Semi-Annual Progress Report No. 6 – Urban Mobility & Equity Center

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	Morgan State University (Lead Institution) *Virginia Polytechnic Institute and State University* *University of Maryland*
Program Director:	Dr. Mansoureh Jeihani 443-885-1873
Submitting Official:	Same as above
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Signature:

1. **ACCOMPLISHMENTS.**

What was done? What was learned?

1.1 What are the major goals and objectives of the program?

The major goal of UMEC is to further urban mobility of people and goods in a safe, environmentally sustainable, and equitable manner and formulate new technologies, policies and practices aimed at mobility. An increasingly important facet of UMEC's research is investigating how automated and connected vehicles will enter the mix, and how equity concerns will be addressed amid such changing technologies.

1.2 What was accomplished under these goals?

Below is a chart listing all 53 UMEC projects.
Twenty-nine have been completed and are listed in green type; one project is complete but the results have not been released due to protecting intellectual property. Final reports for these projects are available on our website, www.morgan.edu/umec, and they have been submitted to the appropriate databases.

As we enter the final year of the grant, we anticipate robust sixth-year projects from our researchers. In the previous five years, these projects have provided students with an opportunity for research, helping shape the future workforce. Through this research, students also gain insight into transportation's rapidly changing technology and accompanying challenges, especially regarding equity.

Project Type/ University	Project Name	PIs
Core- VT	Advanced Mobility for People with Disability: Autonomous Wheelchair Pilot Deployment at the BWI	Mansoureh Jeihani, Kofi Nyarko, Eazaz Sadeghvaziri, Cynthia Glass
Core-VT	Two-Dimensional Mdeling of Bicycle Behavior	Hesham Rakha, Karim Fadhloun
Core-VT	Changes of Bikeshare and Other Non-Automobile Modes of Transportation During The COVID	Jianhe Du, Hesham Rakha
Core-VT	Optimization of Vehicle Trajectories Considering Uncertainty in the Vicinity of Actuated Traffic Signals	Hesham Rakha, Amr Shafik, Seifeldeen Eteifa

Core-VT	**Quantifying the Impact of C-V2x on Transportation system Efficiency, Energy and Environment**	**Hesham Rakha, Kyoungho Ahn**
Core-UMD	**Development of an Intelligent Tool for Assessing the benefits of Highway Safety Improvement Projects**	**Gang-Len Chang**
Core-UMD	**Integrated Mobility Services**	**Paul Schonfeld**
Core-MSU	Investigating Walking and Biking Activities Among Low-Income Americans	Eazaz Sadeghvaziri, Mansoureh Jeihani
Collaborative-UMD, VT	Analysis of Interrelated Network Improvement Alternatives	Paul Schonfeld Hesham Rakha
Collaborative-UMD, VT	Fare Free Public Transportation: A full-scale real-world experiment in Alexandria, Virginia	Cinzia Cirillo, Hesham Rakha
Collaborative-VT, MSU	Optimum Connected Vehicle Speed Control on Signalized Roadways in Mixed Flow	Hao Chen, Hesham Rakha, Mansoureh Jeihani, Eazaz Sadeghvaziri
Collaborative-MSU, UMD	User Preference Analysis for Mobility-as-a-Service (MaaS) and Its Impact in Maryland	Young-Jae Lee, Hyeon-Shic Shin, Paul Schonfeld
Core-MSU	The Typology of Transportation Accessibility: A Qualitative and Quantitative Meta-Analysis	Hyeon-Shic Shin
Core-MSU	Integrated Optimal Transit Network Design with MaaS Implementation	Young-Jae Lee
Core-VT	Impact of COVID-19 on Ridehailing and Other Modes of Transportation	Jianhe Du, Hesham Rakha

Core-VT	Estimating switching times of Actuated Coordinated Traffic Signals: A deep learning approach	Hesham Rakha, Seifeldeen Eteifa
Core-VT	Developing an Intelligent Connected Vehicle based Traffic State Estimator	Hesham Rakha, Ahmed Abdelrahman, Hossam Abdelghaffar
Collaborative – UMD, MSU	EQUITABLE COMPLETE STREETS: Data and Methods for Optimal Design Implementation	Cinzia Cirillo, Mansoureh Jeihani, Paul Schonfeld
Collaborative – VT, MSU	Integrated Optimization of Vehicle Speed Control and Traffic Signal Timing: System Development and Testing	Hao Chen, Hesham Rakha, Mansoureh Jeihani
Collaborative – VT, MSU	Bicyclist Longitudinal Motion Modeling	Hesham Rakha, Karim Fadhioun, Mansoureh Jeihani
Collaborative – MSU, UMD	A Comparative Study of Pedestrian Crossing Behavior and Safety in Baltimore and Washington, D.C., Using Video Surveillance	Celeste Chavis, Kofi Nyarko, Cinzia Cirillo
Core-UMD	Multi-depot and Multi-school bus Scheduling Problem with School Bell Time Optimization	Ali Haghani
Core-UMD	Adoption and Diffusion of Electric Vehicles in Maryland	Cinzia Cirillo
Core-MSU	The Effect of COVID-19 on Mobility and Equity: A Case Study on Transit Users in Baltimore, MD	Mansoureh Jeihani, Celeste Chavis
Core-VT	Estimating Traffic Stream Density Using Connected Vehicle Data	Hesham A. Rakha, Hossam M. Abdelghaffar
Core-VT	A Study of the Impact of Ridesharing on Public Transit Ridership	Hesham Rakha, Jianhe Du
Core-UMD	Optimized Development of Urban Transportation Networks 2.0	Paul Schonfeld
Core-UMD	How Mobility and Accessibility Affect Crime Rates: Insights from Mobile Device Location Data	Lei Zhang

Collaborative –UMD, MSU	Equity in Accessibility to Opportunities: Insights, Measures, and Solutions based on Mobile Device Location Data	Chenfeng Xiong, Hyeon-Shic Shin
Collaborative – VT, MSU	Investigating the Effect of Connected Vehicles (CV) Route Guidance on Mobility and Equity	Mansoureh Jeihani, Ali Haghani, Anita Jones
Collaborative – UMD, MSU	E-Bikes Effect on Mode and Route Choice: A Case Study of Richmond, Va., Bikeshare	Celeste Chavis, Vanessa Frias-Martinez
Collaborative – VT, MSU	Developing and Testing an Advanced Hybrid Electric Vehicle Eco-Cooperative Adaptive Cruise Control System at Multiple Signalized Intersections (Short title: EcoCACC for HEVs)	Hao Chen, Hesham Rakha, Mansoureh Jeihani
Core – MSU	Developing Optimal Peer-to-Peer Ridesharing Strategies (completed but being held to protect intellectual property)	Young-Jae Lee, Amirreza Nickkar
Core – VT	Energy Efficient Transportation Modeling	Hesham Rakha
Core – MSU	Optimal Automated Demand Responsive Feeder Transit Operation and Its Impact	Young-Jae Lee, Amirreza Nickkar
Core – UMD	Dynamic (Time Dependent) Green Vehicle Routing Problem	Ali Haghani, Golnush Masghati Amoli, Moschoula Pternea
Core – UMD	Evaluating Equity Issues for Managed Lanes: Methods for Analysis and Empirical Results	Cinzia Cirillo
Core – MSU	Investigating the Impact of Distracted Driving Among Different Socio-Demographic Groups (formerly Hands on Wheel, Eyes on Road)	Mansoureh Jeihani

Core – VT	Traffic State Prediction: A Traveler Equity and Multi-model Perspective	Hesham Rakha
Core – VT	Development of Multimodal Traffic Signal Control	Hesham Rakha Kyoungho Ahn
Core – MSU	Understanding Access to Grocery Stores in Food Deserts in Baltimore City	Celeste Chavis, Anita Jones
Core – UMD	Optimized Development of Urban Transportation Networks	Paul Schonfeld
Collaborative – UMD, MSU	Optimization of Emergency Traffic Patrols (ETP) Operations	Ali Haghani, Mansoureh Jeihani
Collaborative – VT, MSU	Developing and Testing an ECO-Cooperative Adaptive Cruise Control System for Buses	Hesham Rakha, Hao Chen, Mansoureh Jeihani
Core – MSU	Driver's Interactions with Advanced Vehicles in Various Traffic Mixes and Flows (autonomous and connected vehicles (ACVs) electric vehicles (EVs), V2X, trucks, bicycles and pedestrians) - Phase I: Driver Behavior Study and Parameters Estimation	Mansoureh Jeihani
Core – VT	Developing a Connected Vehicle Transit Signal Priority System	Kyoungho Ahn, Hesham Rakha, Hossam Abdelghaffar
Collaborative – MSU, UMD	Innovative Methods for Delivering Fresh Foods to Underserved Populations	Hyeon-Shic Shin, Young-Jae Lee, Paul Schonfeld
Collaborative – MSU, UMD	Shared Bus/Bike Lane Safety Analysis: Assessing Multimodal Access and Conflicts	Celeste Chavis, Cinzia Cirillo
Core – MSU	Sustainable Design of Concrete Bus Pads to Improve Mobility in Baltimore City	Mehdi Shokouhian , Kadir Aslan

Core – UMD	Managing the Impacts of Different CV/AV Penetration Rates on Recurrent Freeway Congestion from the Perspective of Traffic Management	Gang-Len Chang
Collaborative – UMD, MSU	E3: Evaluating Equity in Evacuation: A Practical Tool and A Case Study	Cinzia Cirillo, Celeste Chavis
Collaborative – VT, UMD	Developing an Eco-Cooperative Adaptive Cruise Control System for Electric Vehicles	Hao Che Hesham Rakha, Cinzia Cirillo
Collaborative – VT, MSU	Improving Public School Bus Operations: Boston Case Study	Youssef Bichiou, Hesham Rakha Young-Jae Lee, William Eger

1.3 How have the results been disseminated?

When projects are complete, the reports are submitted to various databases and posted online. We also email a one-page fact sheet summarizing research to our mailing list of 535 people, including researchers, elected officials and journalists. For some projects, we create a brief video and send out the link. We also email an annual newsletter listing all projects. Here is the Fall 2021 newsletter from the National Transportation Center, which houses UMEC and includes details about UMEC research and programs. https://issuu.com/morganstateu/docs/fall_ntc_newsletter_pages?fr=sN2EwMjI5MDk3ODE

We also offered a Fall webinar on the impact of connected vehicles route guidance systems; it has been viewed 34 times. https://www.youtube.com/watch?v=8eqssglaYOs

A video about UMEC and its research was presented at the ITS conference and also was watched 3,679 times on Web Edge's channel https://www.youtube.com/watch?v=gATaaAlP1WA

Our NSTI summer program, a workforce development initiative designed to interest high school students in transportation careers, was featured in an article in the Baltimore Sun's Education section on Feb. 6, 2022.
https://www.paperturn-view.com/baltimore-sun-media/02-06-22-education?pid=MjE219183&p=3

1.4 What do you plan to do in the next reporting period to accomplish these goals?

2. PARTICIPANTS AND COLLABORATING ORGANIZATIONS. Who has been involved?

What organizations have been involved as partners?

Have other collaborators or contacts been involved?

Two UMEC researchers, who are graduate students, won first and second place in the American Road & Builders Association (ARTBA) video competition. Both of their projects focused on subjects of UMEC research: First place winner Md Muhib Kabir's video resulted from the UMEC project on distracted driving, and Ramina Javid, who won second place, focused on equity in transportation.

Dr. Young-Jae Lee is an Associate Editor for the KSCE Journal of Civil Engineering as well as for Urban Rail Transit. He was a guest editor for a special issue in July of the Journal of Advanced Transportation; the issue is Advanced Data Intelligence Theory and Practice in Transport. He also serves on the TRB Standing Committee on Automated Transit Systems (AP040) and is a member of the SAE International Shared and Digital Mobility Committee as well as being a member of the Maryland Strategic Highway Safety Plan and the Maryland CAV working group.

Dr. Celeste Chavis is a:

- Member, Transit Research Analysis Committee (TRAC), Transportation Research Board, 2018 – Present (national)
- Member, Federal Highway Administration (FHWA) Transportation Innovation Education Stakeholders (TIES), 2020 – Present (national)
- A member of three Transportation Research Board committees, (Bicycle, Equity in Transportation, Innovative Public Transportation Services & Technologies) (national)
- Board Member, Central Maryland Transportation Alliance, 2018 – Present (regional)
- Member, Complete Streets Equity Workgroup, Baltimore City Department of Transportation, 2017-2019 (regional)
- Board Member, Public Advisory Committee (PAC) of the Baltimore Regional Transportation Board (BRTB), 2017 – Present (regional)

Dr. Mansoureh Jeihani is:

- Chair of Strategy 3 for the Highway Safety Strategic Plan.
- Member, Maryland Connected and Autonomous Vehicle Working Group
- Member, Maryland Zero Emission Electric Vehicle Council
- Member of the Transportation Research Board committee on Artificial Intelligence and Advanced Computing Applications
- Member, editorial board of the Journal of Traffic and Logistics Engineering.

Member, National Cooperative Highway Research Program (NCHRP) Panel - Transportation Research Board, 2019-Present

Dr. Eazaz Sadeghvaziri, Postdoctoral Research Associate, is a new member of the Standing Committee on Rural, Intercity Bus, and Specialized Transportation

Ramina Javid, PhD student is a new member of the Standing Committee on Rural, Intercity Bus, and Specialized Transportation

3 OUTPUTS: What new research, technology or process has the program produced?

- The project **Investigating the Effect of Connected Vehicles (CV) Route Guidance on Mobility and Equity** was the first to use a microscopic traffic simulation model to simulate the driving behavior of CV guidance with various penetration rates of CVs, and various traffic conditions. The findings provide insight into the impacts of the gradual deployment of CVs.

3.1 Publications, conference papers and presentations

On Feb. 18, 2022, Dr. Mansoureh Jeihani virtually presented at MDQi, which recorded it for later use; the conference is tentatively scheduled for May.

The Renewable Energy Workforce Innovations Project (REWIP) featured Dr. Mansoureh Jeihani, UMEC director, as a panelist on Feb. 10, 2022. REWIP is a collaborative effort of the Just Transition PowerForce, a national collaboration of environmental/climate justice and workforce organizations, and Microsoft. The project goal is to increase workforce diversity in the renewable energy sector by increasing entry-level education and training opportunities into well-paying career pathways.

Dr. Mansoureh Jeihani, UMEC director, was featured in Morgan's Division of Research and Economic Development - Office of Technology Transfer and Intellectual Property (Page 4 of the following link). Innovation Works Newsletter - Fall/Winter 2021 by asmorris - Issuu
https://issuu.com/msuott/docs/final_newsletter_final

Dr. Mansoureh Jeihani, UMEC director, Dr. Eazaz Sadeghvaziri, postdoctoral research associate and grad student Ramina Javid presented their research into distracted driving and identifying the most distracting behaviors to the Transportation Planning Board Transportation Safety Subcommittee. The Metropolitan Washington Council of Governments organized the Feb. 8, 2022 event.

The 2022 TRB included a poster and flash presentation for the project **E-Bikes' Effect on Mode and Route Choice: A Case Study of Richmond, VA Bike Share**.

Dr. Mansoureh Jeihani was a presenter at the nationwide Department of Energy/National Association of State Energy Officials **Virtual Discussion Series: Workforce, Economic Development and Equity: Cultivating HBCU-State Energy Office Partnerships for Implementation and Impact on Jan. 11, 2022.**

3.2 Journal publications

Nickkar, A., & Lee, Y. J. (2022). Developing an Optimal Peer-to-Peer Ride-Matching Problem Algorithm with Ride Transfers. *Transportation Research Record*.

Nickkar, A., & Lee, Y. J. (2022). Willingness to Pay for Advanced Safety Features in Vehicles: An Adaptive Choice-Based Conjoint Analysis Approach. *Transportation Research Record*, 03611981221077077.

Nickkar, A., Lee, Y. J., & Meskar, M. (2022). Developing an optimal algorithm for demand responsive feeder transit service accommodating temporary stops. *Journal of Public Transportation*, *24*, 100021.

3.3 Conference Papers

Sadeghvaziri, E., Javid, R., Jeihani, M., Fadojutimi, D., "Investigating the Number of Bike Share Program Usage Among Different Races", *101st Transportation Research Board Annual Meeting*, Washington, D.C., January 2022.

Ahangari, A., Jeihani, M., "Driving Simulator Study of the Effectiveness of an Eco-Speed-Control (ESC) System Via Different Types of Eco-Speed Guidance (ESG) in the Vicinity of Multiple Signalized Intersections", Accepted, *101st Transportation Research Board Annual Meeting*, Washington, D.C., January 2022.

Khadem,N, K., Shin, H.S., Choi, Y., Schonfeld, P.M., & Lee, Y.J., "Optimal Options for the Fresh Food Deliveries in Baltimore Food Deserts", *101st Transportation Research*

Board Annual Meeting, No. 22-03740, Washington, D.C., January 2022.

3.4 Websites or other Internet sites

www.morgan.edu/umec

During the last quarter of 2021, the website had 826 visits and 1,957 page views. The research pages were the most popular, and the project The Effect of COVID-19 on Mobility and Equity: A Case Study of transit Users in Baltimore, Maryland, which featured a dashboard garnered 71 page views.

LinkedIn

We added a LinkedIn page this year and we have 105 followers.

www.twitter.com/NTCMorgan

Our twitter account has about 80 followers

Instagram: ntcumec (https://www.instagram.com/ntcumec/).

We have 65 followers on Instagram.

Facebook

We had two Facebook pages, one for UMEC and one for the NTC. Students had been telling us for quite some time that they don't use Facebook, and the platform itself seemed to be less popular. We could not combine our pages, and so we tried to create one new page to lessen the workload, but we had little traffic and few followers. We opted to delete our Facebook account and focus on Linked In and emerging platforms.

YouTube: We have a YouTube Channel.

https://www.youtube.com/channel/UCQ4GSAlNdKTKz6qhWqH1hQA

We anticipate focusing more on using videos to promote our research.

3.5 Technologies or techniques

- The project **Estimating switching times of Actuated Coordinated Traffic Signals: A deep learning approach** uses Long-short term memory (LSTM) recurrent neural networks as an approach for the prediction of the signal switching times. This project presented a step-by-step detailed methodology for data gathering, data preparation, training and tuning the Long-short term memory (LSTM) models and testing and comparing different model architectures. The model was applied to the intersection shown here and provided predictions of up to 200 seconds in the future relying on the past two minutes of data. These estimates can be used to enable more fuel-efficient

operation using GLOSA (Green Light Optimal Speed Advisory) and eco-driving. They can also be used to mitigate dilemma zone safety concerns.

- **Investigating the Effect of Connected Vehicles (CV) Route Guidance on Mobility and Equity** developed and calibrated a microscopic traffic simulation model to replicate the fairly realistic behavior of such vehicles in the traffic simulation environment. Unlike most previous studies that used hypothetical study areas with simple networks, this study developed a real-world medium urban road network. Researchers developed different penetration rates of CVs (0%-100%) to analyze the system-wide effects of CVs with route guidance features on mobility and equity.

3.6 Inventions, patent applications and/or licenses

U.S. Patent Application No. 17/389,741
Title: SYSTEM AND METHOD FOR DRIVER DISTRACTION DETECTION AND CLASSIFICATION was published by the U.S. Patent Office on Feb. 3 and is now in the review process.

4 OUTCOMES. What outcomes has the program produced? How are the research outputs described in section 3 above being used to create outcomes?

- By using a driving simulator combined with a bike simulator, researchers working on EQUITABLE **COMPLETE STREETS: Data and Methods for Optimal Design Implementation** gathered important data on how drivers and cyclists from varying socioeconomic backgrounds react to different complete street designs. The simulation allowed the researchers to examine the impact of bike lanes, pavement markings, lane barriers and pedestrian infrastructure in a realistic setting.

5. IMPACTS. What is the impact of the programs/ How has it contributed to improve the transportation system: safety, reliability, durability, etc.; transportation education; and the workforce?

- The project **EQUITABLE COMPLETE STREETS: Data and Methods for Optimal Design Implementation** provides planners with data on how various CS initiatives cause drivers to reduce speed and which designs make users feel safer. Ensuring that all users – cyclists, pedestrians, drivers and transit riders – can safely use the streets in their neighborhood is an important component of transportation equity.

5.1 What is the impact on the adoption of new practices, or instances where research outcomes have led to the initiation of a start-up company?

- The project **A Comparative Study of Pedestrian Crossing Behavior and Safety in Baltimore and Washington, D.C., Using Video Surveillance** adopted two different CV algorithms for better accuracy for object detection and tracking and used Region of Interest (ROI) to determine the pedestrian crossing for jaywalking implementation.

- **Investigating the Effect of Connected Vehicles (CV) Route Guidance on Mobility and Equity** provides recommendations regarding after-market packages to be used for low-income, non-CV owners as well as information on accommodating mobility-challenged travelers in CVs. This research also helps transportation agencies take advantage of their capabilities in incident detection and congestion relief. The research findings also provide insights into the benefits and impacts of CV buses versus non-CV buses, as a result of CV car penetration rates, and explore feasible ITS strategies to benefit transit users who can't afford CVs.

5.2 What is the impact on the scientific body of knowledge?

- **Investigating the Effect of Connected Vehicles (CV) Route Guidance on Mobility and Equity** developed and calibrated a microscopic traffic simulation model.

5.3 What is the impact on transportation workforce development?

On Feb. 18, 2022, we offered a two-part webinar THE HBCU EDGE: Getting and Surviving a Job and Getting Grant Funding. We offered a panel of experts to discuss these topics. Dawn Tucker-Thomas, University Grants Manager in the Office of the Assistant Secretary for Research and Technology; Kristin S. Jordan, Research Engineer, Controls and Automated Systems, Lead, Palo Alto Ford African Ancestry Network; Stephanie Nellons-Paige, CEO and Board Vice Chair of the Nellons Paige Group, Inc.; and Selenia Allen, MDOT Assistance Manager, Organization Development and Employee Training answered questions about getting a job while Taft Kelly, Regional Field Administrator, Eastern Service Center, Federal Motor Carrier Safety Administration; Celion Delion, Deputy Director for Transportation Systems Management and Operations and Connected and Automated Transportation Systems with the MDOT SHA; Leonardo San Roman, Manager, Procurement Assistant Division, OSDBU; and Dawn Tucker-Thomas spoke about getting grants, collaboration and tech transfer.

6 CHANGES/PROBLEMS.

6.1 Changes in approach and reasons for change.

Nothing to report

6.2 Actual or anticipated problems or delays and actions or plans to resolve them.

Nothing to report

6.3 Changes that have a significant impact on expenditures.

Nothing to report.

6.4 Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards.

Nothing to report

6.5 Change of primary performance site location from that originally proposed

Nothing to report

7. SPECIAL REPORTING REQUIREMENTS

All of our completed research projects – indicated in green in the table at the beginning of this report – have been submitted to the following databases: research.hub@dot.gov, NTLDigitalSubmissions@dot.gov, TRIS-TRB@nas.edu, and the Transportation Library at Northwestern University, The Volpe National Transportation Systems Center, the Federal Highway Administration Research Library and the National Technical Information Service.

Research projects conducted in Maryland are also submitted to MD-SOAR, a statewide repository.