



Center for Advanced Multimodal Mobility Solutions and Education



Annual Performance Indicators Report for University Transportation Centers



October 1, 2019 to September 30, 2020

Submitted by
Center for Advanced Multimodal Mobility Solutions and Education

Prepared for
**Office of the Assistant Secretary for Research and Technology (OST-R)
U.S. DEPARTMENT OF TRANSPORTATION**



University of North Carolina at Charlotte (Lead)
University of Texas at Austin
University of Connecticut
Washington State University – Pullman
Texas Southern University

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1. PROGRAM INFORMATION

USDOT Tier 1 University Transportation Center Annual Performance Indicators Report

Submitted to: U.S. Department of Transportation
Office of the Assistant Secretary for Research
and Technology (OST-R)

Grant Number: 69A3551747133

Project Title: Center for Advanced Multimodal Mobility Solutions
and Education (CAMMSE)

Center Director: Wei (David) Fan, Ph.D., P.E.
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Submission Date: October 26, 2020

DUNS: 06-630-0096

EIN: 56-0791228

Recipient Organization: University of North Carolina at Charlotte

Project/Grant Period: November 30, 2016 - September 30, 2022

Reporting Period Start Date: October 1, 2019

Reporting Period End Date: September 30, 2020

Report Term or Frequency: Annual Performance Indicators

Signature of Submitting Official:



2. PROGRAM-WIDE INDICATORS

University Transportation Centers Program Performance Indicators

UTC Name:	Center for Advanced Multimodal Mobility Solutions and Education (CAMMSE)
University:	Lead University: <ul style="list-style-type: none"> • University of North Carolina at Charlotte (UNCC) Consortium Member Universities: <ul style="list-style-type: none"> • University of Texas at Austin (UT Austin) • University of Connecticut (UConn) • Washington State University – Pullman (WSU) • Texas Southern University (TSU)
Grant #:	69A3551747133
Reporting Period:	October 1, 2019 to September 30, 2020

Performance Indicators	Total	UNCC	UT Austin	UConn	WSU	TSU
1. Number of transportation-related courses offered during the reporting period that were taught by faculty and/or teaching assistants who are associated with the UTC						
Undergraduate courses	27	5	5	12	2	3
Graduate courses	24	3	3	7	1	10
2. Number of students participating in transportation research projects during the reporting period funded by this grant						
Undergraduate students in research	8	0	3	2	3	0
Graduate students in research	31	8	7	5	4	7
3. Number of transportation-related advanced degree programs that utilize grant funds during the reporting period to support graduate students						
Masters level programs	3	1	1	0	0	1
Doctoral level programs	6	1	1	2	1	1
4. Number of students supported by this grant during the reporting period						



Undergraduate students	5	0	0	2	3	0
Masters students	8	1	1	1	0	5
Doctoral students	22	7	6	4	3	2

5. Number of degrees awarded during the reporting period to students supported by this grant

Undergraduate degrees	0	0	0	0	0	0
Masters degrees	6	1	2	0	0	3
Doctoral degrees	2	1	1	0	0	0

6. Number and total dollar value of research projects selected for funding during the reporting period using UTC grant funds (Federal and/or Recipient Share) that you consider to be applied research and advanced research

Number of applied research projects	13	4	3	2	1	3
Dollar value of applied research projects	\$101,0742.18	\$360,026.00	\$215,020.00	\$107,279.00	\$79,599.00	\$248,818.18
Number of advanced research projects	2	0	1	1	0	0
Dollar value of advanced research projects	\$147,053.00	-	\$65,000.00	\$82,053.00	-	-

3. UTC-SPECIFIC INDICATORS

3.1. University of North Carolina at Charlotte

Part II – UTC-Specific Performance Indicators		
UTC Name	Center for Advanced Multimodal Mobility Solutions and Education (Cammse)	
University	University of North Carolina at Charlotte	
Grant #	69A3551747133	
Reporting Period	October 1, 2019 - September 30, 2020	
Category	Description of indicator	Metric
<ul style="list-style-type: none"> Research Capability 	<ul style="list-style-type: none"> Research results published in: <i>International Journal of Transportation Science and Technology</i>, <i>Journal of Transportation Engineering, Part A: Systems, Transportation Planning and Technology</i>, <i>Accident Analysis and Prevention</i>, <i>Traffic Injury Prevention</i>, <i>Journal of Transport Geography</i>, <i>Journal of Transportation Safety & Security</i>, <i>Canadian Journal of Civil Engineering</i>, <i>Transportmetrica A: Transport Science</i>, <i>Journal of Public</i> Transportation Research results presented at: Virtual NCDOT/UTC Roundtable Meeting, USDOT Cammse UTC Webinar Series, Institute of Transportation Engineers (ITE) Student Chapter, the 23rd COTA Winter Symposium and the 99th Annual Meeting of the 	<ul style="list-style-type: none"> Number of refereed journal publications (19) <ol style="list-style-type: none"> Chen, Z. and Fan, W., Analyzing Travel Time Distribution Based on Different Travel Time Reliability Patterns Using Probe Vehicle Data, <i>International Journal of Transportation Science and Technology</i>, Volume 9, Issue 1, pp. 64-75, March 2020. Gu, J.J., Jiang, Z., Fan, W., Wu, J. and Chen, J., Real-Time Passenger Flow Anomaly Detection Considering Typical Time Series Clustered Characteristics at Metro Stations, <i>ASCE Journal of Transportation Engineering, Part A: Systems</i>, Volume 146, Issue 4, February 2020. Lin, Z. and Fan, W., Modeling Bicycle Ridership using Crowdsourced Data: An Ordered Probit Model Approach, <i>ASCE Journal of Transportation Engineering, Part A: Systems</i>, August



	<p>Transportation Research Board, North Carolina Section of the Institute of Transportation Engineers (NCSITE) Annual Meeting, Second Annual CAMMSE Research Symposium, the 2nd COTA International Symposium on Emerging Trends in Transportation (ISETT 2019)</p>	<p>2020.</p> <ol style="list-style-type: none">4. Lin, Z. and Fan, W., Modeling Bicycle Volume Using Crowdsourced Data from Strava Smartphone Application, International Journal of Transportation Science and Technology, March 2020.5. Liu, P. and Fan, W., Exploring the Impact of Connected and Autonomous Vehicles on Freeway Capacity Using a Revised Intelligent Driver Model, Transportation Planning and Technology, Volume 43, Issue 3, pp. 279-292, March 2020.6. Liu, P. and Fan, W., Exploring Injury Severity in Head-on Crashes Using Latent Class Clustering Analysis and Mixed Logit Model: a Case Study of North Carolina, Accident Analysis and Prevention, Volume 135, 105388, February 2020.7. Liu, P. and Fan, W., Modeling Head-on Crash Severity with Drivers under the Influence of Alcohol or Drugs (DUI) And Non- DUI, Traffic Injury Prevention, Volume 21, Issue 1, pp. 7-12, 2020.8. Teng, J., Chen, T. and Fan, W., An Integrated Approach to Vehicle Scheduling and Bus Timetabling for an Electric Bus Line, ASCE Journal of Transportation Engineering, Part A: Systems, Volume 146, Issue 2, February 2020.9. Zhao, J., Fan, W. and Zhai, X. H., Identification of Land-use Characteristics Using Bicycle Sharing Data: A Deep Learning Approach, Journal of Transport Geography, Volume 82, January 2020.10. Zhu, W., Wei, J. and Fan, W., Data Fusion Approach for Evaluating Route Choice Models in Large-Scale Complex Urban Rail Transit Networks, ASCE Journal of
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		<p>Transportation Engineering, Part A: Systems, Vol. 146, Issue 1, 04019056, January 2020.</p> <p>11. Li, Y. and Fan, W., Mixed Logit Approach to Modeling the Severity of Pedestrian-Injury in Pedestrian-Vehicle Crashes in North Carolina: Accounting for Unobserved Heterogeneity, Accepted for Publication, <i>Journal of Transportation Safety & Security</i>, pp.1-22, September 2020.</p> <p>12. Liu, P. and Fan, W., Analyzing Injury Severity of Rear-End Crashes involving Large Trucks Using a Mixed Logit Model: A Case Study in North Carolina, Accepted for Publication, <i>Journal of Transportation Safety & Security</i>, pp.1-14, August 2020.</p> <p>13. Liu, S. and Fan, W., Investigating Factors Affecting Injury Severity in Vehicle-Cyclist Crashes: A Day-of-Week Analysis with Partial Proportional Models, <i>Canadian Journal of Civil Engineering</i>, August 2020.</p> <p>14. Huang, Z., Fan, W., Xu, R.H., Lee, D.H. and Zhu, W., Reliability Measure-Based Data Analytics Approach to Identifying and Ranking Recurrent Bottlenecks in Urban Rail Transit Networks, <i>ASCE Journal of Transportation Engineering, Part A: Systems</i>, Volume 146, Issue 9, pp.04020103, September 2020.</p> <p>15. Zhou, F., Li, C.F., Huang, Z., Xu, R.H. and Fan, W., Fare Incentive Strategies for Managing Peak-Hour Congestion in Urban Rail Transit Networks, <i>Transportmetrica A: Transport Science</i>, pp.1-22, July 2020.</p> <p>16. Song, L. and Fan, W., Combined Latent Class and</p>
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		<p>Partial Proportional Odds Model Approach to Exploring the Heterogeneities in Truck-Involved Severities at Cross and T-Intersections, <i>Accident Analysis and Prevention</i>, Volume 144, 105638, September 2020.</p> <p>17. Zhu, W., Fan, W.L., Wei, J. and Fan, W., Complete Estimation Approach for Characterizing Passenger Travel Time Distributions at Rail Transit Station, <i>ASCE Journal of Transportation Engineering, Part A: Systems</i>, Volume 146, Issue 7, July 2020.</p> <p>18. Chen, Z. and Fan, W., Extracting Bus Transit Boarding and Alighting Information Using Smart Card Transaction Data, <i>Journal of Public Transportation</i>, Volume 20, Issue 1, June 2020.</p> <p>19. Li, Y. and Fan, W., Modelling the Severity of Pedestrian Injury in Pedestrian-Vehicle Crashes in North Carolina: A Partial Proportional Odds Logit Model Approach, <i>Journal of Transportation Safety & Security</i>, Volume 12, Issue 3, pp. 358-379, June 2020.</p> <ul style="list-style-type: none"> • Number of conference papers presented, and other presentations made (13) • Number of technical research reports published (4) <p>1. Fan, W. and Chen, Z, <i>Predicting Travel Time on Freeway Corridors: Machine Learning Approach</i>, Technical Report for CAMMSE Research 2019 Project 01, U.S. Department of Transportation, September 2020.</p> <p>2. Fan, W. and Li, Y, <i>Optimizing Transit Equity and</i></p>
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		<p><i>Accessibility by Integrating Relevant GTFS Data Performance Metrics</i>, Technical Report for CAMMSE Research 2019 Project 02, U.S. Department of Transportation, September 2020.</p> <p>3. Fan, W. and Lin, Z., <i>Analyzing Cycling Behavior During Different Time Periods Using Crowdsourced Bicycle Data</i>, Technical Report for CAMMSE Research 2019 Project 03, U.S. Department of Transportation, September 2020.</p> <p>4. Fan, W. and Liu, P., <i>Trajectory Optimization of Connected and Autonomous Vehicles (CAVs) at Signalized Intersections</i>, Technical Report for CAMMSE Research 2019 Project 04, U.S. Department of Transportation, September 2020.</p>
<ul style="list-style-type: none"> • Leadership 	<ul style="list-style-type: none"> • Guest Editor-in-Chief, <i>Journal of Advanced Transportation</i> • Handling Editor, <i>TRR Inaugural Editorial Board, Transportation Research Record</i> • Associate Editor, <i>IEEE Transactions on Intelligent Transportation Systems</i>, and <i>ASCE Journal of Transportation Engineering, Part A: Systems</i>, and <i>International Journal of Transportation Science and Technology</i> • Editorial Board, <i>Journal of World Review of Intermodal Transportation Research</i>, and, <i>International Journal of Revenue Management</i>, and <i>International Journal of Transportation</i>, and <i>International Journal of Natural Disasters, Accidents and Civil Infrastructure</i> • Academic Outreach and Membership Officer, Board of 	<ul style="list-style-type: none"> • Guest Editor-in-Chief (1) • Editorship (8) • Board of directors (1) • Organizing committee member, session chair or area editor of conference (4) • Number of professional committees or board member (10)



	<p>director, Chinese Overseas Transportation Association</p> <ul style="list-style-type: none"> • Chair of Session and Symposium Steering Committee Member of “Connected and Autonomous Vehicles,” The 23rd COTA Winter Symposium, 2019 CMMSE Research Symposium, The 2nd COTA International Symposium on Emerging Trends in Transportation (ISETT 2019) • Co-Chair of Connected Autonomous Vehicles Section, World Transport Convention • Member, TRB A0020C International Coordination Council (ICC), WTC Shared Logistics and Transportation Systems, ASCE National Connected & Autonomous Vehicles Impacts Committee, ASCE National Advanced Technologies Committee, NCDOT Fully Autonomous Vehicle (FAV) Research Working Group Committee, Sustain Charlotte Transportation Choices Alliance Advisory Council, ASCE National Public Transport Committee, ASCE National Rail Transportation Committee, NCSITE Scholarship Committee, TRB AHB60 Standing Committee, and Professional Engineers of North Carolina (PENC) State Board 	
<ul style="list-style-type: none"> • Education and Workforce Development 	<ul style="list-style-type: none"> • Five existing undergraduate courses and three existing graduate courses • Eight graduate students in CMMSE projects • Two degree programs in the College of Engineering in the Department of Civil and Environmental Engineering at UNC Charlotte 	<ul style="list-style-type: none"> • Transportation related courses offered by faculty (8) • Number of students participating in CMMSE funded projects (8) • Number of transportation related degree programs with students funded by CMMSE (2)



	<ul style="list-style-type: none"> • Three UNC Charlotte ITE student chapter seminars and thirty-one UNC Charlotte transportation graduate student weekly seminars • Reached out to Virtual sessions of the Rowan County drivers education classes, NC State Extension’s Annual 4-H Congress, Discovery Place, Kids Fest, MathCounts (PENC), and summer camp by CATS (Boyd) 	<ul style="list-style-type: none"> • Number of graduated students (1) • Number of outreaching activities (6) • Number of research symposium (1) • Number of transportation seminars (34) • Student scholarships or awards (6) <ol style="list-style-type: none"> 1. Zhen Chen, Outstanding Graduate Ph.D. Student Award, UNC Charlotte, December 5, 2019 2. Zhen Chen, Don Blackburn Memorial Scholarship, North Carolina Section of the Institute of Transportation Engineers, McKimmon Center, North Carolina State University, Raleigh, NC, November 21, 2019 3. Yang Li, Roy D. Williams Memorial Scholarship, North Carolina Section of the Institute of Transportation Engineers, McKimmon Center, North Carolina State University, Raleigh, NC, November 21, 2019 4. Zijing Lin, Emily Blount Honorary Scholarship, North Carolina Section of the Institute of Transportation Engineers, McKimmon Center, North Carolina State University, Raleigh, NC, November 21, 2019 5. Zijing Lin, First Place Award, Graduate Student Poster Competition, Second Annual CAMMSE Research Symposium, UNC Charlotte Center City, Charlotte, NC, November 7, 2019 6. Pengfei Liu, Second Place Award, Graduate Student Poster Competition, Second Annual CAMMSE Research Symposium, UNC Charlotte Center City, Charlotte, NC, November 7, 2019
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<ul style="list-style-type: none">• Technology Transfer	<ul style="list-style-type: none">• Three presentations were made at Virtual/NCDOT/UTC roundtable Meeting, USDOT CAMMSE UTC Webinar Series, and seminar of ITE at UNCC student chapter.• One presentation at NCSITE Annual Meeting• One presentation at the 2nd COTA International Symposium on Emerging Trends in Transportation (ISETT).• Two presentations at the 23rd COTA Winter Symposium• Six presentations at the second annual CAMMSE Research Symposium	<ul style="list-style-type: none">• Presentations given at professional and academic meeting (13)• Number of professionals in the audience (est. 600)
<ul style="list-style-type: none">• Collaboration	<ul style="list-style-type: none">• North Carolina DOT, North Carolina A&T State University, and North Carolina State University in collaborative research and UNC Charlotte in providing cash, in-kind support, facilities, etc.• Research Collaboration with Tongji University• Center personnel: Dr. Wei Fan, Dr. Martin Kane, and Dr. David Weggel	<ul style="list-style-type: none">• Number of collaborative partners (4)• Number of national and international collaboration (1)• Number of Center personnel involved (3)



3.2. University of Texas at Austin

Part II – UTC-Specific Performance Indicators		
UTC Name	Center for Advanced Multimodal Mobility Solutions and Education (CAMMSE)	
University	University of Texas at Austin	
Grant #	69A3551747133	
Reporting Period	October 1, 2019 - September 30, 2020	
Category	Description of indicator	Metric
1. Research Capability	<ul style="list-style-type: none"> Research results published in: <i>Journal of Computer Science</i> Research results presented at: the 99th Annual Meeting of the Transportation Research Board, the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) 	<ul style="list-style-type: none"> Number of refereed publications (1) <ol style="list-style-type: none"> Qian K, Claudel CG. Real-time Mobile Sensor Management Framework for city-scale environmental monitoring. arXiv preprint arXiv:2005.10378. 2020 May 20. Number of refereed conference proceedings (4) <ol style="list-style-type: none"> Zhu, Tengkuo., S. D. Boyles, and A. Unnikrishnan. (2020) Electric vehicle traveling salesman problem with drone. 99th Annual Meeting of the Transportation Research Board, Washington, DC. Liu, H. & Machemehl, R. (2020) A Queueing Theory Based Stochastic Traffic Delay Model for Adaptive Signal Control. 99th Annual Meeting of the Transportation Research Board, Washington, DC. Zhu, T., S. D. Boyles, and A. Unnikrishnan, Electric Vehicle Traveling Salesman Problem with Drone, 99th



		<p>Annual Meeting of the Transportation Research Board, January 2020, Washington, DC.</p> <p>4. Abdullah Mohamed, Kun Qian, Mohamed Elhoseiny, Christian Claudel, Social-STGCNN: A Social Spatio-Temporal Graph Convolutional Neural Network for Human Trajectory Prediction, CVPR, 2020.</p> <ul style="list-style-type: none">• Number of technical research reports published (6) <p>1. Boyles, S. D. and T. Zhu, <i>Assessment of Parcel Delivery Systems Using Unmanned Aerial Vehicles</i>, Technical Report for CAMMSE Research 2019 Project 07, August 2020.</p> <p>2. Hall, J, R. Machemehl, and C. Baumanis, <i>Forecasting Bicycle Facility Demand to Estimate Societal Impacts (Phase II)</i>, Technical Report for CAMMSE Research 2019 Project 05, August 2020.</p> <p>3. Liu, H. and R. Machemehl, <i>Corridor Level Adaptive Signal Control (Phase II)</i>, Technical Report for CAMMSE Research 2019 Project 05, August 2020.</p> <p>4. Mohamed, A. and C. Claudel, <i>Deep-Learning Based Trajectory Forecast for Safety of Intersections with Multimodal Traffic (Phase II)</i>, Technical Report for CAMMSE Research 2019 Project 08, August 2020.</p> <p>5. Mohamed, A., Hua, X., Zhou, X., Claudel, C. (2019) <i>IEA: Inner Ensemble Average within a Convolutional Neural</i></p>
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		<p><i>Network</i>. Center for Transportation Research. https://arxiv.org/abs/1808.10350.</p> <p>6. Mohamed, A., Claudel, C. (2019) <i>MCRM: Mother Compact Recurrent Memory</i>. Center for Transportation Research. https://arxiv.org/abs/1808.02016</p>
2. Leadership	<ul style="list-style-type: none"> • Associate Editor, <i>ITE Journal - Institute of Transportation Engineers</i>, <i>IEEE Transactions on Intelligent Transportation Systems</i> • Editorial Board, Transportation Research Part B, Transportation Research Part C, Journal of Infrastructure Systems • Chair, Transportation Research Board, Transit, Freight, and Logistics Subcommittee • Member, Transportation Research Board, Transportation Network Modeling Committee 	<ul style="list-style-type: none"> • Editorship (5) • Committee membership (2)
3. Education and Workforce Development	<ul style="list-style-type: none"> • Five undergraduate courses and three graduate courses • Three undergraduate student and seven graduate students in CAMMSE projects • One degree program in the Cockrell School of Engineering in the Civil, Architectural and Environmental Engineering Department 	<ul style="list-style-type: none"> • Transportation related course offered by faculty (8) • Number of students participating in CAMMSE funded projects (10) • Number of transportation related degree programs with students funded by CAMMSE (1)
4. Technology Transfer	<ul style="list-style-type: none"> • One Ph.D. student and two MS students have graduated this past year. The CAMMSE-supported students that have graduated during this reporting period will carry the new technology that they have developed with them for the rest of their careers. 	<ul style="list-style-type: none"> • Number of graduated students (3) • Number of presentations (5)
5. Collaboration	<ul style="list-style-type: none"> • City of Austin in collaborative research and UT's Center for 	<ul style="list-style-type: none"> • Number of collaborative partners (2)



	<p>Transportation Research providing in-kind support, facilities, etc.</p> <ul style="list-style-type: none">• NSF in collaborative research• Center personnel: Dr. Randy Machemehl, Dr. Stephen Boyles, Dr. Christian Claudel, Carolina Baumanis	<ul style="list-style-type: none">• Number of Center personnel involved (4)
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3.3. University of Connecticut

Part II – UTC-Specific Performance Indicators	
UTC Name	Center for Advanced Multimodal Mobility Solutions and Education (Cammse)
University	University of Connecticut
Grant #	69A3551747133
Reporting Period	October 1, 2019 to September 30, 2020



Category	Description of indicator	Metric
1. Research Capability	<ul style="list-style-type: none"> Research results published in: <i>arXiv distribution service</i> Research results presented in: ASCE Construction Research Congress 	<ul style="list-style-type: none"> Number of refereed journal publications (1) <ol style="list-style-type: none"> 1. Toman P, Zhang J, Ravishanker N, Konduri K. Spatiotemporal Analysis of Ridesourcing and Taxi Demand by Taxi zones in New York City. arXiv preprint arXiv:2008.00568. 2020 Aug 2. Number of conference papers presented (1) <ol style="list-style-type: none"> 1. Zhu, J., Zhang, Lu, and Ren, Z. (2020). How Transportation Infrastructures Make Human Resilience Possible: Towards A Conceptual Framework. ASCE Construction Research Congress, March 8-10, 2020, Tempe, AZ. Number of technical research reports published (3) <ol style="list-style-type: none"> 1. Cohen, J. and Lownes, N., <i>Highways and Wealth Distribution: A Geospatial Analysis</i>, Technical Report for Cammse Research 2019 Project 09, U.S. Department of Transportation, September 2020. 2. Konduri, K.C. and Ravishanker, N., <i>Are Transportation Network</i>



		<p><i>Companies Synergistic with Other Shared Ride Mode Offerings? An Exploratory Analysis of Demand Data from NYC Utilizing High Resolution Spatiotemporal Models</i>, Technical Report for CAMMSE Research 2019 Project 10, U.S. Department of Transportation, September 2020.</p> <p>3. Garrick, N. and Atkinson-Palombo, C., <i>Understanding the Surprising and Oversized Use of Ridesourcing Services in Poorer Neighborhoods in NYC</i>, Technical Report for CAMMSE Research 2019 Project 11, U.S. Department of Transportation, September 2020.</p>
2. Leadership	<ul style="list-style-type: none"> • Session Chair INFORMS; Paper Review Coordinator TRB Standing committees AP025, ADB10; • Member, TRB Standing Committees (AP025, ADB10), ASCE Public Transportation Committee, Connecticut Transportation Institute 	<ul style="list-style-type: none"> • Editorship (1) • Organizing committee member or subcommittee chair of conference or workshop (3) • Number of professional committees or affiliated centers (4)
3. Education and Workforce Development	<ul style="list-style-type: none"> • Twelve undergrad course offerings and seven graduate course offerings • Five graduate students in CAMMSE projects, two undergraduate students • Degree programs in civil engineering, geography and statistics 	<ul style="list-style-type: none"> • Transportation related courses offered by faculty (19) • Number of students participating in CAMMSE funded projects (7) • Number of transportation related degree programs with students funded by CAMMSE (2)
4. Technology Transfer	<ul style="list-style-type: none"> • Six presentations at professional and academic meetings 	<ul style="list-style-type: none"> • Number of events held (6) • Number of professionals in the audience (est. 200)
5. Collaboration	<ul style="list-style-type: none"> • Connecticut DOT, partnership for Strong Communities, University of Queensland • Dissertation Reviewer, UNSW; 	<ul style="list-style-type: none"> • Number of collaborative partners (3) • Number of international collaboration (2)



	<p>Research Collaboration with University of Queensland</p> <ul style="list-style-type: none">Center personnel: Drs. Nicholas Lownes, John Ivan, Jin Zhu and Amy Burnicki	<ul style="list-style-type: none">Number of Center personnel involved (4)
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3.4. Washington State University – Pullman

Part II – UTC-Specific Performance Indicators		
UTC Name	Center for Advanced Multimodal Mobility Solutions and Education (Cammse)	
University	Washington State University – Pullman	
Grant #	69A3551747133	
Reporting Period	October 1, 2019 to September 30, 2020	
Category	Description of indicator	Metric
1. Research Capability	<ul style="list-style-type: none"> Research results published in: <i>Sustainability, Transportation Research Record, Transportation Research Part C, ASCE and IEEE Journals</i>, etc. Research results presented at: the 2nd Cammse Research Symposium, 99th TRB Annual Meeting, INFORMS Annual Meeting, IEEE 23rd International Conference on Intelligent Transportation Systems, etc. 	<ul style="list-style-type: none"> Number of refereed journal publications (10) <ol style="list-style-type: none"> He Y, Rahman MT, Akin M, Wang Y, Dey K, Shi X. Connected Vehicle Technology for Improved Multimodal Winter Travel: Agency Perspective and a Conceptual Exploration. <i>Sustainability</i>. 2020 Jan;12(12):5071. Zhang Y, Akin M, Shi X. Laboratory Investigation of Prewet Deicer Performance for Winter Mobility in the Pacific Northwest. <i>Journal of Cold Regions Engineering</i>. 2020 Dec 1;34(4):04020022. Akin M, Fay L, Shi X. Friction and Snow–Pavement Bond after Salting and Plowing Permeable Friction Surfaces. <i>Transportation Research Record</i>. 2020 Sep 13:0361198120949250. Du, S., Akin, M., Bergner, D., Xu, G., Shi, X. Material Application Methodologies for Winter Road Maintenance Operations: A Renewed Perspective. <i>Canadian Journal of Civil Engineering</i>, 2020, in press. Winston, C., & Yan, J. (2020).



		<p>Vehicle size choice and automobile externalities: A dynamic analysis. <i>Journal of Econometrics</i>, in press.</p> <p>6. Niroumand, R., Tajalli, M., Hajibabai, L., & Hajbabaie, A. (2020). Joint optimization of vehicle-group trajectory and signal timing: Introducing the white phase for mixed-autonomy traffic stream. <i>Transportation Research Part C: Emerging Technologies</i>, 116, 102659.</p> <p>7. Al Islam, S. B., Aziz, H. A., & Hajbabaie, A. (2020). Stochastic Gradient-Based Optimal Signal Control with Energy Consumption Bounds. <i>IEEE Transactions on Intelligent Transportation Systems</i>, 1-14.</p> <p>8. Tajalli M., M. Mehrabipour, and A. Hajbabaie. Cooperative Signal Timing and Speed Optimization in Connected Urban-Street Networks. <i>IEEE Transactions on Intelligent Transportation Systems</i>, Accepted.</p> <p>9. Islam S., A. Hajbabaie, and H. Aziz. A Real-Time Network-Level Traffic Signal Control Methodology with Partial Vehicle Information. <i>Transportation Research Part C: Emerging Technologies</i>, Accepted.</p> <p>10. Mirheli A., Tajalli M., Mohebifard R., L. Hajibabai, and A. Hajbabaie. Utilization Management of Highway Fleet Equipment: Formulation and Application. <i>Transportation Research Record: Journal of the Transportation Research Board</i>, In Press.</p> <p>•Number of presentations (20)</p> <p>•Number of technical research</p>
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		<p>reports published (3)</p> <ol style="list-style-type: none"> 1. Chen, C., Shi, X. <i>Effects of Incorporating Connected Vehicle Technologies into No-Notice Emergency Evacuation During Winter Weather (Phase I)</i>. Final Report for the Center for Advanced Multimodal Mobility Solutions & Education. Charlotte, North Carolina. August 2020. 2. Willis, O., Reed, C., Zhang, Y., Shi, X. <i>Multimodal Transportation Engineering Curriculum for Middle and High School Students</i>. Final Report for the Center for Advanced Multimodal Mobility Solutions & Education. Charlotte, North Carolina. August 2020. 3. Hajbabaie, A. and Tajalli, M., <i>Dynamic Speed Harmonization in Connected Urban Street Networks: Improving Mobility</i>. Final Report for the Center for Advanced Multimodal Mobility Solutions & Education. Charlotte, North Carolina. September 2020.
<p>2. Leadership</p>	<ul style="list-style-type: none"> • Editor-in-Chief of <i>Journal of Infrastructure Preservation & Resilience</i>; Editorial Board of <i>International Journal of Transportation Science and Technology</i>; Editorial Board of <i>Transportmetrica</i> • One ASCE Fellow, elected July 2020 • Chair of the asset management subcommittee of Traffic Signal Systems Committee of the Transportation Research Board. • Member of two TRB committees and is affiliated with three centers 	<ul style="list-style-type: none"> • Editorship (3) • Fellowship (1) • Organizing committee member or subcommittee chair of conference or workshop (1) • Number of professional committees or affiliated centers (5)
<p>3. Education and</p>	<ul style="list-style-type: none"> • Teaching the following two 	<ul style="list-style-type: none"> • Transportation related



<p>Workforce Development</p>	<p>undergraduate courses related to traffic engineering (approximately 140 students) and one graduate course in transportation materials (8 students)</p> <ul style="list-style-type: none"> • Supporting 3 Ph.D. students and 3 undergraduate students in CAMMSE funded projects. One more Ph.D. student participating but funded by TA • Transportation Engineering Ph.D. program at WSU 	<p>courses offered by faculty (3)</p> <ul style="list-style-type: none"> • Number of students participating in CAMMSE funded projects (7) • Number of transportation related degree programs with students funded by CAMMSE (1)
<p>4. Technology Transfer</p>	<ul style="list-style-type: none"> • Presentations at the 2nd CAMMSE Research Symposium, the 99th TRB Annual Meeting, INFORMS Annual Meeting, the IEEE 23rd International Conference on Intelligent Transportation Systems, etc. 	<ul style="list-style-type: none"> • Presentations given at professional and academic meeting (20) • Number of professionals in the audience (470)
<p>5. Collaboration</p>	<ul style="list-style-type: none"> • Region 10 UTC: PacTrans: providing knowledge and shared interest in connected vehicle technology research • Montana State University: facility utilization • West Virginia University: serving as subcontractor to one CAMMSE project 	<ul style="list-style-type: none"> • Number of collaborative partners (3) • Number of international collaboration (0). • Number of Center personnel involved (5): Dr. Ali Hajababaie, Dr. Jia Yan, Michelle Akin, Cheryl Reed, Dr. Xianming Shi

3.5. Texas Southern University

Part II – UTC-Specific Performance Indicators		
UTC Name	Center for Advanced Multimodal Mobility Solutions and Education (Cammse)	
University	Texas Southern University	
Grant #	69A3551747133	
Reporting Period	October 1, 2019 to September 30, 2020	
Category	Description of indicator	Metric
1. Research Capability	<ul style="list-style-type: none"> Research results published in: <i>Journal of Traffic and Transportation Engineering</i>, <i>Journal of Advanced Transportation</i>, <i>Environmental Monitoring and Assessment</i>, <i>IEEE Access</i>, <i>International Journal of Environmental Research and Public Health</i>, <i>Journal of Safety Research</i>, <i>Mathematical Problems in Engineering</i> Research results presented at: The Transportation Research Board 99th Annual Meeting, the 33rd Annual Conference of International Chinese Transportation Professionals Association Technical reports for Cammse: “Signal Timing and Geometric Design At Intersections with Contraflow Left-Turn Lanes”, “Signal Design and Timing for Continuous Flow Intersection”, and “Investigating the Impact of Different Attributes on Bicycling Mode Share as A Multimodal Connectivity Strategy in Large Cities: A Case Study in Houston” 	<ul style="list-style-type: none"> Number of refereed journal publications (9) <ol style="list-style-type: none"> Qu, W.; Sun, Q.; Zhao, Q.; Tao, T.; Qi, Y. Statistical Analysis of Safety Performance of Displaced Left-Turn Intersections: Case Studies in San Marcos, Texas. <i>International Journal of Environmental Research and Public Health</i>, 17, 6446. September 2020. Shi, J, L. Chen, F. Qiao, L. Yu, Q. Li, and G. Fan. Simulation and analysis of the carrying capacity for road networks using a grid-based approach. <i>Journal of Traffic and Transportation Engineering</i>, Volume 7, Issue 4, Pages 498-506, August 2020. Liu, Z., Guo, R., Qi, Y., & Jiang, C. (2020). Simultaneity of Synchronization and Antisynchronization in a Class of Chaotic Systems. <i>Mathematical Problems in Engineering</i>, July 2020. Zhang, X, X. Chen, A. Fan, and L. Yu. What Motivates the Driver to Comply with Speed Guidance Information at Signalized Intersections? <i>Journal of Advanced Transportation</i>, Volume 2020, Article ID 8862918, July 2020.



		<p>5. J. Du, F. Qiao and L. Yu. Improving Bus Transit Services for Disabled Individuals: Demand Clustering, Bus Assignment, and Route Optimization. in <i>IEEE Access</i>, vol. 8, pp. 121564-121571, July 2020.</p> <p>6. Liu, X., Q. Zhao, S. Zhu, W. Peng, and L. Yu. An Experimental Application of Laser-Scattering Sensor to Estimate the Traffic-Induced PM2.5 in Beijing, <i>Environmental Monitoring and Assessment</i>.</p> <p>7. Qu, W., T. Tao, Q. Zhao, Q. Sun, and Y. Qi, "Two-Way Left Turn Lane or Raised Median? A Truck Safety Based Study", <i>Journal of Safety Research</i>, May 2020</p> <p>8. X. Yi, R. Guo and Y. Qi. Stabilization of Chaotic Systems with Both Uncertainty and Disturbance by the UDE-Based Control Method. in <i>IEEE Access</i>, vol. 8, pp. 62471-62477, March 2020</p> <p>9. Huang, J., G. Song, J. Zhang, C. Li, Q. Liu, and L. Yu (2020) The Impact of Violations of Bicycles and Pedestrians on Vehicle Emissions at Signalized Intersections, <i>Journal of Advanced Transportation</i>, Volume 2020, Article ID 7539829, March 2020.</p> <ul style="list-style-type: none"> • Number of conference papers presented (13) <p>1. Jinna, H., Y. Qi, Q. Zhao and M. Azimi and "Countermeasures for Reducing Truck Congestion at Marine Terminals," Presented at the 99th Transportation Research Board Annual Meeting, Washington, DC, Jan.12-16, 2020.</p> <p>2. Qi, Y., S. Liu, Q. Zhao and W. Qu "Development of a Progression-Based, Signal-</p>
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		<p>Timing Strategy for Continuous Flow Intersections”, Presented at the 99th Transportation Research Board Annual Meeting, Washington, DC, Jan.12-16, 2020.</p> <ol style="list-style-type: none">3. Liu, P., and Y. Qi and “Analyzing Injury Severity of Large Truck Crashes Using a Partial Proportional Odds Model: A Case Study in Texas”, Presented at the 99th Transportation Research Board Annual Meeting, Washington, DC, Jan.12-16, 2020.4. Qiao, F., S. Liu, Q. Li, J. Du, and L. Yu. Implication of Eco-Driving at a Single Lane Roundabout. Proceedings of the 33rd Annual Conference of International Chinese Transportation Professionals Association (ICTAP), May 27-30, 2020, Shanghai, China.5. Du, J, F. Qiao, and L. Yu. Impact Assessment of Traffic Noise on Community Environment under Various Acoustic Barriers during Urban Infill Development Process. The 99th Transportation Research Board Annual Meeting Presentation P20-21494, Transportation Research Board of the National Academies, Washington, Jan 2020.6. Du, J, F. Qiao, and L. Yu. Impact of Highway Managed Lane Pricing Strategies on Ozone Related Vehicle Exhaust Emissions: A Case Study on Houston Kay Freeway Managed Lane. The 99th Transportation Research Board Annual Meeting Paper 20-05802, Transportation Research Board of the National Academies, Washington, Jan 2020.7. Wang, X, G. Song, Y. Wu, Z. Zhai, and L. Yu. Identification of Vehicle Load based on
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		<p>Power Characteristics of Heavy-Duty Trucks for Emission Estimation. The 99th Transportation Research Board Annual Meeting Paper 20-05610, Transportation Research Board of the National Academies, Washington, Jan 2020.</p> <p>8. Jiang, Y, G. Song, Z. Li, Z. Zhai, Z. Zhang, and L. Yu. Estimation of Hourly Traffic Flows from Floating Car Data for Vehicle Emission Estimation. The 99th Transportation Research Board Annual Meeting Paper 20-02879, Transportation Research Board of the National Academies, Washington, Jan 2020.</p> <p>9. Kou, W, X. Chen, and L. Yu. A Bi-level Optimization Model for Exclusive Bus Lane Design to Improve Passenger Travel Time Reliability. The 99th Transportation Research Board Annual Meeting Paper 20-03854, Transportation Research Board of the National Academies, Washington, Jan 2020.</p> <p>10. Qiao, F, M. Nabi, and L. Yu. Estimating Light Duty Vehicle Emission Factors Using Random Forest Regression Model with Pavement Roughness. The 99th Transportation Research Board Annual Meeting Paper 20-06058, Transportation Research Board of the National Academies, Washington, Jan 2020.</p> <p>11. Zhang, Y, X. Chen, and L. Yu. Evaluating Energy and Emission Impact of Autonomous Bus on Urban Expressway. The 99th Transportation Research Board Annual Meeting Paper 20-05052, Transportation Research Board of the National Academies, Washington, Jan 2020.</p> <p>12. Zhang, X, X. Chen, A. Fan,</p>
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		<p>and L. Yu. What Motivates the Driver to Comply with Guidance Information at Signalized Intersections? An Empirical Study of China Based on Multiple-Indicator Multiple-Cause Model and Latent Class Analysis. The 99th Transportation Research Board Annual Meeting Paper 20-02858, Transportation Research Board of the National Academies, Washington, Jan 2020.</p> <p>13. Zhang, Z, G. Song, J. Chen, Z. Zhai, and L. Yu. Development of a Simplified Model of Speed-specific VSP Distribution Based on Vehicle Weight for Fuel Consumption Estimates. The 99th Transportation Research Board Annual Meeting Paper 20-05903, Transportation Research Board of the National Academies, Washington, Jan 2020.</p> <ul style="list-style-type: none"> • Number of technical research reports published (3) <p>1. Qi, Y., Zhao, Q., Liu, J., and Liu, S., <i>Development of Guidelines for Implementation of Contraflow Left-Turn Lanes at Signalized Intersections</i>, Technical Report for CAMMSE Research 2019 Project 12, September 2020.</p> <p>2. Qi, Y., Zhao, Q., Liu, S., and Azimi, M. <i>Signal Timing Strategy for Displaced Left Turn Intersections</i>, Technical Report for CAMMSE Research 2019 Project 13, September 2020.</p> <p>3. Azimi, M. Lan, L., Rahman, M. and Qi, Y. <i>Impacts of Bicycling Corridor Improvements on Users' Behaviors in Large Cities</i>, Technical Report for CAMMSE Research 2019 Project 14, September 2020.</p>
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2. Leadership

- Editorial Board of Journal of Transportation Research Part D; Editorial Advisory Board of Asian Transport Studies; Associate Editor of Current Trends in Civil & Structural Engineering; Lead Guest Editor of Special Issue "Information-Theoretic Methods for Transportation", Journal of entropy, MDPI, 2020; Guest Editor of Special Issue "Control Problems of Nonlinear Systems with Applications" , Mathematical Problems in Engineering, Hindawi, 2020
 - Member, TRB Standing Committees (AT050, AW010, AW020, AW010(2), AW010(3)); Committee Research Coordinator, TRB Standing Committees (AW010); Committee Communications Coordinator TRB Standing Committees (AW020).
 - Member, Maritime Education, Training, and Outreach subcommittee of the Lone Star Harbor Safety Committee (LSHSC)
 - CAMMSE funded students received notable national and regional awards including: Council of University Transportation Center (CUTC) Outstanding Student of the Year (1), The Helene M. Overly Memorial Scholarship (1), The Transportation Club of Houston Scholarship (1), TSU university scholarship (1), and TSU university travel award (1)
- Editorship (5)
 - Number of professional committees or affiliated centers (6)
 - Number and type of notable national and regional awards (5)

3. Education and Workforce Development

- Three existing undergrad courses and ten existing graduate courses
 - Seven graduate students in CAMMSE projects
- Transportation related courses offered by faculty (13)
 - Number of faculty in transportation areas (3)



	<ul style="list-style-type: none"> • One M.S. degree program in the College of Science, Technology and Engineering at TSU; one Ph.D. program in the College of Public Affairs • Three master theses directly supported by CAMMSE “A Method for Estimating Truck Queue Length at Marine Terminal Gates”, “Safety Performance of Displaced Left Turn Intersections Case Studies in San Marcos, Texas”, and “Countermeasures for Reducing Truck Congestion as Marine Terminals” • Organized three Transportation Seminars: “Resilience of Ports and the Marine Transportation System”, “Theoretical Examination of Passing Sight Distance with Application to Marking” and “Transportation Opportunities Q&A” • Organized a virtual recruitment event “Texas Southern University (TSU) Maritime Transportation Management and Security (MTMS) Zoom Information Calls” on May 18th, 2020 	<ul style="list-style-type: none"> • Number of students participating in CAMMSE funded projects (7) • Number of transportation related degree programs with students funded by CAMMSE (2) • Number of master thesis (3) • Number of seminar (3) • Number of outreach activities (1)
<p>4. Technology Transfer</p>	<ul style="list-style-type: none"> • Thirteen presentations (the TRB 99th Annual Meeting and the 33rd Annual Conference of International Chinese Transportation Professionals Association) 	<ul style="list-style-type: none"> • Presentations given at professional and academic meeting (13) • Number of technical research reports published by the consortium (3)
<p>5. Collaboration</p>	<ul style="list-style-type: none"> • Collaborated with University of Alabama, Clemson University, and Mississippi State University, University of Central Florida, Pennsylvania State University, and University of Louisville to develop new proposals • Collaborated with Houston Bike Share, and City of Houston • Center personnel: Dr. Yi Qi, Dr. Lei Yu and Dr. Mehdi Azimi 	<ul style="list-style-type: none"> • Number of collaborative partners (8) • Number of Center personnel involved (3)



**Center for Advanced Multimodal Mobility
Solutions and Education**