Semi-Annual Progress Report No. 8 – Urban Mobility & Equity Center

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	Morgan State University (Lead Institution) *Virginia Polytechnic Institute and State University* *University of Maryland*
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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 improve the mobility of people and goods in urban communities in a safe, environmentally sustainable, and equitable manner and to 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 contribute to this goal, and how equity concerns will be addressed amid these technological changes.

1.2 What was accomplished under these goals?

Below is a chart listing all 51 UMEC projects, all of which have been completed. Final reports for these projects are available on our website, www.morgan.edu/umec, and they have been submitted to the appropriate databases. Additionally, UMEC has actively shared its findings with media publications, business leaders, and policymakers to ensure that its research can benefit travelers in its surrounding communities and beyond.

Project Type/ University	Project Name	PIs
Core-VT	Two-Dimensional Modeling 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-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 – MSU, UMD	Investigating the Effect of Connected Vehicles (CV) Route Guidance on Mobility and Equity	Mansoureh Jeihani, Ali Haghani, Anita Jones
Collaborative – MSU, UMD	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	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 are currently preparing a final briefing outlining the major findings generated by the Center over the grant period, organized by topic. We also email an annual newsletter listing all projects and exploring timely transportation issues related to our research. Click here to read the Spring 2023 newsletter from the National Transportation Center.

- Our director participated in the Grants Resource Center Virtual funding summit hosted by the American Association of State Colleges and Universities in April of 2023. The panel she joined was titled, "How Campuses Can Engage with the Department of Transportation."
- Evan Taylor, a graduate student associated with UMEC, won the "Outstanding Graduate Poster Presentation" award for his presentation at the Transportation Research Board Annual Meeting.
- Four UMEC researchers also presented at the TRB Conference's Bicycle Committee webinar, mostly covering applied research related to bicycle-motorist interactions in shared lanes.
- Alirezza Ansariyar and Dr. Mansoureh Jeihani won the "Best Presentation Award" at the International Conference of Transportation and Traffic Engineering in New York City.
- Dr. Masnoureh Jeihani gave a presentation on "5 Resources Everyone Needs When Applying for Federal Grants" at the Maryland Department of Transportation.

- UMEC researchers have published a book in partnership with Eliva Press titled, "Will Connected Vehicles Affect Equity and Mobility?," ISBN: 978-9994987634
- UMEC researchers were part of the team that received the US Department of Energy's 'Digitizing Utilities Prize.' This work provided valuable insight into the trends and challenges related to electric vehicle adoption in the United States.
- UMEC director Mansoureh Jeihani participated at the HBCU Week Conference at the University of Michigan in Minneapolis in September of 2023.

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

Not applicable. UMEC's grant period has ended.

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

2.1 What organizations have been involved as partners?

The Maryland Aviation administration has collaborated with UMEC to implement the Autonomous Wheelchair being developed by researchers at Morgan State University at the Baltimore-Washington Thurgood Marshall Airport.

Cube Root, Inc. provided consulting services and video data to train pedestrian detection algorithms being developed by UMEC Researchers.

The Maryland Department of Transportation's Highway Safety Office has collaborated with UMEC to develop technologies and best practices that can improve traffic safety along the state's highways.

UMEC has partnered with Cambridge Systematics to craft proposals for the USDOT's National Cooperative Highway Research Program and Transit Cooperative Research Program.

The Center has worked closely with the Federal Motor Carrier Safety Administration to improve safety for travelers, particularly with respect to advanced collision warning systems and work zone practices.

UMEC is working with several firms to implement its Mixed Traffic CAV Testbed. Ouster is working with our research team to install LIDAR units at intersections around campus while Iteris is installing on-board units inside of Morgan State University's shuttles.

2.2 Have other collaborators or contacts been involved?

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 (CAV-WG)
- Co-Chair, CAV-WG technical group
- Member, Maryland Quality Initiative
- 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
- Member, Behavioral Traffic Safety Cooperative Research Program (BTSCRP) Panel – Transportation Research Board, 2023-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

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

- **Optimum Connected Vehicle Speed Control on Signalized Roadways in Mixed Flow** will be the first study to develop an optimal speed control strategy for CVs and CAVs considering mixed engine types including ICEVs, BEVs and HEVs, in the vicinity of signalized intersections. The automated mode controller can help CAVs to achieve even more savings by following energy-optimized trajectories more precisely, compared to human drivers. In addition, the tests in microscopic simulation software and driving simulator will be beneficial for government stakeholders and industry companies to estimate the benefits of implementing the proposed system.
- **A Comparative Study of Pedestrian Crossing Behavior and Safety in Baltimore and Washington, D.C., Using Video Surveillance** has developed techniques to implement Multivariate Clustering when selecting street intersections to analyze pedestrian behavior. This was done by developing a script for the projection of GPS data from pixel values (in video footage) of each object. The study also Implemented perspective transformation from OpenCV library to project points from the image plane into GPS coordinate space

3.1 Conference papers and presentations

- Ansariyar, A., Jeihani, M., (2023), Investigating the Vehicle-Bicyclists Conflicts using LIDAR Sensor Technology at Signalized Intersections, International Journal of Transport and Vehicle Engineering, Vol 17, No 07, July 2023, New York City. Read the paper here.

3.2 Journal publications

- Lee, Young-Jae, et al. *User Preference Analysis for Mobility-as-a-Service (MaaS) and Its Impact*. No. UMEC-043. Urban Mobility & Equity Center, 2023.
- Cirillo, Cinzia, et al. "Fare Free Public Transportation: A full-scale, real-world experiment in Alexandria (VA)." (2023).
- Lee, Young-Jae, Amirezza Nickkar, and Equity Center. *Developing Optimal Peer-to-Peer Ridesharing Strategies*. No. UMEC-022. Urban Mobility & Equity Center, 2023.
- Chang, Gang-Len, Yam Ting Chan, and Yao Cheng. "A Knowledge-Based Expert System for Pedestrian Safety Improvement at Intersections." (2023).
- Schonfeld, Paul, et al. "Analysis of Interrelated Network Improvement Alternatives." (2023).
- Ahangari, S., Bhuyan, I., Chavis, C., Jeihani, M., & Center, E. (2023). The Effect of COVID-19 on Mobility and Equity: A Case Study on Transit Users in Baltimore, Maryland.
- Rakha, Hesham A., et al. *Quantifying the Impact of Cellular Vehicle-to-everything (C-V2X) on Transportation System Efficiency, Energy and Environment*. No. UMEC-051. Urban Mobility & Equity Center, 2023.
- Chen, Hao, et al. *Optimum Connected Vehicle Speed Control on Signalized Roadways in Mixed Flow*. No. UMEC-044. Morgan State University. Urban Mobility & Equity Center, 2023.
- Shafik, A., Eteifa, S., Rakha, H. A., & Center, E. (2023). *Optimal Trajectory Planning Algorithm for Connected and Autonomous Vehicles Towards Uncertainty of Actuated Traffic Signals* (No. UMEC-050). Morgan State University. Urban Mobility & Equity Center.

- Chavis, C., Nyarko, K., Cirillo, C., & Center, E. (2023). A Comparative Study of Pedestrian Crossing Behavior and Safety in Baltimore, MD and Washington, DC Using Video Surveillance.

3.3 Websites or other Internet sites

- www.morgan.edu/umec. The Urban Mobility and Equity Center's website hosts all of the institution's completed and ongoing research projects, complete with one-page fact sheets and detailed descriptions related to the relevant investigators' aims and findings. The site also contains an wide array of information about the Center's staff, facilities, and workforce development initiatives.
- LinkedIn
- Twitter
- Facebook
- YouTube

3.4 Technologies or techniques

- UMEC has established a **Mixed Traffic Connected and Automated Vehicles (CAV) Testbed** at Morgan State to develop innovations related to CAVs in an urban environment. Two intersections have been equipped with Roadside Units, CCTVs, and LiDARs to record the movement of every object passing through the intersections, generating a substantial amount of data. The research team has been working with contractors to install on-board units inside several of the university's campus shuttles. The testbed received the **I-Start Technology Award** from Morgan State's Office of Technology transfer in 2023.
- UMEC Researchers at Morgan State University have developed a methodology for selecting intersections with which to analyze pedestrian behavior using multivariate clustering techniques on **A Comparative Study of Pedestrian Crossing Behavior and Safety in Baltimore and Washington, D.C., Using Video Surveillance.** Researchers also found a novel method of implementing perspective transformation from OpenCV library to project points from the image plane into GPS coordinate space.
- The CAV applications being developed in **Optimum Connected Vehicle Speed Control on Signalized Roadways in Mixed Flow** partially consist of a manual mode controller which enables human drivers to follow simple driving instructions to pass signalized intersections with less energy consumption and delay. Moreover, the automated mode controller being developed can help CAVs achieve even more savings by following energy-optimized trajectories more precisely.
- A model developed in **Optimization of Vehicle Trajectories Considering Uncertainty in the Vicinity of Actuated Traffic Signals** applies innovations in CAV technologies to optimize vehicle trajectories near actuated traffic signal controllers for greater fuel efficiency. The algorithm being used shows great promise in balancing the needs of traffic mobility and sustainability, particularly in high-traffic environments. These technologies can also be applied to traditional vehicles in the form of prompts, as discussed in section 5.

- **Development of an Intelligent Tool for Assessing the benefits of Highway Safety Improvement Projects** will see the development of an AI-based system designed to assist transportation engineers in selecting the most effective measures to improve intersection safety. The tool applies knowledge of the key factors contributing to intersection accidents and make use of the best practices used by senior engineers to guide less-experiences transportation professionals' decision-making processes.

3.6 Inventions, patent applications and/or licenses

- US Patent # 17885080, Autonomous Mobility System
- US Patent # 11565711, System and Method for Generating Vehicle Speed Alerts

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

- Findings from **Integrated Optimal Transit Network Design with MaaS Design** have provided a blueprint for developers and policymakers to implement the emerging Mobility-as-a-service concept to increase the efficiency and equity of public transit systems by integrating different public transit modes in a convenient, cost-effective way.
- Research conducted in **Changes in Bikeshare and Other Non-Automobile Modes of Transportation During Covid-19** has investigated the evolving role of non-motorized modes of transportation during and after Covid-induced lockdowns. The findings from the study suggest the critical role these modes, particularly bikeshare, can play in improving the sustainability and efficiency of public transit networks. This is especially relevant in first- and last- mile travels, where bicycles have a significant ability to complement public bus and rail networks.

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?

- Nearly all UMEC projects have enlisted the contributions of graduate students to conduct high-quality research, training a new generation of transportation scholars and practitioners with the knowledge and experience needed to implement technologies that are rapidly changing the field, such as autonomous vehicles and advanced driving simulators.
- The **Mixed-Traffic CAV Testbed** will serve as the foundation of an innovation center that aims to attract public and private sector researchers and test advanced driving system applications in real-world conditions. The high-resolution transportation data generated from this testbed will not only benefit the campus but also Baltimore City and the Maryland Department of Transportation (MDOT). The applications of such a testbed will enhance safety and mobility on campus and within the Morgan Community Mile.
- Connected and Autonomous vehicles have the potential to significantly reduce fuel consumption by calibrating vehicle speeds with traffic infrastructure. Researchers

working on **Optimum Connected Vehicle Speed Control on Signalized Roadways in Mixed Flow** are actively exploring how CAVs can communication with traffic signals and surrounding vehicles to optimize their movement for sustainability and throughput. The similar technologies are also being applied to traditional vehicles, wherein drivers are prompted to change their speed in accordance with the timing of traffic signals to improve efficiency.

- Systems being developed in **Analysis of Interrelated Network Improvement Alternatives** are being used to identify, optimize, and simulate improvements to regional transportation networks in order to improve efficiency and sustainability. These improvements include transportation projects like additional road and rail links, widened transit links, and the implementation of exclusive bus lanes. Moreover, these systems will consider other variables when making recommendations, such as future demand and budgetary constraints. Graduate students have played integral roles in shaping the optimization and simulation models used in this program.
- **Development of an Intelligent Tool for Assessing the benefits of Highway Safety Improvement Projects** has the potential to dramatically improve roadway engineering practices, and in turn, safety, by providing engineers with a tool to identify hazards in their design. This will be an excellent tool for students as they become acquainted with best practices with respect to safety and will save lives by avoiding collisions with the environment or other vehicles.
- **The Effect of Covid-19 on Mobility and Equity: A Case Study of Transit Users in Baltimore, MD** similarly evaluated how different regions and socio-demographic groups changed their transportation practices in response to the pandemic by comparing public transit ridership data. Early findings suggest that ridership patterns could permanently change as a result of the mass adoption of telework, and that changes in ridership over time vary considerably between those of different professions.

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 a.
- A startup tech company has expressed interest in developing a work zone safety app based on UMEC designs. The app will provided motor carrier drivers with advanced warning and re-routing information as they approach work zones.

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

- **Integrated Optimal Transit Network Design with MaaS Implementation** is exploring how the emerging Mobility-as-a-Service transportation paradigm can improve mobility, accessibility, and sustainability while working within existing transit frameworks. By facilitating tighter connections between mass transit platforms like buses and rail, new micro-mobility options like scooters and bikeshare can provide efficient travel

alternatives to cars, especially in urban areas.

- **Impact of COVID-19 on Ridehailing and other Modes of Transportation** has identified significant increases in the use of bikeshare during and after the pandemic, with important data collected on typical bikeshare routes and duration of usage. This data can inform developers and policymakers who wish to promote bikeshare as a connecting mode between public transit hubs.
- **Fare-Free Public Transportation: A Full-Scale Real-World Experiment in Alexandria, VA** is applying advanced survey methods to determine if free public transportation can increase ridership and facilitate greater access to jobs and other opportunities, particularly for low-income riders. This data can inform policymakers' cost-benefit analyses when implementing public transportation programs.
- Researchers on **Quantifying the Impact of C-V2X on Transportation System Efficiency, Energy and Environment** are currently evaluating the role that Connected Vehicle Technology can play in improving air quality and fuel consumption on a system-wide level.

5.3 What is the impact on transportation workforce development?

Beyond UMEC's ongoing train and provide valuable experience for graduate students in the transportation field, the Center continues to develop the professional development of the transportation workforce through its robust internship and transportation programs. UMEC's parent institution, the National Transportation Center, boasts a 30-year internship program with the Maryland Department of Transportation as well as a longstanding commitment to educating young people through the National Summer Transportation Institute.

- **A Comparative Study of Pedestrian Crossing Behavior and Safety in Baltimore and Washington, DC Using Video Surveillance** was included in the 2021 Smart City Research Experience for Undergraduates and Teachers training program at Morgan State University funded by the National Science Foundation.

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 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.