursuing a career in transportation. One student went on to complete a summer internship with Fiat Chrysler Automotive company and hopes to be offered a full-time job with them or another automotive company in the near future.

UCF

MRI #2 produced one PhD student with STC support. He is currently working as a post-doctoral research associate. The Disaster Analytics project supported one MSc thesis student. The WWD project supported two MS thesis graduates, Omar Al-Sahili and Omar Faruk, who joined the industry after working on this project.

UK

The study offers opportunity for graduate students and postdocs to work on advanced modeling and data analytics, preparing them for future career in transportation system design, operation, planning, and advanced research.

USF

Two CUTR students supported with STC education funds were part of the CUTR collegiate traffic bowl team that won the National Traffic Bowl Grand Championship at the ITE annual meeting in Minneapolis in August.

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

NCAT

The funding received for the pedestrian study enabled us to purchase a virtual reality device and street crossing simulation software.

UCF

The Disaster Analytics project allowed us to purchase a large-scale dataset on Hurricane Matthew from Twitter.

UK

Results were shared with KYTC, and methods developed in this study are also used in a separate study to assess the performance measures for traffic incident management for KYTC.

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

NCAT

The results of the pedestrian safety study may lead to the development of training protocols that will help people understand the impact of distracted walking on street crossing safety.

UCF

The MRI #2 research will help us share the methodology for 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

UTK's Center for Transportation Research is partnering with Vessul Creative to develop a three-part virtual reality film for students who are 14-18 years old. This project will deliver a fully produced VR film and installation of the VR equipment. The film can be paired with the Seatbelt Convincer and will place the viewer in distracted driving scenarios that result in a simulated crash. The video will be timed so that individuals riding the convincer will feel the impact at the same time the crash on the VR video occurs. The video will be able to stand alone as a single, viewable piece and also be separated into three modules. By separating the video into separate modules, those standing in line to ride the Convincer can watch the pre-crash sequence and then watch the post-crash scene after they have ridden the Convincer. The goal of the VR experience is to make the Convincer's crash impact more real for the riders.

NCAT

The pedestrian safety study improved public knowledge (particularly those who participated in the study and those who attended the study presentations) about the hazards associated with distracted walking. It also brought attention to the various behaviors that are affected when listening to music while walking.

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 that prioritizes locations with missing sidewalks and bike lanes that have significant safety impacts.

5. Changes/Problems

No changes or problems during this reporting period.

6. Additional information regarding products and impacts

6.a. Outputs:

UT

- Arvin R., M. Kamrani, A. Khattak & J. Rios-Torres. Safety Impacts of Instrumented Vehicles in Mixed Traffic. Transportation Research Part C: Emerging Technologies, Under Review, 2019.
- Han J., J. Rios-Torres, R. Arvin & A. Khattak. Optimal Coordination Control Systems for Connected Vehicles at Highway On-Ramps: Safety, Traffic Flow, and Fuel Consumption Impacts. In preparation, 2019.

Weekly Transportation Safety Seminar Series
Spring 2018 Seminars at UTK:

- February 1 - 2018 Transportation Research Board Conference Experiences, UTK Graduate Students
- February 8 - Challenges of Roadway Construction in Area with Sulfur-Bearing Formations: Investigation and Mitigation Techniques, Jim Ozment
- February 15- Social Media and Crowd-Sourced Data in Transportation, Dr. Christa Brelsford, Oak Ridge National Laboratory
- February 22 - Transportation Infrastructure: Data to Pave the Way Forward, Pat Hu, US DOT Bureau of Transportation Statistics
- March 8 - Some Creative Thinking in Mobility Data Analytics, Dr. Ho-Ling Hwang, Oak Ridge National Laboratory
- April 5 - High-performance agent-based modeling and simulation of travel behavior: applications to transportation planning, operations, and control, Dr. Husain Aziz, Oak Ridge National Laboratory
- April 16 - Role of Geospatial and Big Data in Emergency Management, Dr. Bandana Kar, Oak Ridge National Laboratory

Fall 2018 Seminars at UTK:

- September 13, 2018, Enhancing Spatial Interaction Research with Social Flows and Creative Datasets, Dr. Clio Andris, Penn State University.
- September 20, 2018, Mobile Sensing to Mobile Control of Vehicular Traffic. Dr. Dan Work, Vanderbilt University.
- September 27, 2018, Optimization of Intra-City Freight Movement with New Delivery Methods, Dr. Amy Moore, Oak Ridge National Laboratory.
- November 8, 2018, TBA, Dr. Joseph Schofer, Northwestern University.
- November 15, 2018, TBA, Dr. Hyun Kim, Geography Department, The University of Tennessee.
- November 29, 2018, TBA, Dr. Anahita Khojandi, Industrial and Systems Engineering, The University of Tennessee.

UCF

MRI # 2

- Two journal papers have been accepted and two conference papers have been presented.

Disaster Analytics O&E

- Two submissions have been accepted at TRB 2019 and IEEE ITSC 2018.
- One journal paper has been published and two journal papers have been submitted.

UK

- Zhang, X., O. Kazi, J. Brashear, and M. Chen. A Data Driven Approach for Quantifying the Impact of Crashes, ASCE Journal of Transportation Engineering Part A: Systems. (submitted)

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.

Disaster Analytics O&E

- Improved understanding of social media use during hurricanes.

Wrong Way Driving O&E

- 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.

Wrong Way Driving O&E

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

UK

- Increased travel time reliability
- Improved incident management
- Increased public knowledge and awareness