Semi-Annual Progress Report for REPS

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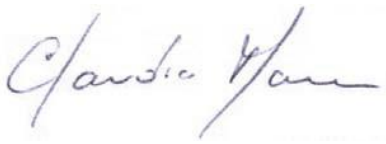
Signature of Submitting Official (signature must be submitted in accordance with agency-specific instructions).	

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1. ACCOMPLISHMENTS

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

The Research and Education for Promoting Safety (REPS) Tier 1 University Transportation Center is a collaborative initiative aimed at enhancing transportation safety through multidisciplinary research. This center integrates cutting-edge research from civil engineering and computer science to tackle challenges related to infrastructure, traffic operations, and cybersecurity.

The team of prominent researchers from four universities in the U.S.: Howard University (HU-Lead), San Jose State University (SJSU), the University of Maryland (UMD), and the University of Nevada, Las Vegas (UNLV).

1.1.1 Research Goals

REPS goal is to develop integrative solutions that improve safety by eliminating traffic-related fatalities, reducing transportation infrastructure failures, and enhancing public transit efficiency. Through research, education, and technology transfer, our team is dedicated to preparing safety professionals with the skills needed to tackle evolving technological and safety challenges. The research aligns with USDOT's strategic goals of Safety, and Transformation, focusing on preserving transportation systems, reducing cybersecurity risks, and implementing technology transfer activities.

REPS is organized around three key thrust areas, each addressing critical aspects of transportation safety:

- **Thrust Area 1: Safe Design and Systems to Increase Transportation Safety**

This focus area centers on projects aimed at improving transportation safety by designing and implementing innovative systems. The research area explores topics such as the impact of enforcement and education on reducing impaired driving, integrating Adjudication Citation and Enforcement (ACE) data, and the role of mental states on driver safety. It also examines the potential of big data analytics to develop smart cities and prevent accidents.

- **Thrust Area 2: Critical Infrastructure Cybersecurity**

This focus area centers on projects aimed at enhancing cybersecurity in critical transportation infrastructure as systems become increasingly digitized. This research area explores the use of Blockchain and Artificial Intelligence (AI) technologies to improve data collection, processing, and security, particularly in railways. Key projects include developing blockchain-based systems for railway track data measurement, creating digital twin-based pipeline safety systems, and incorporating smart AI technologies.

- **Thrust Area 3: Safe Public – Protecting Communities from Safety Risks**

This focus area centers on projects aimed at protecting communities from transportation-related risks by advancing traffic safety research. The aim is to reduce road fatalities through the development of advanced tools, monitoring traffic, and improving safety models. By using local data, Crash Modification Factors (CMFs) will be updated for better safety outcomes. The research area also includes testing various technologies to improve road network performance and infrastructure reliability. Key projects involve creating micromobility crash modification factors, analyzing freeway and arterial safety, and enhancing safety for pedestrians and vulnerable road users.

1.1.2 Education, technology transfer, and Workforce Development goals

REPS is committed to advancing access to transportation resources by engaging a broad range of communities, institutions, and organizations through research, education, workforce development, and technology transfer. By leveraging emerging technologies, expanding educational pathways, and supporting workforce initiatives, REPS partners with local and state Departments of Transportation, as well as public and private stakeholders, to promote safety, innovation, strategic planning, and the cultivation of a skilled transportation workforce.

1.2 What was accomplished under these goals?

1.2.1 Research

Ten research projects of the REPS (06/01/2023 – present) are in progress involving multiple partners. The research projects are categorized within the three trust areas as follows:

Thrust Area 1: Safe Design and Systems to Increase Transportation Safety

1. **Investigating the Impact of Enforcement and Education on Reducing Drug-Impaired Driving**

   Lead Institution: Howard University

   RIP Database: https://trid.trb.org/View/2430395

2. **Effective Practices to Integrate Traffic Citation and Adjudication (TCA) Data**

   Lead Institution: University of Nevada las Vegas

   RIP Database: https://rip.trb.org/View/2431642

3. **Mental States & Machine: Enhancing Driver Engagement in Automated Vehicles for Safer Transitions**

   Lead Institution: San Jose State University

   RIP Database: https://rip.trb.org/View/2431167

Thrust Area 2: Critical Infrastructure Cybersecurity

4. **Smart AI-Technology Employment for Crash Data Analysis**

   Lead Institution: University of Nevada Las Vegas

   RIP Database: https://rip.trb.org/View/2431593

5. **Quantum Machine Learning and Railway Deterioration and Operations**
   Lead Institution: University of Maryland College Park

   RIP Database: https://rip.trb.org/View/2431697

6. **Machine Learning and Railway Track Deterioration Part1: Degree of Railroad Ballast Fouling Using Gaussian Process Regression**
   Lead Institution: University of Maryland College Park

   RIP Database: https://rip.trb.org/View/2431698

7. **Machine Learning and Railway Track Deterioration Part2: Multiway Analytics Applied to Railway Track Geometry and Ballast Conditions**
   Lead Institution: University of Maryland College Park

   RIP Database: https://rip.trb.org/View/2431699

Thrust Area 3: Safe Public – Protecting Communities from Safety Risks

8. **Freeway and Arterial Performance and Safety Analysis with High-Resolution Vehicle Trajectory Data**
   Lead Institution: University of Nevada Las Vegas

   RIP Database: https://rip.trb.org/View/2431597

9. **Enhancing Road Safety for All Road Users**
   Lead Institution: University of Nevada Las Vegas

   RIP Database: https://rip.trb.org/View/2431646

10. **Building AI and Machine Learning Technologies for Enhancing Transportation Station Area Safety in San Jose, CA**
    Lead Institution: San Jose State University

The Research and Education for Promoting Safety (REPS)

RIP Database: https://rip.trb.org/View/2431333

The table below outlines the research projects and summarizes the progress made during the reporting period and constraints.

Projects Status Period: 10/01/2024 to 03/31/2025

Project Title	% Completed	Milestones Achieved	Obstacles/Constraints
Investigating the Impact of Enforcement and Education on Reducing Drug-Impaired Driving	80	- Paper accepted for publication in the proceedings of the ASCE International Conference on Transportation & Development 2025. - Poster accepted for presentation in 66th International Meeting of the Transportation Research Forum - Journal manuscript completed and currently undergoing internal review. - Presented research poster at the Safety21 Summit hosted by US DOT University Transportation Centers. - Developed a novel methodological approach for survey response data analysis. - Abstract submitted and accepted by the Howard Research Month conference.	
Mental States & Machine: Enhancing Driver Engagement in Automated Vehicles for Safer Transitions	100 (in peer review)	Developed experimental designs and conducted a literature review on driving scenarios involving various mental states (distraction, fatigue, mind wandering, emotions, control). Created and refined study materials, including voice recordings, music selections, questionnaires, and consent forms. Submitted a research paper on driver performance in automated vehicles to ASPIRE 2025, a leading Human Factors conference.	- Synchronizing the driving simulator with additional systems (e.g., the eye tracker). - Encountered difficulties designing and controlling realistic experimental conditions to accurately simulate various mental states. - The experiment lasts for a few hours, and it is difficult to recruit more participants
Building AI and Machine Learning Technologies for Enhancing Transportation Station Area Safety in San Jose, CA	100 (in peer review)	- Jan 2025, Completed the Final Report	- Building accurate predictive crime models due to the randomness of social behavior and the complexity of varying crime types. - integrating multi-source data into the Spatial-Temporal Cokriging algorithm, particularly in managing cross-covariance between datasets. - Capturing temporal dynamics due to variability in predictive accuracy between weekdays and weekends.
Smart AI-Technology Employment for Crash Data Analysis	30 (Year 2)	- Professor Jee Woong Park's team developed a natural language processing methodology to automatically analyze a large volume of crash narratives. The approach is well-structured and is currently being applied in ongoing analyses.	- Errors in indicating drug involvement are frequent, complicating the establishment of an accurate ground truth. The research team is implementing a double-stage manual verification process with multiple reviewers to ensure accuracy.
Freeway and Arterial Performance and Safety	90	Publications/presentations in 2024: - T. B. Zahid and B. T. Morris,	- The research team adapted to the loss of vehicle trajectory

Analysis with High-Resolution Vehicle Trajectory Data		"Benchmarking/Limitations of Traffic Prediction with Noisy Field Measurements", in Proc. IEEE Inter. Conf. on Vehicular Electronics and Safety, Dec. 2024. - T. B. Zahid and B. T. Morris, "Using Deep Traffic Prediction for EMFAC Emission Estimation and Visualization", in Proc. IEEE Intell. Transp. Syst. Conf., Sep. 2024	data by shifting focus to highway traffic data, leading to successful research on traffic prediction and emission estimation, which produced two conference publications in 2024.
Enhancing Road Safety for All Road Users	50 (Year 2)	- Enhanced pedestrian safety by distributing 300+ reflective jackets to individuals relying on walking, receiving strong community approval. - Promoted road safety through the #Dusk2Dawn campaign, distributing 1,000 reflective items and securing 500+ public safety pledges at a major community event. - Hosted the Rally to Remember, a multi-modal transportation celebration featuring rallies, a car show, and raffle prizes worth thousands of dollars to encourage community engagement. - Participated in the "Safe Santa" event, collaborating with public and non-profit organizations to educate families on road safety, distributing gear like reflective bands, helmets, and car seats, alongside safety presentations.	- For 2025, the jacket distribution program will be expanded to offer more community involvement opportunities, such as assisting with distribution, to address participation limitations caused by the $35 cost. - Volunteer recruitment for campaign planning, outreach, and prize coordination required significant effort, and partner communication during the rally led to missed opportunities for participants to earn additional raffle tickets by visiting partner stores.
Effective Practices to Integrate Traffic Citation and Adjudication (TCA) Data	40 (Year 2)	- Drafted primers for Nevada's Judicial System and Law Enforcement Agencies (LEAs), incorporating data from 47 agencies and key demand indicators from sources like Nevada DMV, FHWA, and Nevada DOT. - Completed a white paper on data integration and stakeholder collaboration to advance traffic safety in Nevada. - Established an Advisory Committee with representatives from key stakeholder groups across Nevada. - Actively participated in statewide traffic safety initiatives, including Nevada TRCC, SHSP Key Area groups, and Vision Zero meetings. - Delivered key presentations on traffic safety and data integration, including a featured talk at the US DOT CR2C2 Seminar (Feb 2025), updates at Nevada TRCC meetings, and recognition for doctoral student Kiersten Farmer, who earned the Best Student Presentation Award at the Nevada Fall Transportation Conference (Oct 2024) for her work on traffic citations and adjudication.	- Key stakeholder engagement was impacted by concerns from judicial, legal, and law enforcement officials regarding participation in deliberations, particularly due to sensitivities around the November 2024 national, state, and local elections.. - Despite election-year challenges limiting stakeholder engagement, the team remains on track to achieve several (but not all) milestones in the coming months
Quantum Machine Learning and Railway Deterioration and Operations	80	- Processed track geometry dataset for model training and testing. - Investigated quantum support vector machines (QSVM) for predicting railway track geometry failures. - Compared various quantum circuit layouts against a classical SVM baseline. - Completed analysis and drafting of manuscript for journal peer review is in progress.	- Faced computational limitations inherent in simulating quantum machine learning models on classical hardware, impacting experimentation timelines. - Limited access to complete datasets due to privacy concerns, which restricted usable segments.

Machine Learning and Railway Track Deterioration Part1: Degree of Railroad Ballast Fouling Using Gaussian Process Regression	70	- Critical review of existing literature on the current methods used in the evaluation of Ballast fouling in railway tracks. - Critical review of literature on railroad track predictions done so far involving railway superstructure and substructure. - Critical review of the existing machine learning methods used in relation to railway superstructure and substructure. - Implemented Gaussian Process Regression in the prediction of railroad ballast fouling using railway geometric variables as predictors. - The research adopted a train-test split method of 80%-20% and the model performance proves to be substantial. - The model results include the importance feature plot showing the contribution of each variable to the prediction of fouling in the track and the generation of a surface response plot, which shows the degree of fouling in the track. The manuscript is in progress.	- The obstacle encountered is primarily the implementation of Gaussian Process Regression on our modern computers for a track length of 1820 ft. However, a method to overcome this challenge has been partially evaluated by subsetting the dataset and running the model for each subset, thereby significantly impacting the project completion timeline.
Machine Learning and Railway Track Deterioration Part 2 Multiway Analytics Applied to Railway Track Geometry and Ballast Conditions	95	- Collected and preprocessed track geometry and ballast condition data for U.S. railroad. - Applied PARAFAC tensor decomposition to a multidimensional data tensor. - Performed exploratory data analysis, including boxplots, kernel density plots, and correlation matrices. - Interpreted model outputs using biplots and identified interdependencies between track geometry and ballast condition variables. - Published in ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering.	- Limited access to complete datasets due to privacy concerns, which restricted usable segments. - Absence of contextual variables (e.g., maintenance logs, sleeper condition, traffic density) reduced the depth of assessment. - No user-friendly tools currently exist for practitioners to implement tensor decomposition insights in routine maintenance operations.

1.2.2 Education and Workforce Development

Across the REPS consortium institutions—HU, UNLV, SJSU, and UMD—comprehensive efforts have been made to advance transportation research, education, workforce development, and community engagement. Faculty and students actively contributed to national and international conferences, workshops, and industry events, sharing innovative research on topics such as traffic safety, AI/ML applications, and quantum machine learning in transportation. Workforce development was supported through graduate and undergraduate coursework, mentorship of research projects and theses, leadership training programs, and hands-on experience in emerging technologies. All institutions emphasized student involvement, providing opportunities for research, professional development, and conference participation. Additionally, significant outreach initiatives targeted K-12 communities through workshops, summer camps, and STEM events, fostering early interest in transportation careers and promoting diversity in STEM fields. Some activities are included below, and some others are described in detail in section 4.5.

- At HU, undergraduate students are actively involved in transportation engineering research work. Some of the highlights include the creation of a new Institute of Transportation Engineers (ITE) student chapter, which held its first meeting on March 26, 2025, in collaboration with the District Department of Transportation (DDOT). K-12 outreach is also being developed to inspire future interest in transportation careers through workshops and STEM events. Research outcomes were shared with industry and academic communities through presentations at summits and conferences.

- At UNLV, faculty and their teams actively contributed to national and international conferences, including IEEE events, the Transportation Research Board (TRB) annual meeting, and specialized workshops such as the NSF CIRC & CNS MRI PI Meeting. Graduate students successfully completed thesis work focused on topics like traffic prediction, environmental impact assessment, and road safety analytics. Research outcomes were shared with industry and academic communities through presentations and integrated into graduate coursework to support workforce development. Faculty led undergraduate and graduate courses in transportation engineering and safety, with a focus on service-learning projects addressing real-world transportation challenges. Additional efforts included mentoring senior design projects, guiding thesis and dissertation research, and organizing seminars, field trips, and outreach activities in collaboration with professional organizations. REPS also supported K-12 outreach initiatives to engage students, educators, and administrators, promoting traffic safety awareness and encouraging interest in STEM fields.
- At SJSU, activities focused on leadership development, student research, and the integration of AI/ML into transportation safety education. The Leadership Academy was customized for Metro North, with preparations underway for a two-day intensive program and a Leadership Fellows interview featuring a prominent industry CEO. Support for student development included funding research positions, sponsoring conference attendance, and providing training in experimental design, reporting, and data analysis. Additionally, an AI-driven crime prediction algorithm was incorporated into the MS in GIS curriculum, enabling students to pursue advanced capstone projects. Outreach efforts extended to K-12 education through the MSTI Summer Camp, where over 40 high school students engaged in GIS and mapping activities, enhancing STEM exposure and community impact.
- At UMD, efforts focused on advancing transportation research through active participation in major conferences and student engagement. The team showcased ongoing research at the TRB 104th Annual Meeting, presenting innovative approaches and preliminary findings to policymakers, researchers, and industry leaders. Additionally, they contributed to the ASCE T&DI Conference on Pioneering Transportation with Generative AI by presenting on the challenges and opportunities of integrating generative AI and quantum machine learning in transportation. Five research students were actively involved in these conferences, enhancing their professional development and contributing to the dissemination of cutting-edge research.

1.3 How have the results been disseminated?

Across the REPS consortium institutions actively advanced transportation research through publications, conference presentations, and professional outreach. HU, UNLV, SJSU, and UMD showcased their findings at prestigious conferences, summits, and workshops, including ASCE, TRB, TPMDC, and international forums, while also securing publications in respected journals. Research topics spanned transportation safety, AI/ML applications, human factors in autonomous vehicles, geospatial analytics, and emerging technologies for road user safety. In addition to academic contributions, the teams engaged in public outreach, media engagement, and collaborative initiatives through interdisciplinary efforts as described in detail in section 3.

- At HU, research findings have been presented and published in several academic and professional outlets. One will be a presentation at the ASCE International Conference on Transportation & Development. A poster presentation was accepted at the 66th Transportation Research Forum International Meeting. The project findings were presented at the U.S. DOT University Transportation Centers for Safety21 Summit. Several presentations were made at Howard University's Research Month conference.
- At UNLV, faculty and researchers actively contributed to national and international transportation safety discussions through media engagement, keynote speeches, conference presentations, and panel participation. Highlights include multiple invited keynote addresses and sessions focused on leveraging data and emerging technologies to enhance road user safety at prominent international conferences in India. Research on complete streets and smart AI technology for crash data analysis was presented at global forums, including the TPMDC and the upcoming ASCE i3CE 2025. Public outreach was also emphasized, with expert quotes featured in widely-read articles on traffic signs and a presentation at the Nevada Safety Conference, where a workshop addressed the impact of speed on pedestrian and cyclist safety.

- At SJSU, research efforts focused on human factors in autonomous vehicles and the application of AI/ML for transit safety and urban analytics. Findings from the Mental States & AVs project were submitted to ASPIRE 2025, a leading conference in human factors, with plans for presentation upon acceptance. The team also showcased AI-powered crime prediction and geospatial safety research through invited and conference presentations at events such as VTA GIS Day, the SJSU graduate student symposium, the American Association of Geographers (AAG) Annual Meeting, and the 2025 PSR UTC Annual Congress. .
- At UMD, research findings were published in reputable journals, including the ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems. The team actively participated in key conferences such as the TRB 104th Annual Meeting, the ASCE T&DI Artificial Intelligence in Transportation Committee Conference, and the Hack the Railroad conference. Additionally, REPS contributed to specialized workshops, including supporting the organization of the ASCE T&DI AI in Transportation Conference.

1.4 What Do You Plan to Do During the Next Reporting Period to Accomplish the Goals And Objectives?

1.4.1 General Plan and Actions for the Upcoming Reporting Period

The REPS consortium institutions have outlined comprehensive plans for the next reporting period, focusing on advancing transportation safety research, education, outreach, and collaboration. HU will launch an internal call for interdisciplinary projects aligned with USDOT goals, foster collaborative research with consortium partners, and engage faculty through peer-reviewed initiatives. UNLV will continue diverse activities, including intersection safety analysis using computer vision, crash data research, stakeholder engagement, public outreach events like art contests and community forums, and educational programs such as Teen Driver Safety Day. SJSU will focus on finalizing deliverables from completed projects, seeking additional funding, publishing research on AI/ML applications in public safety, and developing user-friendly tools for broader use. UMD will maintain momentum on existing research efforts while actively participating in conferences to disseminate findings. More details are below.

Howard University's general plan for the next reporting period under the REPS initiative includes:

- Launching an internal call for proposals to fund 2–4 interdisciplinary projects that align with USDOT's safety and transformation goals.
- Advancing collaborative research with consortium members (such as UNLV, SJSU, and UMD) to tackle transportation safety challenges using advanced technologies like computer vision (CV) and automated vehicles.
- Engaging faculty from different departments and evaluating proposals through a Peer Review Committee to ensure alignment with REPS objectives.

UNLV's general plan for the next reporting period under the REPS initiative includes:

- Launching the Year 2 project "Observational Intersection Traffic Safety Analysis," to examine intersection safety using video cameras. This project combines research and workforce development, with UNLV CV researchers training Howard students in CV methods and developing intersection monitoring applications for Washington, D.C. The analysis will identify safety hotspots and provide reports for countermeasure planning.
- Continuing crash narrative data analysis, assessing methodology performance against ground truth, preparing journal and conference publications, and integrating findings into outreach and graduate-level course enhancements.
- Expanding stakeholder engagement with elected officials and law enforcement, and finalizing the Judiciary Primer, LEA Primer, and the white paper "Advancing Traffic Safety: A Strategic Framework for Data Integration and Stakeholder Collaboration in Nevada," along with quantifying demand indicators using data from Nevada DMV, FHWA, and Nevada DOT.
- Ongoing participation in meetings, working groups, and committees such as TRCC, Vision Zero, Nevada Advisory Committee on Traffic Safety, and ATSIP's Traffic Records Forum.

- Organizing the “Save A Life, Win A MacBook” art contest for school-aged students to design bus shelter or in-bus ads promoting traffic safety, with prizes, a traveling art show starting May 20, 2025, and a calendar featuring top entries.
- Hosting a half-day community forum on May 28, 2025, to address pedestrian fatalities and how incident reporting influences driver perceptions.
- Hosting “Teen Driver Safety Day” in mid-July 2025, featuring a mock crash, educational sessions with emergency responders, law enforcement, judiciary, and testimonials from families affected by traffic crashes.
- Planning fall 2025 outreach events, including #Dusk2Dawn activities, “Safe Santa”, and a teen driving awareness event titled “Santa Claus is Coming to Town, and Please Don’t Hit Him”.

SJSU general plan for the next reporting period under the REPS initiative includes:

- The "Mental States & AVs" project has concluded, with the report under peer review. The team is actively seeking additional funding to continue research and expand data collection for future journal and conference publications.
- Following the completion of the "Building AI/ML for Station Area Safety" project analysis and final report, efforts will focus on finalizing scholarly and practical deliverables. This includes polishing the manuscript "Enhanced Spatio-Temporal Cokriging Crime Predictions Using Social Media Data: A Multi-Type Case Study in San Jose, California" for journal submission, and refining algorithms and visualization tools into user-friendly software for practitioners and researchers. These outputs aim to enhance accessibility and support integration into academic curricula, municipal planning, and public safety operations.
- The research will also extend by incorporating real-time social media data, such as geo-tagged tweets, into the ST-Cokriging model to improve crime prediction across multiple types. A comprehensive analysis will address model accuracy, temporal-spatial patterns, and the value of social signals in forecasting.

UMD general plan for the next reporting period under the REPS initiative includes:

- Continue working on current research projects.
- Attend conferences and give presentations on ongoing projects and publications.

1.4.2 Research

During the upcoming reporting period (April 1, 2025 – September 30, 2025), we aim to:

Complete Ongoing Year 1 Research Projects:

- We will finalize the research projects outlined in Section 1.2 that remain incomplete.
- The table below provides an overview of Year 1 research projects, summarizing the pending milestones and their proposed completion dates.

Initiate and Advance Year 2 Research Projects:

- We will begin and make progress on new projects planned for Year 2.
- The budget for Year 2 is still pending approval.

Year 1 research projects

Project Title	Pending Milestones	Timeline to Complete
Investigating the Impact of Enforcement and Education on Reducing Drug-Impaired Driving	Completed internal review and submitted a journal manuscript and prepared a second manuscript on the new methodology for submission to the 2026 TRB Annual Meeting and future journal publication.	8/1/2025
Mental States & Machine: Enhancing Driver Engagement in Automated Vehicles for Safer Transitions	Await the outcome of the ASPIRE 2025 manuscript review and prepare for a potential presentation if the abstract is accepted	The conference will be held on 10, 2025
Building AI and Machine Learning Technologies for Enhancing Transportation Station Area Safety in San Jose, CA	We aim to complete the journal manuscript submission and finalize the deliverable software packages	09/30/2025
Smart AI-Technology Employment for Crash Data Analysis	Developed an automated method to improve the identification of drug-involved crashes by addressing ambiguities in crash narratives and enhancing data reliability.	10/30/2025
Freeway and Arterial Performance and Safety Analysis with High-Resolution Vehicle Trajectory Data	Complete the final report	10/30/2025
Enhancing Road Safety for All Road Users	Organize age-appropriate activities and events for K-12 students, Hold community/stakeholder engagement events to raise traffic safety awareness.	10/30/2025
Effective Practices to Integrate Traffic Citation and Adjudication (TCA) Data	Garnered participation from elected officials and law enforcement agencies, finalized the Judiciary Primer, Law Enforcement Agency (LEA) Primer, and a white paper on data integration and stakeholder collaboration, and quantified key demand indicators using data from the Nevada DMV, FHWA, Nevada DOT, and related sources.	10/30/2025
Quantum Machine Learning and Railway Deterioration and Operations	Completed manuscript drafting, submission for journal peer review, and revisions based on reviewer feedback leading to finalization for publication.	10/30/2025
Machine Learning and Railway Track Deterioration Part1: Degree of Railroad Ballast Fouling Using Gaussian Process Regression	Completed formatting and proofreading of the manuscript, submitted it to the appropriate journal, and compiled related project outputs for the final report preparation.	10/30/2025
Machine Learning and Railway Track Deterioration Part 2 Multiway Analytics Applied to Railway Track Geometry and Ballast Conditions	Compile with other projects and prepare the final report	10/30/2025

1.4.3 Education and Workforce Development.

At HU we will continue:

- The integration of emerging transportation technologies into coursework, such as smart mobility and infrastructure resilience.
- K-12 STEM outreach and transportation safety education in underserved communities.
- Workshops on AI in infrastructure monitoring, safety analytics, and advanced tech tools.
- Industry-led mentoring and internship opportunities.
- Funded research roles for undergraduate and graduate students.
- Interdisciplinary learning integrating engineering, computer science, economics, and planning.

At UNLV we will be:

- Hosting the Summer 2025 NSF REU Site: Smart Cities - Advancing Mobility, welcoming 12 students nationwide for mentored research, co-curricular training, and industry talks, with a focus on safety-related projects.

- Incorporating methodological advances from ongoing research into educational modules, particularly in civil and transportation engineering.
- Regular REPS UTC activities in partnership with ITE, CEEC, and PSR UTC, including weekly seminars/webinars, field trips, site visits, and resume review sessions featuring thought leaders from academia, industry, and non-profits.
- Delivery of key courses: CEE 362: Transportation Engineering (Fall 2024) with 40 students, emphasizing diversity and inclusion. And CEE 727: Transportation Safety (Fall 2024), a graduate course with service-learning projects addressing societal transportation safety challenges.
- Mentorship of students on capstone projects, dissertations, and theses, including topics such as pedestrian safety, data analytics for road safety, and traffic signal operations.

At SJSU we will:

- Delivery of a 2-day intensive Leadership Academy for Metro North participants (May 12-14, 2025) and a Leadership Fellows interview with Greg Kelly, CEO of STV (May 15, 2025).
- Finalizing and submitting a journal article and software deliverables from the Building AI/ML for Station Area Safety project, along with presenting research at academic conferences. Revisions to the project report will follow peer review feedback.

2. PARTICIPANTS & COLLABORATING ORGANIZATIONS

Several state governments and industrial partners are in the process of partnering with REPS to provide financial and in-kind support and facilities to the Center:

Organization Contributions to REPS

Name of Organization/Entity	Location	Contribution to Project
Andrew Farkas	Maryland	Advisor
Dr. Austin Angulo, the principal investigator at TRAVL (Transportation Research and Visualization Laboratory)	University at Buffalo	Collaborative research. Technical advisor for the research efforts, given his expertise in solutions for pedestrian distraction
District of Columbia Department of Transportation	Washington, DC	In-kind support
Metropolitan Police Department (MPD)	Washington, DC	In-kind support
MPD Headquarters	Washington, DC	In-kind support
Amazon	Arlington, VA	In-kind support
Metro North	New York City	Facilities
STV	New York City	Facilities
National Science Foundation	Alexandria, VA	Equipment from NSF MRI award #2216489, for the development of a self-driving car platform and advanced intersection monitoring systems.
Nevada Office of Traffic Safety	Carson City, NV	Synergistic funding and support to garner access to relevant data
Nevada Dept of Transportation	Carson City, NV	Provide access to relevant data
Clark County Office of Traffic Safety	Las Vegas, NV	Facilitate access to relevant data and subject matter experts
Various state and local agencies and organizations;	Las Vegas, Henderson, Reno, Carson City (all in Nevada)	Facilitate access to relevant data and subject matter experts
Print and broadcast media outlets	Las Vegas, NV	Disseminate information through broadcasts and print coverage
Center for Advanced Transportation Technology	College Park, MD	Provided data
Maryland Transportation Institute	College Park,MD	Staff and Outreach Support
University of Delaware	Newark, DE	Railway Data

3. OUTPUTS

3.1 Publications, conference papers, and presentations

3.1.1 Peer-Reviewed Journal Publications

1 P. Woldemariam and N. Attoh-Okine, "Multiway Analytics Applied to Railway Track Geometry and Ballast Conditions." ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering, Vol. 11, No. 1, March 2025. Status: Published. Federal Support: Yes.

3.1.2 Conference Papers (Published in Proceedings)

1. Luwei Zeng, Claudia Marin. "Public Perceptions and Behavioral Intentions Regarding Impaired Driving: Analysis of Educational and Enforcement Strategies." International Conference on Transportation & Development (ICTD), ASCE Proceedings, June 2025. Status: Accepted. Federal Support: Yes.
2. T. B. Zahid, B. T. Morris. "Benchmarking/Limitations of Traffic Prediction with Noisy Field Measurements." IEEE International Conference on Vehicular Electronics and Safety, December 2024. Status: Published. Federal Support: Yes.
3. T. B. Zahid, B. T. Morris. "Using Deep Traffic Prediction for EMFAC Emission Estimation and Visualization." IEEE Intelligent Transportation Systems Conference, September 2024. Status: Published. Federal Support: Yes.
4. Barua, T., Das, N., Park, J. "Understanding Contributing Factors to Pedestrian Related Crashes of Massachusetts Using Factor Map Analysis." ASCE International Conference on Computing in Civil Engineering, May 2025. Status: Accepted. Federal Support: Yes.
5. Das, N., Park, J., Barua, T. "Benefits and Challenges: Using Language Models in Crash Narratives Including Ambiguous Statements." ASCE International Conference on Computing in Civil Engineering, May 2025. Status: Accepted. Federal Support: Yes.
6. Lo, W. H., et al. "The Impact of Mental States on Informative Takeover Requests: A Study of Visual and Tactile Modalities in Automated Driving." Human Factors and Ergonomics Society Annual Meeting, 2025. Status: Under Review. Federal Support: Yes.

3.1.3 Conference Presentations and Posters

1. Merssaideiz U. Howard, Luwei Zeng, Claudia Marin. "Evaluating the Influence of Micromobility Initiatives on Travel Behavior in Washington, D.C." Howard University Research Month, April 2025. Status: Accepted. Federal Support: No.
2. Kelsea Jacobs, Luwei Zeng, and Claudia Marin. “Enhancing Transportation Safety Through A Computer Vision System: Case Study of Georgia Ave & Irving St Intersection In Washington, D.C.” Howard University Research Month, April 2025. Status: Accepted. Federal Support: No.
3. Dyani Wilkins, Luwei Zeng, and Claudia Marin. “Hack-Proofing the Commute: Cybersecurity in Modern Transit Systems.” Howard University Research Month, April 2025. Status: Accepted. Federal Support: No.
4. Jaylin M. Holmes, Luwei Zeng, and Claudia Marin. “Optimizing Urban Mobility and Patterns throughout the DC Metropolitan Area to Surrounding Neighborhoods: A New Innovative Way of Travel”, Howard University Research Month, April 2025. Status: Accepted. Federal Support: No.
5. Nuha Thaha, Luwei Zeng, and Claudia Marin. “A Solution to Rising Asthma Rates due to High-Traffic Areas in Washington D.C. - Green Buffer Zones.” Howard University Research Month, April 2025. Status: Accepted. Federal Support: No.
6. Luwei Zeng and Claudia Marin, “Evaluating Prevention Strategies for Impaired Driving: An Integrated Assessment of Community Perceptions and Response Intentions.,” *Safety21 Summit, US DOT University Transportation Centers*, Washington D.C., Mar. 2025, Federal Support: Yes.

7. Luwei Zeng and Claudia Marin, "Educational and Enforcement Approaches to Impaired Driving: A Mixed-Methods Analysis of Community Response and Behavioral Change.," *66th International Meeting of the Transportation Research Forum*, St. Louis, Apr. 2025 (Best Poster Award). Federal Support: Yes.
8. Shashi Nambisan. Data and Emerging Technology Considerations to Enhance Road User Safety, International Passive Safety Seminar (IPASS -2024), International Centre for Automotive Technology, Manesar, New Delhi, India. October 17-18, 2024. Invited Keynote Speaker.
9. Shashi Nambisan. Data and Emerging Technology Considerations to Enhance Road User Safety, International Passive Safety Seminar (IPASS -2024), International Centre for Automotive Technology, Manesar, New Delhi, India. October 17-18, 2024. Invited Keynote Speaker.
10. Shashi Nambisan. The Role of Autonomous Vehicles in Enhancing or Diminishing Passive Safety Requirements, International Centre for Automotive Technology, Manesar, New Delhi, India. October 17-18, 2024. Invited Panelist.
11. Shashi Nambisan. Session 1 - Redefining Safety: Vehicle Development Perspective, International Centre for Automotive Technology, Manesar, New Delhi, India. October 17-18, 2024. Invited Session Moderator.
12. Erin Breen, presentation at Nevada Safety Conference and charrette on pedestrian and bicycle safety.
13. Additional speaking engagements at Rotary groups and partner events.
14. Bo Yang, Enhancing Transportation Safety through AI-Driven Crime Prediction in Urban Environments (AAG 2024 Honolulu)
15. Xiangyu Ren, Bo Yang, Ahoura Zandiatashbar; Comparing Transportation Hub Built Environment & Social Variables as Auxiliary Data in Street Crime Prediction, a case study in San Jose, USA; Pacific Southwest Region UTC Annual Congress, March 24-25, 2025. University of California, Berkeley. Poster. Federal Support: Yes.
17. Other Presentations at: TRB 104th Annual Meeting. ASCE T&DI AI in Transportation Conference. Hack The Railroad Conference. Contributions to specialized workshops, including organizing the ASCE T&DI AI in Transportation Conference.

3.1.4 Media Engagements

1. Shashi Nambisan, quoted in "Here's What It Means If You See a Pink Traffic Sign," Article by Kelly Bryant in RD.com, January 14, 2025.https://www.rd.com/article/pink-traffic-sign/
2. Shashi Nambisan, quoted in "Here's What It Means If You See a Blue Stop Sign," Article by Kelly Bryant in RD.com, December 02, 2024. https://www.rd.com/article/blue-stop-sign/

3.2 Policy Papers

1. White paper entitled "Advancing Traffic Safety: A Strategic Framework for Data Integration and Stakeholder Collaboration in Nevada", Status: Draft. Federal Support: Yes.
2. White paper entitled "Nevada Judicial Primer" which incorporates court system-related data. Status: Draft. Federal Support: Yes.
3. Law Enforcement Agency (LEA) primer by incorporating data from 47 agencies across Nevada, and key attributes of each LEA. Status: Draft. Federal Support: Yes.

3.3 Websites or Internet Sites

1. Leadership Academy: https://transweb.sjsu.edu/workforce-development/mineta-leadership-academy
2. Building AI/ML for Station Area Safety: https://github.com/gis-yang/Crime-prediction

3.4 New Methodologies, Technologies, or Techniques

1. Performed causal effect analysis on survey data to determine primary drivers of behavior change, establishing causal relationships beyond correlations. Developed methods for analyzing nonlinear

data patterns to better understand complex behavioral responses to transportation safety interventions. (Discussed by Luwei Zeng and Claudia Marin)

2. Developed a novel HMI that delivers takeover requests using both visual and tactile signals.
3. Integrated eye tracking, skin response, and motion capture to objectively assess driver engagement and performance under varying mental states.
4. Application of quantum machine learning in rail engineering.
5. Application of topological data analysis in rail track geometry

3.5 Inventions, Patents, and/or Licenses

Nothing to report yet

3.6 Other Products

Nothing to report yet

4 OUTCOMES

4.1 Increased understanding and awareness of transportation issues

- Disseminated findings on AI-driven crime prediction and the integration of built environment variables at major conferences (AAG 2024 and PSR UTC Congress 2025), enhancing awareness of public safety issues around transportation hubs.
- Shared research on mental states' impact on driver behavior and autonomous vehicle safety at national meetings, informing industry and academic discussions.
- Presented impaired driving intervention research results at the Transportation Research Forum and Safety21 Summit, raising awareness among transportation, law enforcement, and public health sectors.

4.2 Passage of new policies, regulations, rulemaking, or legislation

- Research activities supported stakeholder engagement efforts that contribute to data-driven policy discussions, such as judiciary and law enforcement collaborations in Nevada on impaired driving and traffic safety data integration.
- Research outputs are informing local agency practices and future legislative considerations, particularly related to road safety data use and public outreach initiatives.

4.3 Increases in the body of knowledge

- Developed validated methodologies for assessing public perceptions toward impaired driving interventions, enhancing transportation safety literature.
- Advanced AI-based traffic crash narrative analysis using NLP techniques, broadening analytical capabilities in transportation incident studies.
- Applied multiway analytics (tensor decomposition) to railway track and ballast condition monitoring, improving predictive maintenance strategies.
- Published proceedings papers and conference presentations across multiple disciplines, expanding access to transportation safety research findings.

4.4 Improved processes, technologies, techniques and skills in addressing transportation issues

- Developed and introduced contralateral human-machine interface (HMI) designs and multimodal sensor integration protocols for autonomous vehicle safety studies.
- Created an ST-Cokriging based crime prediction model using transportation hub and socio-economic data for urban safety planning.
- Integrated AI, ML, and quantum computing approaches into applied transportation safety research, advancing skill development for participating students and researchers.

- Enhanced methods for linking transportation safety data from disparate sources to improve data-driven decision-making.

4.5 Enlargement of the pool of trained transportation professionals

Besides the details presented in section 1.2.1 below are the REPS contributions to training transformation professionals.

- Engaged five undergraduate students at Howard University in transportation research and supported the establishment of a new ITE student chapter in partnership with DDOT.
- Provided K-12 outreach programs to build early interest in transportation careers through workshops and STEM events.
- At UNLV, funded undergraduate and graduate student researchers, sponsored students for conference participation, and delivered specialized training in experimental design, data analysis, and reporting.
- Students across institutions were introduced to advanced analytics, AI, ML, and quantum computing tools, preparing them for emerging transportation technology roles.

4.6 Adoption of new technologies, techniques or practices.

- Advanced crash narrative analysis through AI/NLP integration, offering new capabilities for traffic safety analysis and reporting.
- Adopted a Spatial-Temporal Cokriging-based method for urban crime prediction, integrating transportation and environmental data.
- Introduced tensor decomposition techniques in railway infrastructure health monitoring, contributing to improved predictive maintenance modeling.
- Promoted cyber resilience tools and hybrid ML/AI approaches for railway applications, supporting broader adoption of innovative analytics in transportation safety research.

5 IMPACTS

5.1 The effectiveness of the transportation system

The research and activities conducted during this reporting period contributed to advancing the effectiveness of the transportation system. The AI/NLP-based crash narrative analysis developed under REPS initiatives deepens the understanding of crash causes and contributes to more targeted safety interventions. Efforts related to traffic safety data integration, including the combination of judiciary, law enforcement, and demographic data, provide a more comprehensive view for transportation safety decision-making. Research into mental states and driver behavior has advanced understanding of safe transitions between automated and manual driving, contributing to emerging practices in improving driver responses in semi-autonomous vehicles. Public safety outreach efforts, such as forums and community engagement on pedestrian and cyclist safety, raised awareness and encouraged safer behaviors at the community level.

5.2 Technology transfer

During this reporting period, initial steps toward technology transfer were made. Research teams have developed modular deliverables, such as the AI/NLP crash analysis tool and the Spatial-Temporal Cokriging model for crime prediction around transportation hubs. Preliminary results and models were shared with relevant partners, including municipal and transportation agencies. Although no formal adoption or commercial transfer occurred during the period, discussions with agencies have begun regarding potential integration of research outputs into operational practices for urban planning and transportation safety management.

5.3 The increase in the body of scientific knowledge

Research conducted under the REPS program has expanded the body of scientific knowledge across multiple transportation fields. Key contributions include the application of tensor decomposition methods for railway track and ballast condition monitoring, advancing predictive maintenance strategies; the integration of AI and NLP techniques into crash narrative analysis, offering new methodologies for transportation safety

studies; and the development of crime prediction models combining transportation, environmental, and socio-economic variables. These advances have been shared through peer-reviewed journal publications, conference proceedings, and technical presentations, contributing to broader academic and professional communities.

5.4 Transportation workforce development.

The program has made a significant impact on transportation workforce development by providing diverse opportunities for education, skill-building, and practical experience across multiple levels and disciplines. It has engaged K-12 students, undergraduates, graduates, and current professionals through hands-on research, advanced training, and exposure to emerging technologies in transportation science.

Students and professionals were equipped with evidence-based insights for developing impaired driving prevention strategies, along with research-backed guidance for law enforcement on effective enforcement practices and communication. Transportation planners benefited from a knowledge framework that supports the integration of educational campaigns with infrastructure improvements and enforcement measures, enhancing their ability to design comprehensive safety strategies.

At UNLV, REPS-related activities expanded the pool of trained transportation professionals by involving participants across K-12, undergraduate, graduate, and professional sectors, fostering growth in transportation research and practice.

The Mental States & AVs project contributed by engaging students in advanced research, focusing on experiment design, data analysis, and human-machine interaction (HMI) technologies.

The Building AI/ML for Station Area Safety project provided valuable research experience to undergraduate and graduate students, including those from underrepresented groups, through work on AI-driven crime prediction and geospatial analytics. This effort also enhanced the MS GIS curriculum at San José State University, integrating real-world applications in urban safety and transportation planning. Furthermore, the MSTI Summer Camp introduced over 40 K-12 students to GIS and mapping technologies, fostering early interest in transportation science and technology.

Additionally, the program offered opportunities for transportation infrastructure experts to explore the application of cybersecurity frameworks like MITRE ATT&CK and graphical models to secure transportation systems. Civil engineers and related professionals were also exposed to innovative approaches, learning how quantum machine learning and generative AI can address critical challenges in civil infrastructure.

Through these combined efforts, the program has strengthened workforce capabilities, promoted diversity, and prepared the next generation of transportation professionals to tackle evolving challenges with advanced technical skills and interdisciplinary knowledge.

6. CHANGES/PROBLEM

6.1 Changes in approach and reasons for change

The approach to all projects was revised to ensure full compliance with applicable Presidential Executive Orders and Secretarial Orders and Memoranda, with such requirements applying uniformly to both research initiatives and education and workforce development activities, as authorized under the statutory mandate of the UTC program.

On the Traffic Citations and Adjudications project, the team has significant challenges in engaging with key stakeholder groups. These included reluctance from elected and appointed officials in the judicial/legal domains and the law enforcement community. They expressed concerns/reservations about “being on record” in related deliberations. Further, they were also concerned about the timing of major national, state, and local elections that were held in November 2024.

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 expenditure

At UNLV, the delay in the release of Year 2 grant funds has required to scale back the pace of expenditures, which has, in turn, impacted student engagement and slowed progress on certain grant activities.

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

Nothing to report