Semi-Annual Progress Report No. 2 – The SMARTER Center

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	Morgan State University (MSU) (Lead Institution) *Howard University (HU), University of Maryland, College Park (UMD), University of Pittsburgh (Pitt), University of Virginia (UVA), Virginia Polytechnic Institute and State University (VT. West Virginia University (WVU)*
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1. ACCOMPLISHMENTS.[1]

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

As a USDOT Regional UTC, the Sustainable Mobility Accessibility Regional Transportation Equity Research (SMARTER) Center assesses and addresses the multi-modal transportation challenges faced by travelers in the mid-Atlantic. The center's researchers are committed to the guiding principles of the UTC: mobility, accessibility, and equity. SMARTER Center researchers are especially focused on the equitable distribution of transportation-related assets, network resilience in the face of climate change, accessibility concerns, network efficiency and mobility, freight and shipping bottlenecks, and the implementation of emerging technologies like electric and connected vehicles.

Assessing, addressing, and improving the mid-Atlantic region's dynamic transportation landscape will be accomplished through a robust research program--guided by researchers working closely with students of all levels--with immediate and near-term implementation capabilities for policy makers, industry, and the public at large. A driving priority for SMARTER researchers is community engagement, ensuring that its research and outcomes are shared with the communities within its region—urban, rural, and in-between—through a wide-ranging program of technology transfer, community engagement, education, and workforce development. SMARTER researchers are also committed to the implementation of technology programs and the development of best practices for transportation administrators.

1.2 What was accomplished under these goals?

The SMARTER Center has shepherded twenty "core" projects in its first grant year.

SMARTER Center "Core" Research Projects, Year 1		
Univ.	**Project Name**	**PI(s)**
MSU	A Novel Driver Warning System with Hedging to Promote Defensive Driving	Di Yang
MSU	Smart, Green, Equitable, Safe, Complete Streets for All - Phase I: Providing a smart campus using a CAV testbed around Morgan State University	Mansoureh Jeihani, Di Yang, Anam Ardeshiri
MSU	Deriving Transit Performance Metrics from GTFS Data	Gregory Newmark
MSU	The Mass Transit Dilemma: Streamlining Regulatory Regimes to Address Climate Change And Poverty	Joseph Niehaus
UDel	Crime Prevention through Environmental Design (CPTED) for Public Transit Stations	Jennie Saxe
UDel	Understanding the Role of Equity in Delaware Department of Transportation Expenditures	Philip Barnes, Andrea Pierce

[1] What was done? What was learned?

SMARTER Center "Core" Research Projects, Year 1		
Univ.	**Project Name**	**PI(s)**
UDel	The Impacts of Climate Change and Urbanization on Non-Motorized Transportation Facilities and Negative Consequences on Lower Income Neighborhoods	Ardeshir Faghri
VT	Energy consumption modeling of ships: towards a Door-to-Door (D2D) freight optimization	Hesham A. Rakha, Ahmed Aredah
VT	Enabling GLOSA through Domain Knowledge Aware SPAT Prediction and Queue Length Aware Trajectory Optimization	Hesham A. Rakha, Amr Shafik, Seifeldeen Eteifa
Pitt	Ensuring Equity in Pavement Rehabilitation Strategies	Lev Khazanovich, Julie Vandenbossche
Pitt	Socially Responsible Road Charging for Online Retailers to Support Disadvantaged Urban Communities	Aleksandar Stevanovic, Lev Khazanovich
UMD	Design and Evaluation of an Arterial-Friendly Local Ramp Metering System	Gang-Len Chang
UMD	A Comprehensive Analysis of EV Charging Demand Prediction, Infrastructure Planning, and Power Network Resilience in the Era of Electric Mobility	Xianfeng Yang
UVA	Connected Vehicle Identification System for Cooperative Control of Connected Automated Vehicles	B. Brian Park
UVA	Measuring Pedestrian Psycho-Physiological Well-Being in the Built Environment	T. Donna Chen, Andrew Mondschein
UVA	Smart Rideshare Matching – Feasibility of Utilizing Personalized Preferences	B. Brian Park, Afsaneh Doryab, T. Donna Chen, Andrew Mondschein
WVU	Automated vehicle-supported mobility services for rural areas	V. Dimitra Pyrialakou, David Martinelli
WVU	Advancing Equity through Regional Multimodal Planning in Small Urban and Rural Communities	V. Dimitra Pyrialakou
HU	Near-Real-time Health Monitoring and Assessment of a Railway Track system	TBD

Researchers have reported robust early accomplishments in their work:

- "A Novel Driver Warning System with Hedging to Promote Defensive Driving" has developed a blind spot warning with hedging, a new driver warning system to promote defensive driving around trucks.
- A significant outcome of the "Smart, Green, Equitable, Safe, Complete Streets for All (Phase I: Development of a CAV Testbed-enhanced Smart Campus at Morgan State University)" project is the potential scaling of the CAV Testbed (now called the SMART Intersection) along the West North Avenue corridor in Baltimore City. Based on early exciting results from the SMART Intersection, SMARTER researchers and staff have developed an exciting relationship with the West North Avenue Development Authority (WNADA), an economic development authority formed to support the development and approval of a comprehensive neighborhood revitalization plan in the West North Avenue Development Area of West Baltimore, benefiting the area's residents, to improve housing, neighborhood health, economic development, and transportation—particularly the safety of vulnerable road users--to catalyze equitable economic development opportunities in the area historically hamstrung by discrimination. SMARTER Center staff and researchers have worked closely with WNADA planners to identify five critical intersections along the West North Avenue corridor at which to install the SMART Intersection infrastructure.
- In support of executing the SMARTER Center's mission, the National Transportation Center hired two dedicated staff in late fall 2023. Brandy Savarese, the associate director who supports SMARTER Center grant administration and community engagement, has had a busy first five months metabolizing the USDOT requirements for grants administration, managing the RFP for competitive collaborative research projects, participating in meetings and conferences, and promoting the SMARTER Center through community engagement and focused outreach. A testament to her commitment to building community relationships, Ms. Savarese has been appointed to three notable advisory boards: the Transform Maryland Transportation Executive Committee, the West Baltimore United Stakeholder Working Group and the Baltimore Metropolitan Council's Bicycle Advisory Board. This is in addition to her relationship building with local and regional organizations, to include the Baltimore Neighborhood Indicators Alliance at University of Baltimore, the Neighborhood Design Center, 21st Century Cities (at Johns Hopkins University), Bikemore, Better Transit Now, the Neighborhood Design Center, Reservoir Hill Neighborhood Association, Historic Mount Royal Terrace Association, and many others. Not only will each relationship promote SMARTER's goals of engagement with and service to its local communities, the collaborations may lead to data sharing and site-specific research opportunities.
- The SMARTER Center hosted a very successful SMARTER Collaboration Forum in December 2023, which facilitated engaging and enthusiastic cross-university collaborations and produced an excellent suite of competitive-collaborative proposals, as shown in the following table.

"Competitive-Collaborative" Research Projects, Year 1		
Univ.	**Project Name**	**PI(s)**
Pitt & UVA	Implementing and Testing Multimodal Equity through Connected Everything and Traffic Signal Operations in Virtual Reality	Lev Stevanovic, B. Brian Park
UVA & MSU	Assessing Feasibility of Deploying Transit Signal Priority with Connected Vehicle Technology using MSU Testbed	B. Brian Park, Di Yang

"Competitive-Collaborative" Research Projects, Year 1		
Univ.	**Project Name**	**PI(s)**
MSU & UMD	Development of a Pedestrian Collision Avoidance System for Connected and Autonomous Vehicles with Cooperative Perception	Xianfeng Yang, Di Yang
WVU & MSU	A Framework for Volunteer Integration in Rural and Small Urban Transit	V. Dimitra Pyrialakou, Gregory Newmark

- The SMARTER Center's new Program Coordinator, Christol Medley, made significant progress in the reporting period in planning and programming the 2024 National Summer Transportation Institute (NSTI). We are enthusiastic that this year's class will have the largest attendance in NSTI's history, and that the curriculum and schedule of field trips will be the best yet. At the time of reporting, there are an all-time high of 50 applications in progress. The NSTI program has embraced a new mission for 2024: to nurture an interest in and knowledge of transportation engineering as early as middle school and encourage those students to return to NSTI each year through middle and high school, as we guide them into STEM and transportation studies at the college level. Ms. Medley is also planning to relaunch the Teacher Transportation Institute in 2024, the first class since 2017.

1.3 What opportunities for training and professional development has the program provided?

SMARTER Center success is driven by its student researchers, who have earned significant successes in this reporting period.

- The "A Novel Driver Warning System with Hedging to Promote Defensive Driving" has provided invaluable hands-on training and learning opportunities for students across various fronts. Participants have been actively engaged in the development of traffic networks within a driving simulator environment, offering them practical experience in understanding and constructing complex driving scenarios. Students have been extensively trained in the intricacies of advanced driver warning systems, gaining insights into their functionality and importance in enhancing road safety. The project has empowered students to apply their knowledge and skills towards the design and implementation of advanced driving warning systems, fostering a real-world understanding of how theoretical concepts translate into practical solutions within the realm of transportation engineering and safety.
- "Smart, Green, Equitable, Safe, Complete Streets for All (Phase I: Development of a CAV Testbed-enhanced Smart Campus at Morgan State University)" has provided significant opportunities for training and development across various domains: hands-on experience in the installation, configuration, and operation of advanced LiDAR sensors, roadside units (RSUs), and onboard units (OBUs); technical skills in sensor deployment and network connectivity. The implementation of driver warnings and analysis of pedestrian violations/desire lines have enabled student researchers to develop expertise in data analysis, pattern recognition, and safety assessment methodologies. Furthermore, the utilization of machine learning algorithms for real-time traffic analysis and safety enhancement has facilitated proficiency in data processing and algorithmic implementation. The project has encouraged interdisciplinary collaboration, allowing participants to gain insights into transportation engineering, urban planning, and policy-making processes. Overall, this project has served as a comprehensive platform for skill development,

offering opportunities to acquire both technical and analytical competencies crucial for addressing contemporary challenges in ITS and cybersecurity concerns.

- "Socially Responsible Road Charging for Online Retailers to Support Disadvantaged Urban Communities," still in its early stages, will develop graduate students' ability to navigate the often-complicated decision-making that comes with transportation research implementation. The research, conducted at the University of Pittsburgh, helps future workforce to understand trade-off between road charging policies and priority given to specialized transportation users. This is one of the transportation aspects which has not been considered enough in our practice.
- Students at the University of Delaware project have been trained in Crime Prevention Through Environmental Design (CPTED) principles as part of Dr. Saxe's "Crime Prevention through Environmental Design for Public Transit Stations" project.
- Dr. Chang, PI for "Design and Evaluation of an Arterial-Friendly Local Ramp Metering System," has offered a workshop for state and county engineers to properly operate the innovative ramp metering system developed in his project.
- Dr. Jeihani, SMARTER Center director, presented "Exploring Maryland's Transportation Workforce: A Session for Morgan State Students" at Maryland Quality Initiative (MDQI) on February 7, 2024. MSU students were given an opportunity to interact with distinguished transportation professions in a Q&A panel. Students received guidance and expertise from industry professionals, fostering a collaborative path forward for the next generation of transportation professionals.
- SMARTER Center staff attended multiple events during Engineer's Week 2024, notably "Introduce a Girl to Engineering," which introduced Morgan State and the NSTI program to more than 100 high school girls. Researchers and staff also welcomed Girl Scout Troop 2237 to the SABA Lab for an introduction to the university environment and transportation research.

Girl Scout Troop 2237 visits SMARTER SABA Lab (L); future engineers gather at the WTS Engineering Week program (R).

1.4 How have the results been disseminated? If so, in what way(s)?

The SMARTER Center's SMART Intersection was featured prominently in the January 2024 City for All Forum: Envisioning Baltimore's Transportation Future event, spearheaded by Baltimore City Delegate Robbyn Lewis and held at Morgan State University. SMARTER researchers demonstrated the SMART Intersection (a research implementation of the Smart, Green, Equitable, Safe, Complete Streets for All project. Most notably, through our demonstration, we made connections with local developers (Cross Street Partners and Beatty Development) and local representatives (Maryland Delegate Mark Edelson, who now serves on the SMARTER Advisory Board).

SMARTER Center graduate students and Dr. Jeihani at City for All forum (L); Dr. Jeihani explains the SMART Intersection to Del. Mark Edelson (R).

The SMART Intersection was also featured at the 2024 Maryland Legislative Technology Fair in March, 2024. The demo was viewed by six Maryland legislators, 54 legislative staffers, and 56 ITS Maryland attendees.

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

In addition to continuing to provide administrative support to SMARTER PIs in their competitive and collaborative research projects, we will also facilitate the launch of year two core project proposals to our network of advisors so that we are prepared to kick off year two research on June 1, 2024.

In April, the SMARTER Center will host the Maryland Connected and Autonomous Vehicle (MDCAV) Working Group meeting at Morgan State University. We anticipate attendance of 120 participants from across all sectors: state government, academic research, public safety, law enforcement, and private industry. Dr. Jeihani is a member of the MDCAV Working Group, and the chair of the MD CAV technical subgroup. SMARTER student researchers will demonstrate center research outputs, such as the autonomous wheelchair, the SMART Intersection, and CAVe in a Box.

April also brings the launch of the SMARTER Transportation Talks series of interviews, which provide in-depth conversations with SMARTER researchers. The Transportation Talks format is an effort to humanize transportation research and promote accessibility. The first Transportation Talks featured guest is SMARTER researcher Dr. Celeste Chavis, who will speak on the concept of equity and transportation research and implementation.

In early May, the SMARTER Center will host USDOT leadership at Morgan State University. We are excited to welcome Dr. Robert Hampshire, Dr. Firas Ibrahim, and Mr. Caesar Singh, who will tour the SMARTER Center's Safety and Behavioral Analysis (SABA) lab, take a tour of the SMART Intersections, and address Morgan State students. We are honored to have Dr. Hampshire confer the inaugural SMARTER Student Fellowship, a $5000 research award to promote undergraduate and graduate student transportation research.

We are excited to have been engaged by the TRB Conference on Advancing Transportation Equity (CATE) as a partner in producing 2024's event, which will be held in Baltimore, MD, in July. There is no better location for critical equity discussions than Baltimore City, in the SMARTER Center's backyard, and SMARTER research will be front and center in the programming.

Near the very end of the reporting period, the Baltimore's Francis Scott Key Bridge was struck and collapsed, severing a major local and regional transportation artery. Acknowledging the tragedy of the incident, SMARTER researchers will begin to explore the unique and timely research opportunities it presents.

2. PARTICIPANTS AND COLLABORATING ORGANIZATIONS.[2]

2.1 What organizations have been involved as partners?

The table below illustrates some of the relationships developed and leveraged by SMARTER researchers through their UTC research:

Project	Organization, location	Agency Type	Contribution
The Impacts of Climate Change and Urbanization on Equity Focus Areas, Active Transportation, and Micromobility	DelDOT Dover, DE	State Agency	Information sharing; site visit support
	WILMAPCO Wilmington, DE	MPO	Information sharing
	DE Environmental Justice Wilmington, DE	State Agency	Information sharing
	University of Delaware College of Engineering Newark, DE	Educational	Match, in-kind, IT support
Crime Prevention through Environmental Design (CPTED) for Public Transit Station	SEPTA Philadelphia PA	Transit Agency	Information Sharing; Site Support
	DART Wilmington, DE	Transit Agency	Information Sharing
	City of Philadelphia, PA	Local government	Information Sharing
	MTA Baltimore MD	Transit Agency	Information Sharing
Understanding the Role of Equity in Delaware Department of Transportation Expenditures	DelDOT Dover, DE	Transportation Agency	Information Sharing
	WILMAPCO Wilmington, DE	MPO	Information Sharing
	Dover-Kent Dover, DE	MPO	Information Sharing
Design and evaluation of an Arterial-Friendly Local Ramp Metering System	MDOT State Highway Administration	State agency	Information Sharing

[2] Who has been involved?

Project	Organization, location	Agency Type	Contribution
Smart Rideshare Matching – Feasibility of Utilizing Personalized Preferences	UVA Parking and Transportation Charlottesville, VA	Educational	Cost-share and in-kind participation
Connected Vehicle Identification System for Cooperative Control of Connected Automated Vehicles	Toyota InfoTech San Francisco, CA	R&D	Unrestricted research funding
	Commonwealth Cyber Initiative (UVA) Charlottesville, VA	R&D	Commercialization Seed Fund
Measuring Pedestrian Psycho-Physiological Well-Being in the Built Environment	UVA Environmental Resilience Institute Charlottesville, VA	Educational	collaboration (data collection facilities)
	UVA School of Engineering and Applied Science, Charlottesville, VA	Educational	financial support (for graduate researcher)
	Commonwealth Cyber Initiative Arlington, VA	Educational (university consortium initiative)	financial support (to purchase equipment)
Advancing Equity through Regional Multimodal Planning in Small Urban and Rural Communities	The City of Morgantown, WV, Engineering and Public Works Department	Local Gov	Collaboration (as potential stakeholders)
	Mountain Line Transit Authority Monongalia County, WV	Transit agency	Collaboration (as potential stakeholders)
	The Morgantown Monongalia Metropolitan Planning Organization Monongalia County, WV	MPO	Collaboration (as potential stakeholders)
Automated vehicle-supported mobility services for rural areas	Mountain Line Transit Authority Monongalia County, WV	Transit agency	Collaboration (as potential stakeholders)
	The Morgantown Monongalia Metropolitan Planning Organization Monongalia County, WV	MPO	Collaboration (as potential stakeholders)
Smart, Green, Equitable, Safe, Complete Streets for All (Phase I: Development of a CAV Testbed-enhanced Smart Campus at Morgan State University)	West North Avenue Development Authority (WNADA) Baltimore, MD	Development Authority	Collaboration (research implementation)
	Baltimore City (MD) Department of Transportation	Local agency	Collaboration (implementation and data collection)
	Maryland DOT	State agency	Matching support
A Novel Driver Warning System with Hedging to Promote Defensive Driving	Forum 8 Japan	Equipment provider	Technical Support

2.2 Have other collaborators or contacts been involved?

Project Title	Collaborator/contributor	ORCID or Title
Measuring Pedestrian Psycho-Physiological Well-Being in the Built Environment	Arsalan Heydarian, PhD	Associate Professor, Civil & Environmental Engineering, University of Virginia

3. OUTPUTS.[3]

3.1 Conference papers and presentations

SMARTER Center research was very well represented at the 103rd Transportation Research Board Meeting in January, 2024:

- V. Dimitra Priayalakou (WVU): 2 posters
- T. Donna Chen (UVA): 1 poster
- Lev Khazanovich (Pitt): 2 posters, 1 paper
- Andrew Mondschein (UVA): 1 poster
- Hesham Rakha (VT): 5 posters, 3 papers
- Ahmed Aredah (VT):1 poster
- Amr Shafik (VT): 1 poster
- Paul Schonfeld (UMD): 1 paper
- B. Brian Park (UVA): 1 poster
- Cinzia Cirillo (UMD): 2 posters, 1 paper
- Gang-Len Chang (UMD): 2 posters
- Xiangfeng Yang (UMD): 4 posters
- Jihane Du (UMD): 1 poster, 1 paper

Morgan State University graduate students and SMARTER researchers were also busy at TRB 2024:

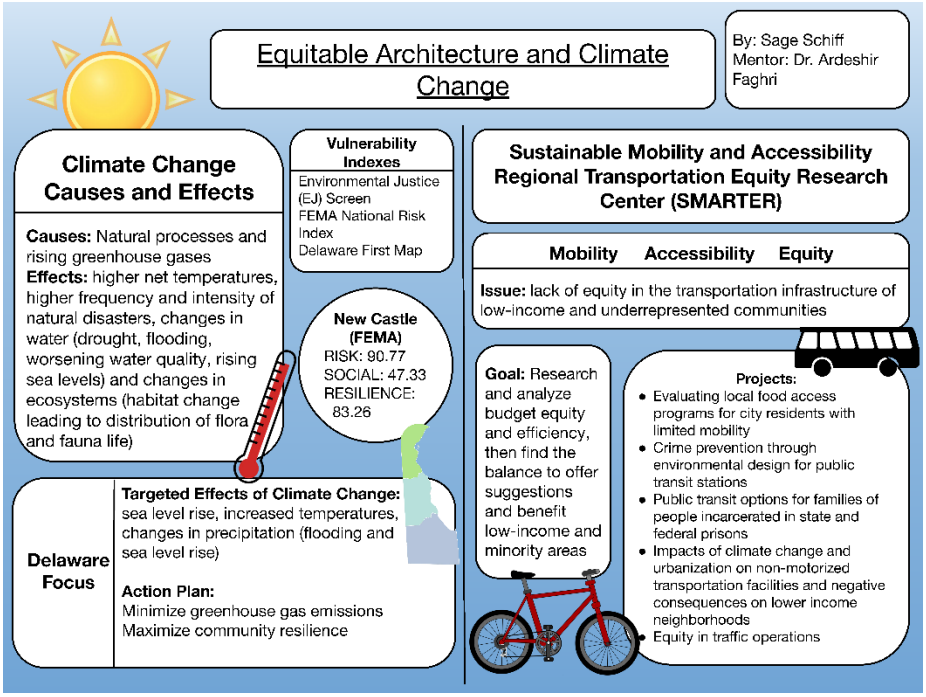
- Gregory Newmark led the Standardizing Transit Survey Data workshop.
- Mansha Swami gave the Solutions to Funding and Mobility Challenges in Transportation Planning lectern session.
- The Text and Voice Message Distraction Detection: A Machine Learning Approach Using Vehicle Trajectory Data poster was presented by Abolfazl Taherpour, Parisa Masoumi, Alireza Ansariyar, Di Yang, Samira Ahangari, and Mansoureh Jeihani.
- The TRB Minority Student Fellows poster Evaluating Driver's Behavior While Passing Bicyclist; An Integrated Simulator Approach was presented by Parisa Masoumi, Anam Ardeshiri, Eazaz Sadeghvaziri (Mercer University), Mansoureh Jeihani, and Alaina Payne.

[3] What new research, technology or process has the program produced?

- The Equitable Mobility: Analyzing Active Transportation Behavior Within Low-Income Black Communities poster was presented by Eazaz Sadeghvaziri (Mercer University), Ramina Javid, and Mansoureh Jeihani.
- The Race, Rail, and the Rider Experience: Using On-Board Survey Data to Assess Transit Equity poster was presented by Gregory Newmark and Christina Funk (Kansas State University).
- The Enhancing Speed Control Guidance for Mixed Traffic Flow at Urban Signalized Intersections: Insights from a Driving Simulator Study poster was presented by Parisa Masoumi, Eazaz Sadeghvaziri (Mercer University), and Mansoureh Jeihani.

Additional conference presentations included:

- "Smart, Green, Equitable, Safe, Complete Streets for All (Phase I: Development of a CAV Testbed-enhanced Smart Campus at Morgan State University)" was presented at the 2024 ASCE Transportation Conference in Atlanta, Georgia.
- On behalf of the University of Delaware, undergraduate research assistant Sage Schiff, presented two posters: one at the University of Delaware Undergraduate Research Symposium and the other at the City of Philadelphia Research Symposium.



3.2 Journal publications.

- Ansariyar, A., Ardeshiri, A., & Jeihani, M. (2023). Investigating the collected vehicle-pedestrian conflicts by a LIDAR sensor based on a new Post Encroachment Time Threshold (PET) classification at signalized intersections. *Advances in transportation studies*, *61* (link).
- Ansariyar, A., & Jeihani, M. (2023). Statistical analysis of jaywalking conflicts by a lidar sensor. *Zeszyty Naukowe. Transport/Politechnika Śląska* (link).

- Ansariyar, A., Taherpour, A., Yang, Di., Jeihani, M. (2023). Enhancing Pedestrian Safety by Providing a LiDAR-Based Analysis of Jaywalking Conflicts at Signalized Intersections, *Acta Scientiarum Polonorum Administratio Locorum* (link).
- Ansariyar, A., & Jeihani, M. (2024). Investigating the Vehicle-Bicyclists Conflicts using LIDAR sensor technology at signalized intersections, *International Journal of Transport and Vehicle Engineering*, Vol:18, No:3 (link).

3.3 Books or other non-periodical, one-time publications.

SMARTER Center researchers were featured in the following media appearances:

- Cars and roads will soon get smarter. Morgan State students are paving the way with new tech, *Baltimore Banner*, 12/26/2023 (Ali Ansariyar, Dr. Mansoureh Jeihani, Abolfazl Taherpour).
- How long will it take to replace the Key Bridge? Engineers stress need to do it right, 3/27/2024 (Dr. Medhi Shokouhian).
- Pedestrian oasis or car nightmare? Harborplace plans could slow downtown traffic, 3/25/2024 (Dr. Gregory Newmark).

Dr. Mansoureh Jeihani, SMARTER Center Director, promoted SMARTER research in two live interviews:

- Scripps News Interview
- Interviews with MDOT Social Media Team

3.4 Websites or other Internet sites.

The SMARTER Center's website hosts all of the UTC's ongoing research projects with detailed project descriptions and investigators' aims and findings. The site also contains a wide array of information about the center's staff, facilities, and workforce development initiatives.

SMARTER social media ramped up in the reporting period, with the following follower metrics:

- LinkedIn: 551
- Twitter (X): 120
- Facebook: 22
- YouTube: 431 views in the reporting period

The SMARTER Newsletter is published quarterly to a distribution list of 576 subscribers.

Some SMARTER researchers have built websites for their projects:

- Measuring Pedestrian Psycho-Physiological Well-Being in the Built Environment
- Crime Prevention through Environmental Design (CPTED) for Public Transit Station
- Design and evaluation of an Arterial-Friendly Local Ramp Metering System

Some SMARTER researchers are disseminating their work on GitHub, such as the repository for Connected Vehicle Identification System for Cooperative Control of Connected Automated Vehicles

Jennie Saxe, PI for "Crime Prevention through Environmental Design for Public Transit Stations" promoted her work on Twitter (X) as @jenniesaxe and on LinkedIn in January, 2024.

3.5 Technologies or techniques.

The following technologies are currently being developed under the SMARTER UTC:

- University of Pittsburgh is developing a complex decision-making algorithm for a specialized priority is under development but still not completed as part of its "Ensuring Equity in Pavement Rehabilitation Strategies" project.
- PIs at the University of Delaware are developing geographic information systems predictive models for SLR specifically as they relate to non-motorized transportation facilities as part of "The Impacts of Climate Change and Urbanization on Equity Focus Areas, Active Transportation, and Micromobility."
- Dr. Jennie Saxe is developing a complex decision-making algorithm for a specialized priority is under development but still not completed as part of ""Crime Prevention through Environmental Design (CPTED) for Public Transit Station," in addition to a checklist for evaluation of CPTED principles as transit stations and a streamlined checklist for use at bus stations/shelters was developed.
- Dr. Gang-Len Chang is developing multi-path signal progression and dynamic ramp metering models in his project, "Design and Evaluation of an Arterial-Friendly Local Ramp Metering System."
- PIs at Virginia Tech, working on "Energy Consumption Modeling of Ships: Towards a Door-to-Door (D2D) Freight Optimization" are currently developing a full-scale multi-ship simulator for cargo vessels developed in C++ programing language that will be available to the public as an open-source software.

3.6 Inventions, patent applications, and/or licenses.

Researchers at Morgan State University have filed a patent for a "Blind Spot Warning with Hedging to Promote Defensive Driving Around Trucks," an outcome of the "Novel Driver Warning System with Hedging to Promote Defensive Driving" project.

4. OUTCOMES.[4]

Several SMARTER projects, including "Crime Prevention through Environmental Design for Public Transit Stations," "The Mass Transit Dilemma: Streamlining regulatory regimes to address climate change and poverty," and "Advancing Equity through Regional Multimodal Planning in Small Urban and Rural Communities," are designed to provide guidance to policymakers and transportation planners in the form of best practices and design frameworks.

5. IMPACTS.[5]

5.1 What is the impact on the effectiveness of the transportation system?

As part of the Smart, Green, Equitable, Safe, Complete Streets for All, the Mixed Traffic Connected and Autonomous Vehicle Testbed is actively collecting data on traffic conflicts on the roadways near Morgan State University. Moreover, this technology is preparing to accommodate connected vehicles

[4] What outcomes has the program produced? How are the research outputs described in section 3 above being used to create outcomes? (Outcomes are the application of outputs; any changes made to the transportation system, or its regulatory, legislative, or policy framework, resulting from research and development outputs.)

[5] 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?

by providing them with static warning messages and traffic signal timing information as they approach specific intersections on the testbed.

In support of SMARTER sustainability goals, University of Delaware's project "The Impacts of Climate Change and Urbanization on Equity Focus Areas, Active Transportation, and Micromobility" will increase the body of the knowledge related to the planning and designing of the non-motorized transportation facilities in an era of climate change and urbanization.

5.2 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?

Nothing to report.

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

Nothing to report.

5.4 What is the impact on transportation workforce development?

As illustrated in section 1.3, SMARTER research engages students from middle school through graduate school. By touching students at all levels, the SMARTER Center is creating a pipeline of educated and experienced transportation professionals.

6. CHANGES/PROBLEMS.

A few SMARTER PIs have encountered issues in their core projects, all but one relating to staffing.

6.1 Changes in approach and reasons for change.

Due to the nature of X-Mode data (based on 150 smartphone applications' location data), it has taken much longer than expected to reduce the data to understand smartphone users' travel behavior. Researchers in UVA's "Smart Rideshare Matching – Feasibility of Utilizing Personalized Preferences" project are pivoting from X-Mode to using Wejo data for actual vehicular movement data (at three second intervals), including origin and destination.

MSU researchers of "A Novel Driver Warning System with Hedging to Promote Defensive Driving" initially planned to develop hedging mechanisms to enhance defensive driving practices for all vehicles. However, thorough research, literature review, and initial driving simulator testing, they have determined that focusing their efforts on trucks or heavy vehicles would be more advantageous.

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

The following projects encountered staffing issues that may result in delays:

- The primary PhD student working on "Ensuring Equity in Pavement Rehabilitation Strategies" was granted a medical leave of absence from January 1 to August 31, 2024. University of Pittsburgh PIs have requested and additional six months to complete the project.
- Both projects at West Virginia University have been affected by PI transitions, with Dr. Martinelli (the original SMARTER Associate Director and core project PI) leaving WVU. Although Dr. Dimitra Pyrialakou has stepped into both roles and quickly come up to speed, the research has been delayed by changes in personnel and difficulties in the recruitment of graduate students due to institutional and other challenges. WVU may request a no-cost extension to make up for the time lost.
- The SMARTER Associate Director and core project PI at Howard University is currently on leave, temporarily halting progress on the "Near-Real-time Health Monitoring and Assessment

of a Railway Track System" project. We await news from Howard on who will continue the SMARTER research.

6.3 Changes that have a significant impact on expenditures.

There is a change in Howard University's UTCs staffing. It might affect deliverables and/or expenditures.

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.