Semi-Annual Progress Report for University Transportation Centers

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  Mid-America Transportation Center for Transportation Safety and Equity (MATC-TSE)

- **Program Director (PD) Name, Title, and Contact Information**
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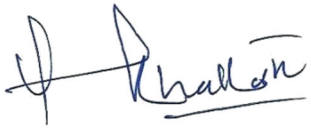

Aemal Khattak, MATC Director

1. ACCOMPLISHMENTS

What are the major goals of the program?

The major goals of the Mid-America Transportation Center (MATC), which were outlined in the MATC proposal, are indicated in the table below. Activities related to research, education, technology transfer, and USDOT requirements are well underway. Please refer to the table below for an update on the status of each activity.

Table 1: Status of MATC's Research, Educational, and Technology Transfer Activities and Reporting Requirements

Research Activities	**Status**	**Percent Completed for Year 1**
Data Management Plan (DMP) - Overarching Plan for MATC-TSE	Complete	100%
Collect DMPs from PIs for Individual Research Projects	In Process	60%
Collect ORCIDs from all MATC-TSE Researchers	In Process	100%
Submit Project Descriptions to TRB's RiP Database	Complete	100%
Education and Workforce Development Activities		
Graduate MATC-TSE Course Development & Implementation	In Process	0%
MATC-TSE Graduate Seminar Series	In Process	0%
MATC-TSE Undergraduate Summer Internship Program	In Process	0%
MATC-TSE Scholars Program	In Process	0%
MATC-TSE/UTC Outstanding Student of the Year	Complete	100%
MATC-TSE Roads, Rails, and Race Cars After-School Program	In Process	0%
MATC-TSE Sovereign Native Youth STEM Leadership Academy	In Process	0%
MATC-TSE Summer Institute	In Process	0%
MATC-TSE Research Experience for Undergraduates (REU) Program	In Process	0%
Technology Transfer Activities		
Technology Transfer Tech Briefs, Webinars & Presentations	In Process	0%
Roadside Safety Short Course (UNL)	In Process	0%
Roadside Safety Workshop (UNL)	In Process	0%
Traffic Safety Classes (KU TASK Program)	In Process	0%
Structural Condition Assessment Short Course (MS&T)	In Process	0%
LTAP Workshops	In Process	0%
USDOT OST-R Reporting Requirements:		
Federal Financial Reports	In Process	100%
Post Research Project Descriptions on MATC Website	In Process	100%
Semi-Annual UTC Program Progress Performance Report	In Process	100%
Annual Performance Indicators Report	In Process	100%
Additional USDOT OST-R Requirements:		
Annual Progress Meetings	In Process	100%
UTC Director's Meetings	In Process	100%

Participate in UTC Symposiums	In Process	100%
Maintain Website (personnel directory, research pages and reports)	In Process	100%

What was accomplished under these goals?

Research Activities

The Mid-America Transportation Center for Transportation Safety and Equity (MATC-TSE) for US DOT Region 7 focuses on the statutory research priority area of *Promoting Safety* and supports the US DOT Strategic Plan goals of safety (primary goal), economic strength and global competitiveness, equity, climate and sustainability, and transformation. The strong MATC-TSE consortium consists of the University of Nebraska-Lincoln (UNL), the Nebraska Indian Community College (NICC), the Missouri University of Science and Technology (MS&T), the University of Iowa (UI), the University of Kansas (KU), and the University of Missouri-St. Louis (UMSL).

MATC-TSE considers the transportation system a complex "system-of-systems" through which humans, technologies, and infrastructure interact. The US DOT Research, Development, and Technology Strategic Plan (2022-2026) governs MATC-TSE research philosophy. Using the US DOT Innovation Principles as benchmark, MATC-TSE addresses the grand challenges of Vision Zero, Resilient Supply Chains, Equitable Mobility for All, Net Zero Emissions, and the Transportation System-of-Systems of the Future. Guidance for MATC-TSE comes from the US DOT Strategic Plan (2022-2026), the US National Roadway Safety Strategy (2022), and the US DOT Equity Action Plan (2022).

As of this reporting period UNL currently has two (2) active USDOT funded projects, supported by eight (8) PI's and Co-PI's. The University of Iowa (UI) currently has ten (10) ongoing USDOT funded projects, supported by eleven (11) PI's and Co-PI's. The University of Kansas (KU) currently has nine (9) ongoing USDOT funded projects, supported by thirteen (13) PI's and Co-PI's. The Missouri University of Science & Technology (MS&T) currently has nine (9) ongoing USDOT funded projects, supported by five (5) PI's and Co-PI's. The University of Missouri-St. Louis (UMSL) currently has ten (10) ongoing USDOT funded projects, supported by seven (7) PI's and Co-PI's. The Nebraska Indian Community College (NICC) currently has one (1) ongoing USDOT funded project, supported by two (2) PI's and Co-PI's.

Throughout the reporting period, individual project PIs from Nebraska, Iowa, Kansas, and Missouri submitted quarterly reports detailing the progress, activities, and outcomes of their individual research projects. Some of the accomplishments reported by PIs are outlined below.

Specific Research Objectives, Significant Results, and Key Outcomes

In addition to ongoing extensive literature and case study reviews, experiment development, and data acquisition, MATC Researchers reported the following project objectives, results, and key outcomes for this reporting period.

In a research project titled "Improving Safety by Eliminating the Bump at End of the Bridge Using Lightweight Backfill and Geosynthetics", Dr. Jie Han of KU and his research team completed a parametric study to investigate the effects of lightweight backfill at different density and friction angles on the performance of bridge abutments including the reduction of bridge abutment movement and lateral earth pressures on the bridge abutments. The parametric studies showed that lightweight backfill with a lower density and higher friction angle had lower lateral earth pressures behind the bridge abutment

and eliminated bump at end of the bridge. Lightweight backfill with a lower density has a lower self-weight and a higher strength and effectively reduces lateral pressures on bridge abutments and settlement of approach embankments, thus eliminating the bump at the end of bridges.

The research team will conduct another parametric study to investigate the effects of geosynthetic at different stiffness and its intersection with lightweight backfill on the performance of bridge abutments including the reduction of bridge abutment movement. Additionally, the research team will reduce the numerical data and perform analyses.

In a research project titled “Impact of Extreme Weather on Highway Infrastructure Condition and Safety”, Dr. Jenny Liu of MS&T and her research team worked on completing their literature review, which has identified several available climate databases. They are currently developing a one-dimensional pavement temperature prediction model using MATLAB programing language. The model will consider the nonlinear effects from the interaction between ambient temperatures and the pavement thermal properties.

The available weather databases include the Modern-Era Retrospective Analysis for Research and Applications Version 2 (MERRA-2) database and the National Oceanic and Atmospheric Administration (NOAA) Weather Service database. In the Midwest, Illinois, Iowa, Kansas, Missouri, and Nebraska have 62, 61, 39, 37, and 46 weather stations available for the NOAA database. The MERRA-2 database contains weather datasets from 1980 to the present.

A case study of a pavement temperature prediction model was implemented. By changing the albedo of the road surface while keeping other inputs, including weather data and other pavement material properties, constant, the study investigated the impact of albedo on pavement temperature. The results showed that the albedo of the road surface indeed affects the absorption of solar radiation energy, thereby influencing the pavement temperature. This also indicates that the established pavement temperature prediction model currently has the capability to predict pavement temperature under simple conditions.

In the coming months, the pavement temperature prediction procedure will be further refined, and more case studies will be conducted. If the results are reliable, a draft of a comprehensive case study article on the temperature prediction procedure will be produced.

At the University of Iowa, Dr. Al Ratner and his research team made significant progress on a research project titled “Use of Carbon Dots to Boose Energy Content of Biodiesel to Enable Next-Generation Hybrid Heavy Vehicles for Ground Transportation While Improving Safety.”

An experimental investigation has been completed to systematically characterize the droplet combustion characteristics of liquid fuels infused with Carbon Dots (CDs). Dodecane and Jet-A are utilized as representative single-component and multi-component fuels, respectively. The influences of surfactants on combustion characteristics are also explored.

- Preliminary findings were presented at the 2024 Spring Technical Meeting of the Central States Section of The Combustion Institute.
- A conference paper based on preliminary findings has been accepted for conference proceedings publication and will be presented at IMECE 2024.

- Comprehensive results are being formulated into a research article for journal publication and are currently under review.

An experimental investigation has been completed to establish baseline droplet combustion trends for thirteen different liquid fuels, representing both conventional and alternative fuels.

- The experiments have been conducted, and data analysis is finished.
- Comprehensive results are being formulated into a research article for journal publication and are currently undergoing the preparation of the final draft.

An experimental investigation has been carried out to systematically characterize the droplet combustion characteristics colloidal suspension of diesel fuels with Carbon Dots (CDs). Hexadecane and Iso-cetane are utilized as representative single-component fuels, while commercial diesel serves as the multicomponent fuel with higher volatility compared to Jet-A to illustrate the effect of the multicomponent nature on G-CDs based nanofuels.

- Experiments are completed.
- Data analysis is in progress.
- Comprehensive results will be formulated into a research article for journal publication.

An experimental investigation has been completed to systematically characterize the droplet combustion characteristics of suspension of liquid fuels (Dodecane and methyl decanoate) and nanocellulose as an additive.

- Experiments are in progress.
- Data analysis is in progress.
- A conference paper based on preliminary findings has been accepted for conference proceedings publication and will be presented at IMECE 2024.
- Comprehensive results will be formulated into a research article for journal publication.

The upgraded nanofuel stability analyzer is completed and currently in operation to analyze different nanofuels.

- A method paper has been accepted for conference proceedings publication and will be presented at IMECE 2024.

At the University of Missouri-St. Louis, Dr. Shakiba Enayati and her research team continue research on a project titled “Collaborative Last-Mile Delivery with Drones in Rural America.” During this reporting period, the primary activities focused on developing an optimization model and a comprehensive case study. The optimization model aims to improve the logistics and delivery operations of medical supplies, emphasizing the integration of drones and traditional vehicles. This model adeptly selects locations to serve as drone bases and recharging stations and devises efficient routes for drones and other ground vehicles, ensuring the seamless transfer of medical supplies. Operating on a hub-and-spoke network optimization structure, it integrates the vehicle routing problem with time windows into its formulation. Presently, the optimization model deliberately omits weather and other environmental considerations to concentrate on the accuracy of operational needs. This model considers several key attributes: decision variables, objective function, and constraints. The decision variables include vehicle routes for medical supply pickup and return to their base, the paths for order request pickups and deliveries, and the recharging or refueling requirements for vehicles along the way. The objective function is designed to minimize the total transportation costs by optimizing the paths taken by ground vehicles and drones. The model's constraints ensure the feasibility of vehicle operations, the flow of commodities, and

adherence to delivery time windows. These constraints account for factors such as vehicle capacities, recharging needs for drones, and the ability to meet the time-sensitive nature of medical deliveries. A PhD research assistant led the development of this optimization model under direct guidance and regular meetings with the PI as the faculty advisor.

Also, building upon the efforts to establish connections with external collaborators to access real-world data, from Shield Illinois testing centers (also referred to as SHIELD), the other major activity in this period was development of a case study using Shield data. SHIELD facilitated the rapid and widespread distribution of medical supplies, including test kits and samples, during the COVID-19 pandemic. Focusing on a rural region in southern Illinois neighboring St. Louis, the selected region under study includes over 60 test centers (K-12 schools and colleges) and a lab location in Springfield. It provides detailed data on the network configuration, including the location of nodes, arcs connecting each pair of locations by drone and car, travel times, and distances. The study also encompasses order requests, the weight of samples to be transported, and time windows for delivery (earliest pickup from test centers and latest delivery to the lab). This case study serves as a practical application to validate and refine the optimization model, demonstrating its potential impact on real-world logistics and healthcare delivery. In collaboration with UMSL, which led model development, external collaborators from DePaul University and Northern Illinois University spearheaded the case study development. The UMSL team provided a data template, aligned with the necessary input parameters for the model draft, which was shared with these external partners.

Furthermore, the initial implementation of the optimization model has been carried out to verify and validate the proposed model using the developed case study. Preliminary results have been obtained, and the model has been refined based on observations of the solutions provided. It is expected that the optimization model will be finalized soon.

Finally, collaborative efforts with a drone technology expert have commenced, offering valuable insights into the specifications and performance of drones across diverse weather conditions. Currently, the weather factors are narrowed down to wind conditions in the region. The drone expert collaborating on this project from Saint Louis University is leading the incorporation of wind factors—such as magnitude and direction—into a proper energy consumption model from the literature. This involves discretizing the region into grids of wind fields to capture hourly weather conditions. It is planned to incorporate this into the optimization model to optimize the routes and schedules of pickups and deliveries based on hourly weather conditions estimates.

Through the development of a cutting-edge optimization model, we've laid the groundwork for transforming the delivery of medical supplies, especially crucial during pandemic scenarios. We have verified that delivery drones have been successfully implemented in various healthcare settings, with their utilization steadily increasing across the USA. Our proposed optimization model will facilitate the integration of drone delivery systems into the existing transportation infrastructure, potentially revolutionizing healthcare quality and services in rural areas.

Dr. Mojdeh Pajouh of the University of Nebraska-Lincoln, and her research team continued progress on their research project titled “Advancement of Gender Equity in Transportation Safety, Design, Development, and Evaluation of Roadside Safety Hardware.” Their literature review is nearing completion and includes: (1) the current safety criteria and practices including both US and European safety standards that are followed in the evaluation of roadside safety hardware; (2) major difference in male and female body injuries in the real-world vehicle crashes; (3) major differences in male and

female driving behavior affecting their injuries; (4) male and female biomechanical properties; and (5) assessment of appropriate male and female crash test dummies and associated finite element models for use in further evaluation of male/female differences in identical crash test scenarios. This review helps with identifying the potential shortcomings in the current safety manuals regarding female drivers/passengers' safety and potential adjustment to address those shortcomings.

While the original scope of this project focused on differences in average size male and small female occupant safety risk, literature shows that risk might also differ for large males and children. Given funding restrictions and time constraints, literature will be collected on large male and children occupant risk for future studies.

The highlights of the literature review conducted include as below:

- Several studies suggested that female drivers are at the higher risk of abdomen, chest, and lower extremity injuries in angle crashes than male drivers. In rear end crash conditions, abdomen, chest, and lower extremity injuries were more likely to be experienced by female drivers, while male drivers were more likely to experience back injuries or no injury.
- In an investigation of female drivers' vulnerability, it was found that the odds for a belt-restrained female driver to sustain severe injuries were 47% higher than those for a belt-restrained male driver involved in a comparable crash.
- Research shows that females are at greater risk of Abbreviated Injury Scale (AIS) 2+ and AIS 3+ injury. Also, Females exhibited a greater risk of lower extremity injury, even after adjusting for age, height, BMI, and delta-V compared to males.
- While women are more vulnerable in lower extremity, the remaining disparity in sex-based injury risk could be attributed to variations in vehicles and crashes rather than physiological differences, suggesting the need for alternative countermeasures to address these factors.
- The difference in the risk of fatality between males and females in identical physical impacts diminishes in newer model year vehicles, particularly those equipped with advanced occupant protection systems.
- Several studies showed that female drivers sit close to the steering wheels compared to male drivers. The height of the driver was found to be an effective substitute for assessing the distance from the steering wheel. Another study showed that individuals below the average height of 5 ft – 7 in. experienced a 64% higher likelihood of lower-extremity fractures. Consequently, the occurrence of such injuries seems to correlate with driver height, showing an elevation among shorter drivers, predominantly females.
- Numerous available dummy models were located, such as Hybrid III, SID-II, USSID.

The key outcome for this reporting period was to gather and analyze the literature relevant to female and male differences in terms of injury risk and vulnerability in vehicle crashes, as well as how current safety criteria address or overlook these differences when evaluating roadside safety hardware. The review of real-world crash data highlighted that women are more vulnerable in crashes particularly in the lower extremities. This finding was linked to driver height as drivers with shorter height would experience higher likelihood of injuries in crashes, which are more predominately, but not exclusively, female drivers. Additionally, the review revealed that women tend to sit closer to the steering wheel, which can impact the severity of their injuries. Given these findings and the reliance of current safety criteria on male-based crash test dummies, next step is to assess the suitability of current safety for female drivers.

Education and Outreach Activities

In 2016, MATC implemented several educational outreach programs in support of USDOT's Strategic Plan and the center's mission to increase the number of students in STEM education and transportation-related careers. Descriptions of each educational program that is being continued with the MATC-TSE UTC funding are detailed below.

MATC-TSE After-School Program - Road, Rails, and Race Cars (RRRC)

MATC's after-school program combines the talents of local middle school teachers, UNL undergraduate student mentors, and the MATC Education and Outreach Program Manager to educate the diverse leaders about STEM principles. This program is for middle school students in grades 6, 7, and 8. Each participating school offers a club for an hour every week. Teachers and mentors present on an engineering or transportation-related topic and lead students in an interactive activity encompassing the lesson's concepts. Examples of activities include:

- constructing bridges and conducting strength tests
- creating towers that can withstand simulated earthquakes
- building a variety of car types powered by potential energy
- building levees to protect cities
- time, speed, velocity, and acceleration

MATC-TSE Sovereign Native Youth Leadership Academy (SNYLA)

The MATC Sovereign Native Youth STEM Leadership Academy is a multi-day summer program held on the University of Nebraska-Lincoln campus. The mission is two-fold: 1) to provide an extended learning opportunity in science, technology, engineering, and math (STEM) subjects, and 2) explore a wide-range of postsecondary education and career options after high school.

The 2025 Sovereign Native Youth STEM Leadership Academy is expected to occur at the University of Nebraska–Lincoln campus from Sunday, June 8, 2025 – Thursday, June 12, 2025. The program requirements, policies, and procedures can be found at https://matc.unl.edu/about-sovereign-native-youth-stem-leadership-academy.

We are planning to receive applications from Region VII high school students. We plan to admit 30 – 35 students to this year's academy. To increase diversity and inclusion, we are reaching out to many schools in our districts and reservation areas to have more students apply.

Possible activities for the 2025 program include Chemistry lab tours and activities, a field trip to Strategic Air Command and Aerospace Museum, a field trip and activities at Mahoney State Park, and a field trip and activities at Spring Creek Prairie Audubon Center. These activities aim to build students' interest and awareness of the engineering and transportation fields. The students will also attend activities at Nebraska Innovation Campus to learn about and use various high technology and hands-on maker space equipment. Further, students will participate in a public speaking and communication presentation, and a leadership activity game called BAFA BAFA that allows participants to learn the effects that culture plays in every person's life by experiencing it themselves. The goal is to further strengthen their leadership, communication, and public speaking confidence skills.

During the program, each student will be asked to participate in a pre-survey and a post-survey to provide their input on the program and how we can always make it better going forward.

MATC-TSE Intern Program

MATC-TSE will expand its undergraduate Summer Intern Program, which provides critical exposure to the transportation profession and graduate academic programs, by twenty percent. To date, 134 undergraduates have been involved in the program across all four states of Region 7. Over 20 percent of participants are from underrepresented groups. In addition, over 13 private sector sponsors and 11 public sector sponsors have hosted student interns. MATC-TSE will continue to recruit students from NICC and other MSIs across the US.

We intend to begin advertising soon for summer 2025 internship opportunities.

MATC-TSE Research Experience for Undergraduates (REU)

MATC-TSE will continue to support academic year undergraduate research assistantships and summer research opportunities. At the graduate level, this will occur through participation in MATC-TSE graduate research projects, all of which include at least one graduate research assistant (section A.1). At the undergraduate level, this will occur through its Research Experiences for Undergraduates (REU) program that provides opportunities for students from across the US to participate in a research-intensive summer program at a MATC-TSE consortium university.

MATC-TSE was not able to support any REU students during this reporting period. We are reviewing undergraduate options and hope to support two (2) MATC REU students for Summer 2025.

How have the results been disseminated?

The MATC Program Coordinator continues to maintain individual project records on the Transportation Research Board's Research in Progress (RiP) and Transportation Research Information Database (TRID), as well as on MATC's online database at https://matc-data.unl.edu/research-database.

MATC projects are committed to having a sustained impact on the transportation system through technology transfer and workforce development efforts. For example, proposals for this research included technology transfer plans. As these are new projects where major results are yet to be produced, there has been limited dissemination.

At the Missouri University of Science & Technology, Dr. Grace Yan and her research team are developing a Driving through Extreme Weather Mobile App for Improving Risk Communication from National Weather Service to Vehicle Drivers. While the app is still under development, preliminary results and the conceptual framework have been shared through:

- Internal Presentations: Regular presentations within our development team and to departmental boards to refine concepts and gather feedback.

- Stakeholder Engagements: Discussions with potential stakeholders on the integration and operational deployment of the app once it is launched.

At the University of Missouri – St. Louis, finding from Dr. Shakiba Enayati's research have not been shared publicly as of yet however, she plans to present the problem and the progress on the methodologies and findings, at the INFORMS Annual Meeting in October, as part of an invited session celebrating the Journal of the Operational Research Society's 75th anniversary. This presentation will provide an opportunity to receive valuable feedback as the first year of the project wraps up.

Additionally, a manuscript detailing the research is currently being prepared for submission to a peer-reviewed journal, further disseminating the findings to the broader academic community.

At the University of Nebraska-Lincoln, Dr. Abigail Cochran reported that for her research project titled "Transportation Barriers to Vision Care for the Visually Impaired", an academic abstract was accepted for presentation at the 2024 ACSP annual conference. Graduate Research Assistant, Aysan Esmaely and Dr. Cochran will present the work in Seattle, WA, in November 2024. A draft manuscript was completed (authors: Aysan Esmaely, Ciara Nelson-Forcade, John D. Shepherd, and Abigail L. Cochran), which was submitted and, ultimately, rejected for presentation at the 2025 TRB annual meeting and, once revised, will be submitted for publication in a peer-reviewed transportation journal. A poster was prepared by the research team to disseminate key findings for this project during the UNL/US DOT-MATC showcase on September 26, 2024. The research team is also preparing to present key findings from this work during a presentation to the Transportation Graduate Seminar on Friday, October 25, 2025. Students and PI Cochran further plan to develop draft academic abstract(s) and manuscript(s) for publication from the study related to RQ 2 (progress on initiating the next phase of qualitative, interview-based study examining clinician perspectives on transportation barriers to low vision care) and RQ 3 (continued progress on evaluating and mapping medical purpose trip (or, NEMT) demand across Nebraska).

MATC Research Webinars

No USDOT funded research webinars were hosted by MATC during this reporting period. Previously hosted webinars are uploaded to the MATC YouTube channel (https://www.youtube.com/user/MidAmericaTrans/videos) with full research briefs and presenter bios available on the MATC website (http://matc.unl.edu/webinarseries.php).

2. PARTICIPANTS & COLLABORATING ORGANIZATIONS

What organizations have been involved as partners?

During the reporting period, MATC worked with twenty-nine (29) organizations to develop and implement research, education, and technology transfer activities. Each organization and its location are listed in Table 2 along with information describing the specific area or capacity in which the respective organization is committed to supporting the center.

Table 2: MATC Partners and Type of Collaboration

MATC Program Affiliation	Organization Name	City	State	Financial	In-Kind Support	Contribution Facilities	Collaborative Research	Personnel Exchanges
All Programs	University of Nebraska-Lincoln	Lincoln	NE	X	X	X	X	X
Research	University of Nebraska Medical Center	Omaha	NE				X	
Research	University of Missouri	Columbia	MO				X	
Research	The St. Louis Regional Freightway	St. Louis	MO				X	
Research	University of Wisconsin – Eau Claire	Eau Claire	WI				X	

Research	Quallent Pharmaceuticals Health LLC	George Town	Cayman Islands				X	
Research	University of Southern California	Los Angeles	CA				X	
Research	DePaul University	Chicago	IL		X		X	
Research	Northern Illinois University	DeKalb	IL		X		X	
Research	St. Louis University	St. Louis	MO		X		X	
Research	North Carolina State University	Raleigh	NC				X	
Research	George Washington University	Washington	DC				X	
Research	Cass Information Systems	St. Louis	MO		X			
Research	South China Agricultural University	CHINA					X	
Research	Tianjin University of Commerce	CHINA					X	
Research	Bilkent University	TURKEY					X	
Research	UI Hydroinformatics Lab	Ames	IA				X	
Research	CEMATRIX Inc.	CANADA			X		X	
Research	Tensar International Corp.	Alpharetta	GA		X		X	
Research	Advanced Manufacturing Innovation Center	St. Louis	MO	X			X	
Research	UMSL Bridge Program	St. Louis	MO		X			
Research	University of Missouri Extension	St. Louis	MO				X	
Research	Center for Rural Health Innovation at BioSTL	St. Louis	MO				X	

3. OUTPUTS

Publications, conference papers, and presentations

Journal Publications

1. Parveg, A. S., Zhou, Y., Leblanc, R. M., & Ratner, A. (Under review). Effects of Gel-like Carbon Dots (G-CDs) and Surfactant (Span80) on the Droplet Combustion Dynamics of Liquid Fuels.

2. Enayati, S. and Özaltın, O.Y.; Supplier selection under disruption risk with hybrid procurement; Computers & Operations Research; 2024; p.106593.
3. Sivakumaar, V., Enayati, S. and Shittu, E.; Uncovering heterogeneous inequities induced by COVID-19 interventions: Evidence from three states in the US; Socio-Economic Planning Sciences; 2024; 92, p.101820.
4. Hupman AC, Li H, Zhuang J, Subramaniam J. "Predicting Pharmaceutical Supply Chain Disruptions Before and During the COVID-19 Pandemic." Risk Analysis; Accepted.
5. Parveg, A. S., & Ratner, A. (2025). A comprehensive review of liquid fuel droplet evaporation and combustion behavior with carbon-based nanoparticles. Progress in Energy and Combustion Science, 106, 101198.
6. Parveg, A. S., Zhou, Y., Leblanc, R.M., & Ratner, A. (2025). Effects of gel-like carbon dots (G-CDs) and surfactant (Span80) on the droplet combustion dynamics of liquid fuels. Fuel, 381, 133385.
7. Li, H., W. Tang, and L. Mai, (2024), A Game-Decision-Theoretic Approach to Optimize the Dynamic Credit Terms. Annals of Operations Research. Accepted.
8. Anani, A., I. O. Fores, H. Li and Afrooz Jalilzadeh (2024), Heuristic and Exact Approaches to Optimize the Production Scheduling of Mines Transitioning from Open Pit to Block Caving. Mining, Metallurgy & Exploration. Accepted.

Conference Papers

1. Parveg, A. S., & Ratner, A. (2024, November). Droplet Combustion Behaviors of Liquid Fuel Doped with Carbon Dots. In ASME International Mechanical Engineering Congress and Exposition. Portland, OR. (Accepted).
2. Mollick, R., & Ratner, A. (2024, November). Investigating the Potential of Nanocellulose as an Additive in Liquid Fuels to Enhance Combustion Behavior. In ASME International Mechanical Engineering Congress and Exposition. Portland, OR. (Accepted)
3. Nagarkar, N., Steiner, W., Mollick, R., & Ratner, A. (2024, November). Design, Calibration, and Validation of a Robust and Reliable Nanofuel Stability Analyzing Device. In ASME International Mechanical Engineering Congress and Exposition. Portland, OR. (Accepted)

Presentations

1. Innovations: Advancing Geotechnical Practice and Improving Infrastructure Performance and Sustainability, Keynote Lecture, International Geotechnical Innovation Conference, Jeddah, Saudi Arabia, May 7, 2024
2. Ground Improvement: Overview, Recent Developments, and Design, Invited Course Lecture, International Geotechnical Innovation Conference, Jeddah, Saudi Arabia, May 5, 2024
3. Geosynthetic-Stabilized Roads and Reinforced Slopes and Walls: Basics, Applications, and Design, Invited Course Lecture, Terrafix Seminar Series 2024, Toronto, Canada, April 19, 2024
4. Evaluation of Lightweight Cellular Concrete (LCC) Properties and Performance for Geotechnical Engineering Applications, Invited Lecture, the Aerix Industries Series Lecture, virtual, April 3, 2024.
5. Parveg, A. S., & Ratner, A. (2024, May). Droplet Combustion Dynamics of Liquid Fuels Enhanced with Carbon Dots. 2024 Spring Technical Meeting of the Central States Section of The Combustion Institute. May 12 - 14, 2024. Case Western Reserve University in Cleveland, OH.
6. Mollick, R., & Ratner, A. (2024, May). Exploring the Potential of Nanocellulose as an Additive in Liquid Fuels to Improve Combustion Performance. 2024 Spring Technical Meeting of the Central States Section of The Combustion Institute. May 12 - 14, 2024. Case Western Reserve University in Cleveland, OH.
7. Steiner, W., Nagarkar, N., Mollick, R., & Ratner, A. (2024, May). Design, calibration and validation of

a robust and reliable nanofuel stability analyzing device. 2024 Spring Technical Meeting of the Central States Section of The Combustion Institute. May 12 - 14, 2024. Case Western Reserve University in Cleveland, OH.

8. Hupman A. "Risk Prediction & Mitigation in a Dynamic Environment," 2024 Supply Chain & Analytics Annual Applied Research Symposium. Saint Louis, MO, April 18, 2024.
9. Hupman A. "Constructing Ensemble Estimates for the Risk Averse Decision Maker," 2024 Advances in Decision Analysis Conference, Helsinki, Finland, July 10-12, 2024. Accepted.
10. Enayati, S., Campbell, J.F., Peker M. (2024, August). Optimizing Vaccination Outreach with Drones in Remote Areas, Bellingham Symposium on Modeling and Data Analytics (BSOMADA), University of Missouri- Saint Louis, Bellingham, WA.
11. Enayati, S., Ansari, S., Wang, Z., & Gururajan, S. (2024, October). Efficient Drone Integration for Last-Mile Rural Healthcare Delivery. Journal of the Operational Research Society 75th Anniversary Session, INFORMS Annual Meeting, Seattle, WA.
12. "Integrating Simulation, Optimization and Reinforcement Learning for Data-Driven Optimization in Supply Chains", Featured Talk, The 4th Bellingham Symposium on Modeling and Data Analytics (BSOMADA), Bellingham, Washington, Aug 2024.
13. Poster Presentation: "Advancement of Gender Equity in Evaluation of Roadside Safety Hardware" presented at the 2024 US DOT Future of Transportation Summit.
14. Poster Presentation: "Advancement of Gender Equity in Transportation Safety, Design, Development, and Evaluation of Roadside Safety Hardware" presented at the 7th International Conference on Women and Gender in Transportation.

Patent Applications

1. A S M Parveg and Albert Ratner, inventors; Nanofuels LLC, applicant. Improved Liquid Fuels Containing Carbon Dots. US provisional patent application 63/694,792. Filed September 13, 2024.

Website(s) or other Internet site(s):

MATC-TSE intends to continue maintenance of five online sites that distribute information utilizing the internet. Links to each site can be found below. We will begin collecting metrics from these sites starting October 1, 2024 so as not to double report from our 2016 MATC final Semi-Annual Progress report for the same reporting period.

MATC Website

By clicking the following link, http://matc.unl.edu, you will be directed to MATC's website.

SlideShare

https://www.slideshare.net/matcRegion7UTC/presentations/.

Facebook

https://www.facebook.com/pages/Mid-America-Transportation-Center-MATC/141238439284182.

Twitter

MATC's Twitter handle is @MATCNews. The page can be viewed by clicking the following link: https://twitter.com/MATCNews.

YouTube

MATC's YouTube feed can be viewed by clicking the following link: http://www.youtube.com/user/midamericatrans?feature=results_main.

4. OUTCOMES

At the University of Missouri – St. Louis, several key outcomes have emerged from the ongoing research conducted by Dr. James Cambell and his research team, contributing to both the academic community and practical applications in healthcare and transportation logistics. In his project titled "Rural Transportation System Design for Omnichannel Healthcare", the following outcomes were indicated during this reporting period:

1. Increased Understanding and Awareness of Healthcare Access in Rural Areas: The research has contributed to a deeper understanding of the challenges related to healthcare access in rural communities, particularly through the development and implementation of Telehealth Kiosks/Booths (TKBs). The discrete choice experiment and continuous approximation models have provided valuable insights into patient preferences for telehealth services, particularly the sensitivity of rural populations to travel time, which directly informs strategies for improving access to healthcare.
2. Increases in the Body of Knowledge: The project has made significant contributions to the body of knowledge in healthcare logistics and telehealth by advancing modeling techniques, such as continuous approximation and discrete optimization, for the strategic placement of TKBs. These methods have added to the existing literature on healthcare access and equity, particularly in underserved rural areas.
3. Improved Processes and Techniques: The research has improved processes for evaluating healthcare accessibility through the application of advanced mathematical models. By refining models that account for travel time decay and population coverage, the project is helping to optimize the deployment of TKBs, which has the potential to influence healthcare planning and transportation logistics for medical services in rural areas.
4. Adoption of New Techniques: The modeling approaches developed through this project can be considered for broader application in telehealth infrastructure planning. By exploring different travel time decay scenarios and optimizing the placement of TKBs, these techniques offer new ways to address transportation and healthcare access challenges, particularly in rural areas where such innovations can have a profound impact.

Through a project titled "Decision Support for Dynamic Risks to Improve Supply Chain Resilience", Dr. Andrea Hupman's research has helped to train a graduate research assistant in research methods relevant to transportation, increasing the pool of trained transportation professional. The research is also contributing to the development of decision support tools that will both increase the body of knowledge and may lead to patentable risk mitigation technology. As part of this research, teaching materials have been developed for graduate-level students to better understand how to analyze and model decision making.

5. IMPACTS

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

Dr. Will Collins of the University of Kansas anticipates that his project titled "Development of In-situ Fracture Toughness Evaluation for Bridge Safety" will greatly increase the safety of aging infrastructure, as it will potentially allow for the rapid evaluation of metallic structures as related to the fracture limit state. Prior to 1978, no fracture toughness requirements existed for steel bridges. Therefore, there is no historical record of material properties for many in-service bridges around the country. When evaluation of these structures is needed, often with time as a major constraint due to damage caused to the structure by various emergencies, material properties are needed. A non-destructive or minimally

invasive method of estimating fracture toughness would be truly transformative, rapidly providing engineers information they currently do not possess.

In a project titled “Intelligent Transportation Network Decision Support with Real-time Routing and Data Analytics” believes that the decision support system that his research team proposed will support detecting, analyzing, and resolving the unpredicted disturbances in the transportation network due to disasters and emergencies. The web-friendly framework will allow decision makers and field agents to access it from any device on the go. The framework supports analysis based on real-time disaster conditions and simulates ‘what-if’ flood scenarios to identify vulnerable areas and populations to aid in decisions for mitigation, planning, response, and recovery activities.

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?

Dr. Islam El-Adaway of Missouri University of Science and Technology believes that his project titled “Enhancing Safety and Well Being of Aging Workforce within the Transportation Sector” shall equip the transportation sector with proactive prevention and safety management solutions and policies that are broadly applied to all transportation associated workforce in a way that promotes diversity, equity, and inclusion for all stakeholders. This shall in turn bolster the USDOT’s strategic goals of having safe workers and eventually maintaining the jobs that it aims to provide. In fact, the economic stability of a society would then rely on such a firm industry that is not only growing in demand but will never be depleted. Therefore, marketing a safe and proliferate working environment for a workforce would ensure the success of a project, in turn the USDOT and eventually the national economic interests.

In the project titled “A New Optimization Approach to Distributed Manufacturing System Design” led by Dr. Haitao Li of the University of Missouri – St. Louis, the game-decision-theoretic models and algorithms developed in this research can be embedded into decision-support tool hosted on a server with database connection, graphical user interface (GUI), and user access control, which has the potential to be patentable. This technology is attractive to a manufacturer who is interested in advanced manufacturing technologies for mass customization. The PI plans to file an invention disclosure in the next reporting period.

What is the impact on the body of scientific knowledge?

MATC’s current and ongoing transportation research will have a variety of safety-related impacts on the current body of scientific knowledge.

In a project at the University of Kansas titled “Investigation of Key Safety Measures for Pre- and Post-Deployment of Connected and Automated Vehicles,” Dr. Alexandra Kondyli and her research team hope to develop new surrogate safety measures and their threshold values for automated vehicles that can more accurately illustrate the safety benefits of automation.
Dr. Genda Chen of Missouri University of Science and Technology expects his project titled “Seamless Vehicle and Bridge Monitoring for Transportation and Infrastructure Safety” to contribute innovative data processing techniques on existing bridge weigh in motion methods in the assessment of influence lines, girder distribution factor and dynamic amplification factor during bridge assessment withing the civil engineering discipline.

Dr. Trilce Encarnacion at the University of Missouri – St. Louis believes that her project titled “Optimal Design of Inland Waterway System to Enhance Intermodal Transportation” will enhanced understanding

of challenges and opportunities for inland waterway freight transport will provide insight to ground future research into theories and models in transportation logistics to the realities of the industry. This research will also inform public policy and strategic planning by providing evidence-based recommendations for transportation policies, investment decisions, and regulatory frameworks.

What is the impact on transportation workforce development?
MATC's research and outreach activities play a vital role in inspiring and preparing students to become future professionals of the transportation workforce. The MATC Scholars Program, STEM Academy, Intern Program, and After-School Program are designed to increase access and retain students from underrepresented groups in STEM and transportation-related degree granting programs and careers. MATC research projects provide graduate students with the opportunity to gain hands-on research experience in the field of transportation. The interdisciplinary projects completed during program activities bolstered students' conceptual and practical skills in STEM subjects. Students were encouraged to reconfigure their expectations of STEM subjects and perceived barriers and extend their interest beyond classroom experiences.

Dr. Daniel Tran at the University of Kansas expects that his project titled "Strategies to Improve Safe Behaviors of Highway Construction Workers" will impact the development of the transportation workforce, particularly in terms of safety management. By establishing clearer pathways for safety compliance and management, the research can aid in career development for aspiring safety managers and construction workers focused on safety roles. The additional impact may include enhanced construction safety education by developing more effective safety training programs based on the findings of the research.

University of Iowa PI, Dr. Charles Stanier, was one of the founding creators of the first certificate at the University of Iowa with climate in the certificate name: ACSET, Applied Climate Science and Energy Technologies. This became available to students in June 2024. Dr. Stanier believes that through his project titled "Protecting People in Midwest Road and Transport Systems During Periods of Extreme Heat", University of Iowa graduate and undergraduate students will receive important training on climate impacts research as applied to climate systems, and incorporation of findings into relevant engineering courses.

6. CHANGES/PROBLEMS
Due to the lateness of the award, recruitment of graduate research assistants for Year 2 was delayed until January 2025.

7. SPECIAL REPORTING REQUIREMENTS
Nothing to report.