Semi-Annual Progress Report for University Transportation Centers

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- **Program Director (PD) Name, Title, and Contact Information**
  Dr. Aemal Khattak, Director, Mid-America Transportation Center (MATC)
  Professor, Civil and Environmental Engineering
  khattak@unl.edu – 402-472-8126

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  The Board of Regents, University of Nebraska for the University of Nebraska-Lincoln
  2200 Vine Street
  151 Prem S. Paul Research Center at Whittier School
  Lincoln, NE 68583-0861
  Telephone: 402-472-1825

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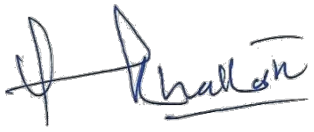

Aemal Khattak, MATC Director

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	Complete	100%
Collect DMPs from PIs for Individual Research Projects	In Process	60%
Collect ORCIDs from all MATC Researchers	In Process	100%
Submit Project Descriptions to TRB's RiP Database	Complete	100%
Education and Workforce Development Activities		
Graduate MATC Course Development & Implementation	In Process	0%
MATC Graduate Seminar Series	In Process	0%
MATC Undergraduate Summer Internship Program	In Process	0%
MATC Scholars Program	In Process	0%
MATC/UTC Outstanding Student of the Year	Complete	100%
MATC Roads, Rails, and Race Cars After-School Program	In Process	20%
MATC STEM Leadership Academy	In Process	20%
Technology Transfer Activities		
Technology Transfer Tech Briefs, Webinars & Presentations	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 (MATC) for USDOT Region 7 focuses on the statutory research priority area of *Promoting Safety* and supports the USDOT Strategic Plan goals of safety (primary goal), economic strength and global competitiveness, and transformation. The strong MATC 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 considers the transportation system a complex "system-of-systems" through which humans, technologies, and infrastructure interact. The USDOT Research, Development, and Technology Strategic Plan (2022-2026) governs MATC research philosophy. Using the USDOT Innovation Principles as benchmark, MATC addresses the grand challenges of Vision Zero, Resilient Supply Chains, Net Zero Emissions, and the Transportation System-of-Systems of the Future. Guidance for MATC comes from the USDOT Strategic Plan (2022-2026).

As of this reporting period, UNL has seven (7) ongoing USDOT-funded projects, supported by sixteen (16) PI's and Co-PI's. The University of Iowa (UI) 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) has nine (9) ongoing USDOT-funded projects, supported by five (5) PI's and Co-PI's. The University of Missouri-St. Louis (UMSL) has ten (10) ongoing USDOT-funded projects, supported by eleven (11) 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 *Transportation Safety, Design, Development, and Evaluation of Roadside Safety Hardware* at the University of Nebraska-Lincoln, Dr. Mojdeh Pajouh and her research team conducted several activities to support the objectives of this Phase II project.

Expanded Literature Review: Building on the foundation from Phase I, the team conducted an in-depth review of additional sources focused on biomechanical differences amongst drivers, limitations in current safety criteria (ORA, OIV), and comparisons among anthropomorphic test devices. These efforts were aimed at informing simulation planning and model validation.

Simulation Planning and Setup: The research team began preparing for finite element (FE) simulations using LS-DYNA, identifying relevant dummy models and initiating validation steps based on established

frontal crash scenarios. Publicly available models were acquired and preprocessing steps (e.g., mesh checking, boundary condition setup) were completed.

Occupant Position Identification: Using findings from Year 1, the research team defined a range of seated occupant configurations to be modeled in simulations. These include varied postures, belt positions, and driver anthropometry that are representative of road users.

Graduate Student Involvement: Graduate research assistants were actively engaged in literature synthesis, data organization, and simulation model setup. Planning has begun for high-performance computing (HPC) time and LS-DYNA license usage to support upcoming simulation tasks.

During this reporting period, the research team uncovered critical evidence showing that many of the criteria used in roadside hardware evaluations were originally developed using male-only data and do not reflect the full range of real-world injury risks.

Their expanded literature review has laid the groundwork for the next phase of simulations, which will evaluate how well current crash test criteria protect occupants of different sizes, ages, and sexes. This work is setting the stage for more inclusive safety standards that can better serve all road users. Additional achievements include:

- Identification of diverse seated occupant positions for simulation based on real-world data.
- Setup of FE dummy models for crash simulation.
- Graduate student training in advanced simulation tools and injury biomechanics research.

In a research project titled *Development of a Real-Time Flood Forecasting System for Railroad Crossings in the Midwest*, Dr. Witold Krajewski and his team at University of Iowa set up the HLM model for the Smoky Hill watershed and tested it using MRMS rainfall and USGS observations. The main goal in this reporting period was to validate the HLM for the Smoky Hill watershed using the soil and land use parameters and the USGS observations. The results from their approach will allow them to formulate a general model that can represent the Mid-West region's heterogeneities by using the available information. They found that the description of the soil parameters given by POLARIS is relevant. Using POLARIS, they estimated the organic soil percentage, the hydraulic conductivity, and the topsoil storage. These parameters are of high relevance for HLM. Their results indicate that an accurate estimation of these is essential for formulating an accurate flood forecasting system. However, they also found uncertainties in the parameter estimation that hinder the model performance.

During this period, the research team focused on processing and organizing all the information to apply the flood model in an initial zone in a watershed in Kansas. This report contains the information process for this zone, in particular, the initial evaluation of the variables and states applied to the model, and the distribution of this parameter in this state.

The detailed stream network of one of the zones of interest was made. This helps us identify streams that the national model may not consider in their flood model that can affect railroads. As shown below in the example of one of Kansas watersheds, the more detailed network considers additional streams in zones that can present possible flooding. Figure 1 shows the location and detailed streams made for the model.

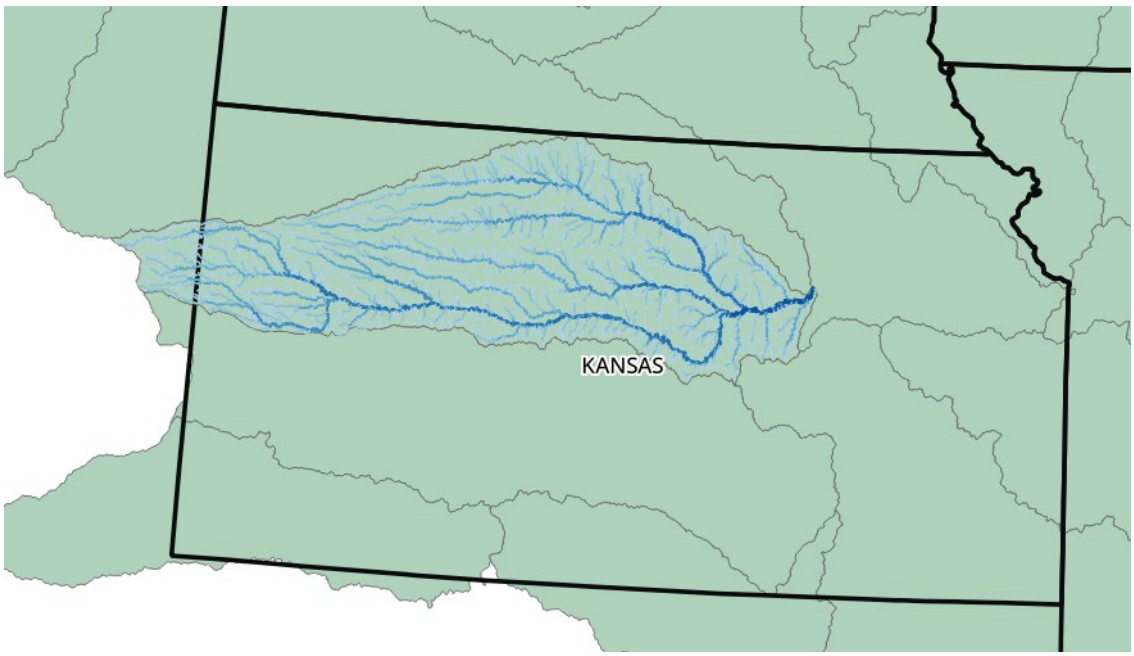

Figure 1: Detailed streams network for the initial zone of interest

To run and organize all the information for the flow prediction model, the researchers analyzed the hydraulic conductivity of the zone of interest, saturated storage, residual storage, the organic matter, and the soil uses.

Dr. Jian Li from the University of Kansas reported major activities in his project titled *Enhancing Structural Safety in Infrastructure Maintenance through Human Centered Bridge Inspection Empowered by Artificial Intelligence and Augmented Reality*. According to Dr. Li, development has begun on a new HoloLens 2 app for infrastructure inspection using the latest version of Microsoft's Mixed Reality Tool Kit (MRTK) and Unity version 6. The application front end has been developed, and underlying systems are being created and tested. The use of Unity Sentis has been employed for machine learning (ML) inferencing to be done locally on the HoloLens without the need for a secondary device on a local network to make inferences and allowing inspections to be more efficient and require less user setup. Graduate students have collaborated to work out issues with the inference process producing incorrect outputs that do not resemble their input images. Functionality has been developed to utilize the HoloLens camera to take images for ML inferencing, and work has begun on anchoring inferences to their real life positions through the use of unity's projector components, which allow a 2D image (which is in this case the ML inference) to be projected on a 3D mesh, such as the spatial mesh generated by the HoloLens in real time based off of its surroundings. The software package will require holograms to maintain spatial persistence across sessions so that data gathered inspecting infrastructure can be reused when it is next inspected. Microsoft World Locking Tools have been identified as a promising solution to this problem and implementation of these tools has begun.

The user interface for their AR platform on HoloLens has been developed. Figure 2 shows the application user interface. This interface will allow inspectors to interact seamlessly with the inspection tool through the headset. The featured buttons will allow the user to capture images for ML processing and storing, view the spatial mesh generated by the HoloLens, customize the view of the processed images as well as exit the program. Figure 3 features the debugging tool developed to allow for more efficient development, allowing error codes to be viewed from within the HoloLens as features are added.

Figure 2. HoloLens user interface.

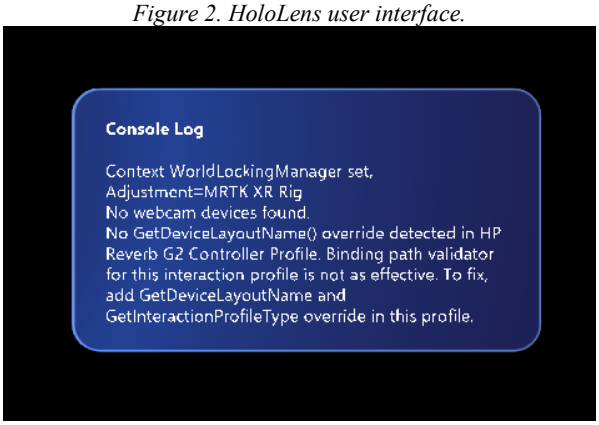

Figure 3. HoloLens development debug tool.

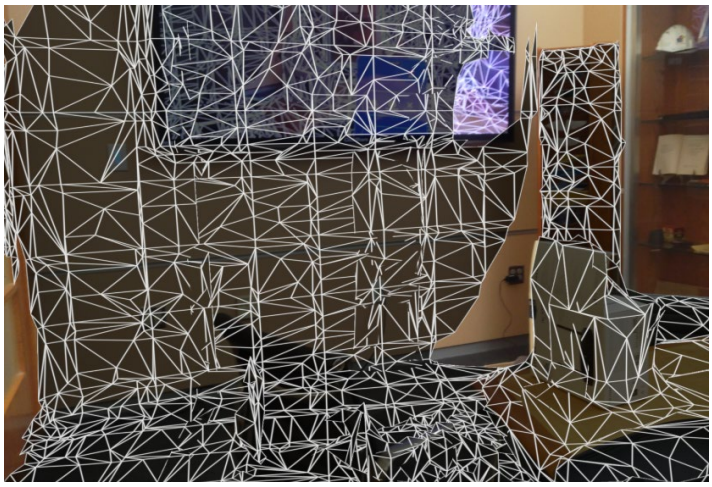

Figure 4. HoloLens generated spatial mesh.

The HoloLens offers the feature of spatial mesh generation for apps in which it is necessary for virtual components of the app to interact with boundaries and objects present and around the

user. This tool has been enabled as part of the software package and will be used in the process of anchoring processed images to their respective physical positions. Figure 4 shows the real-time spatial mesh generation enabled in our HoloLens application.

Issues were encountered with respect to moving the ML inference to run natively on the HoloLens. The deep learning models were trained using Ultralitics YOLO, however these models are not natively compatible with Unity and as such would not run natively on the HoloLens. To solve this issue, the YOLO models were exported as ONNX models. Originally, the researchers planned to process the inferences using Unity's Barracuda package, built for processing ML inferences and tensors, however this package was outdated and could not properly process the models. The research team discovered that Unity has a more up-to-date package for these tasks, named Sentis, which was able to properly import the model and make an inference. The model outputs can be seen in figure 5. and figure 6. However, they are incorrect and did not match their input images, so the team is now moving towards using YoloSharp, a third-party package for processing YOLO models in C Sharp, to process the ML inferencing.

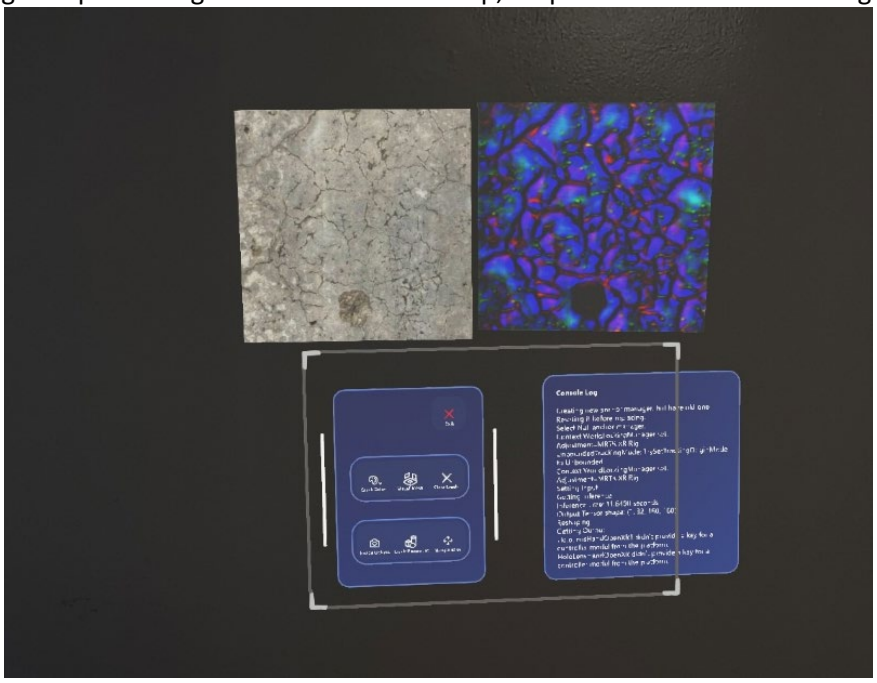

Figure 5. Deep Learning inference on a concrete crack, processed natively on the HoloLens.

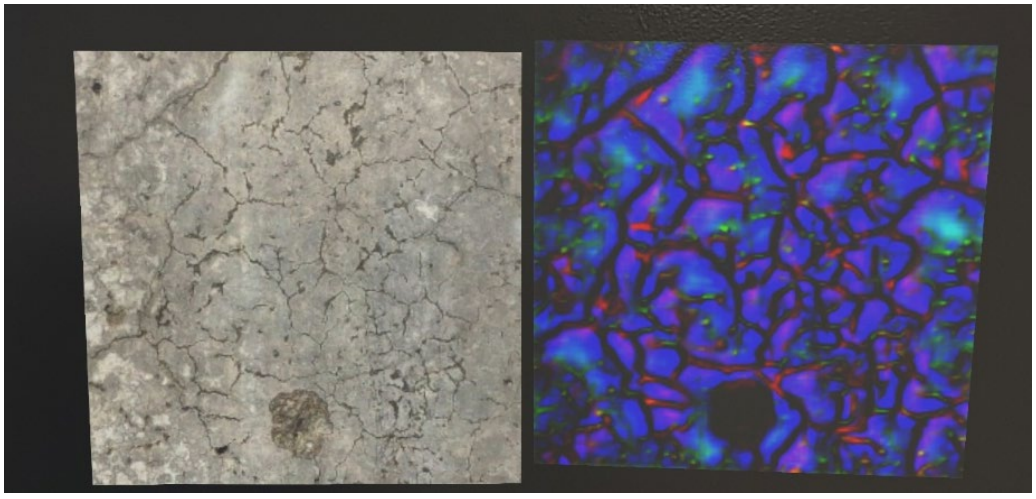

Figure 6. Image of crack before (left) and after (right) Deep Learning processing.

Anchoring ML inferences of concrete damage to their real-life counterparts has been a major question of the AR software package all through development, and the team believes that Unity's projector components will provide a viable solution. Unity's projector components are used to project a 2D image onto a 3D surface in the same way that a real projector would, wrapping around corners and edges of objects. The research team plans to use this feature to project the inference results onto the surfaces they are taken from as seen in figure 7.

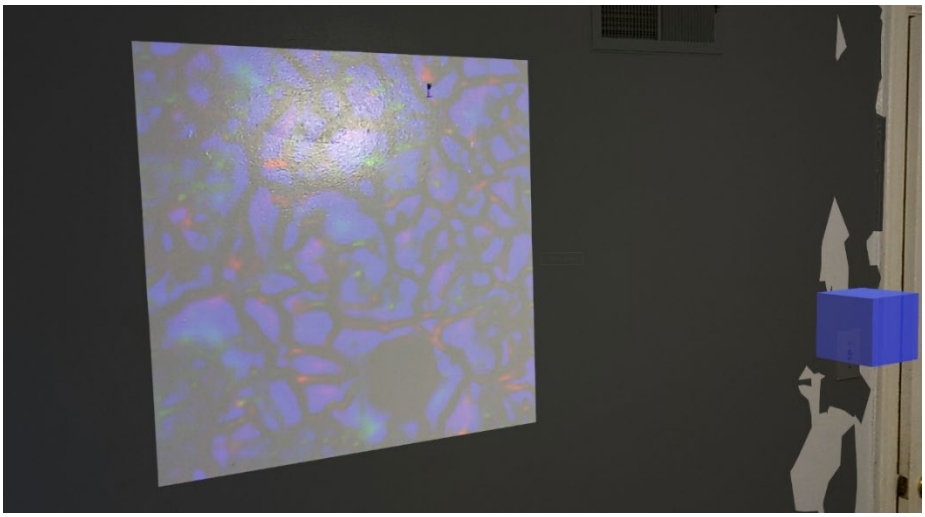

Figure 7. Deep Learning output anchored to a wall via projection from the blue cube.

Maintaining the position of holograms after inspection for future inspections is known as spatial persistence and is a big part of the AR software's requirements. To solve this, Microsoft's "World Locking Tools" have been identified as the most likely solution to maintain spatial persistence. The team has chosen this software package as the best possible option for spatial persistence as it is designed with the team's specific requirements in mind and would allow for spatial anchors to be saved and loaded across sessions. Installation and implementation of this software package is ongoing.

At the Missouri University of Science and Technology, Dr. Grace Yan and her research team focused on laying the foundation for retrieving and visualizing tornado-specific alerts from the National Weather Service (NWS) API and preparing for integration with Google Maps API in a research project titled *Driving through Extreme Weather (DEW) Mobile App*. Key activities in this reporting period included API Connectivity where they established a stable connection with the NWS API, allowing for real-time retrieval of weather data. Preliminary Filtering Systems where they designed and implemented an initial filtering mechanism to isolate tornado-specific alerts from the broader stream of weather data. Mapping Tornado Alert Data where they analyzed and documented the structure of tornado alerts to understand key information fields (e.g., coordinates, timestamps, severity levels) essential for visualization and navigation. Identifying Challenges where they recognized limitations in the API, particularly regarding access to historical and test data, which could affect testing and validation processes.

The project has achieved the following significant results during this reporting period:

- API Connectivity: Successfully established real-time data retrieval from the NWS API.

- Filtering Mechanism: Developed an initial system to filter tornado-specific alerts from the weather data stream.
- Data Mapping: Identified and documented key data fields (e.g., geolocation, severity) necessary for visualization and navigation.
- Challenge Identification: Discovered challenges with historical and test data access, which will be addressed in the next phase.
- These results mark a significant step toward creating a functional app that improves public safety during tornado events.

Dr. James Campbell at the University of Missouri-St. Louis, leads a project titled *Rural Transportation System Design for Omnichannel Healthcare*. During this reporting period, significant results were achieved across the various components of the project, marking substantial progress toward its completion. The findings from empirical analysis, modeling efforts, and case study evaluations provide critical insights into enhancing rural healthcare access through the deployment of telehealth kiosks/booths (TKBs).

The integration of discrete choice experiment data into the Hybrid Discrete Choice (HDC) models provided a deeper understanding of public attitudes toward TKBs. The finalized travel time decay functions revealed distinct patterns in how different age groups respond to travel distance when choosing between TKBs and traditional hospital services. Seniors and school-age children were confirmed to be the most sensitive to travel distances, with their likelihood of utilizing TKBs declining sharply beyond certain thresholds. The integration of these functions into the HDC models allowed for precise predictions of healthcare preferences based on variables such as consultation type and travel time. These models provide the first empirically grounded travel time decay functions specific to TKBs, offering a valuable resource for future research and practical applications in telehealth technology deployment. A draft manuscript detailing these findings, including the methodology and implications, is nearing submission to a peer-reviewed journal.

The continuous approximation (CA) models, applied to two case study regions in Missouri, yielded critical insights into the impact of TKB deployment on healthcare access. The analysis demonstrated that increasing the number of TKBs significantly reduces average travel times for rural residents, with travel time decreasing from an average of 25 miles with 10 TKBs to 15 miles with 20 TKBs. However, the models also highlighted the diminishing returns associated with higher numbers of kiosks. For example, deploying 15 TKBs provided coverage for 85% of the population, while increasing to 20 TKBs only slightly improved coverage to 90%. Additionally, under strong travel time decay conditions, the number of TKBs required to maintain sufficient coverage increased by approximately 30%, emphasizing the need to account for population travel behavior in deployment strategies. These findings illustrate the trade-offs between cost-efficiency and accessibility and underscore the importance of tailoring deployment strategies to demographic and geographic characteristics.

The discrete optimization models developed for tactical-level TKB deployment revealed key insights into achieving equitable and efficient healthcare access. The proposed model, implemented in Python and solved using Gurobi, addressed the objective of maximizing the total expected coverage while ensuring equitable access through Gini coefficient constraints. Application of these models to Missouri case studies demonstrated how strategic placement of TKBs can reduce disparities in healthcare access. Notably, the results highlighted the tension between cost-efficiency and equity, with optimal placements varying depending on the tolerance for inequity. In scenarios where equity was prioritized, TKBs were more evenly distributed across regions, enhancing access for underserved populations but

requiring a higher number of kiosks. Conversely, when equity was less of a priority, the models favored clustering kiosks in population centers, maximizing overall accessibility but leaving some regions underserved. These findings contribute to a nuanced understanding of the trade-offs involved in rural healthcare planning and provide a foundation for actionable policy recommendations.

Collectively, these results reflect the culmination of efforts to address the multifaceted challenges of rural healthcare access through innovative modeling and empirical analysis. The findings not only validate the potential of TKBs to improve accessibility and equity but also offer practical insights for policymakers and practitioners aiming to optimize resource allocation in underserved regions. The documentation of these results in the final report and related manuscripts ensures their dissemination to both academic and policy-making audiences, fulfilling the objectives of the research project.

Education and Outreach Activities

In 2023, MATC implemented 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 are being funded by the MATC UTC program are detailed below.

MATC 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.

During this reporting period, eight sites implemented RRRC on a weekly basis with materials supplied by MATC staff. The programming details are as follows:

Park Middle School, Lincoln, NE:
The total number of students who participated during this reporting period was 26 (15 female and 11 male); 6th Grade (10 students), 7th Grade (6 students) and 8th Grade were (10 students). The total number of sessions for this school during this reporting period was 11 sessions.

The following activities were covered during this period: Gears, Fan Car, Eureka Bridge, Spectroscope, Bernoulli Principle, Recycled Road, The Salt Creek Tiger Beetle and sodium as an absorbent, and Seismograph/Earthquake.

Culler Middle School, Lincoln, NE:
The total number of students was 20 (seventeenth females and three males); 6th Grade (15 students), 7th Grade (1 student), and 8th Grade (4 students). The total number of sessions for this school during this reporting period was 19 sessions.

The following activities were covered during this period: Edible Car, Team Towers, Paper Airplane challenge, Paper Airplane launcher slides, Parachute lab, Rochet's engineering, Egg Drop, Traffic, and Traffic Maps.

Mickle Middle School, Lincoln, NE:
The total number of students was 29 (thirteen females and sixteen males); 6th Grade (9 students), 7th Grade (12 students), and 8th Grade (8 students). The total number of sessions for this school during this reporting period was 17 sessions.

The following activities were covered during this period: Tallest Paper Tower, Testing wood and adhesives for building a tower, Tower: Base and top design Development, Tower: Height and levels, Towers: Final competitions, Make a wind work: Build a wind turbine to generate energy, Unleash the Power of a Pinwheel!, Road Cant: Building a race track, Wind Turbine efficiency, STEM challenge Sleighs and Ramps, Cranes, Space Needle Tower, Animal fencing, Kite Activity, Styrofoam Glider.
Lefler Middle School, Lincoln, NE:
The total number of students was 11 (all male); 6th Grade (8 students), and 7th Grade (3 students). The total number of sessions for this school during this reporting period was 15 sessions. The total attendance during this period was 84 attendees.

The following activities were covered during this period: Catapults, Finger Skateboard, Straw Tower, Suspension Bridge, Suspension bridges, Articulated Grabber, Parachute, Balance and Mobile, setting shapes and figures, Crane for lifting, Go Fly A Kite, Mechanical Hand, O-Wing Airplane (Glider), Paper Airplane Activity, Balloon car, and Paper windmill activity.

Goodrich Middle School, Lincoln, NE:
The total number of students was 27 (12 male, 14 female, and 1 they/them); 6th Grade (14 students), 7th Grade (7 students), and 8th grade (7 students). The total number of sessions for this school up to this point was 17 sessions.

The following activities were covered: Catapults, Motion and You, Articulated Grabber, Edible Car, Fan Car, Bridges, Foil Sculpture, Parachute, Setting shapes and figures, Crane for lifting, Mechanical Hand, O-Wing Airplane (Glider), Paper Airplane Activity, and Paper windmill activity.

Scott Middle School, Lincoln, NE:
The total number of students was 24 (21 male and 3 female); 6th Grade (3 students), 7th Grade (15 students), and 8th Grade (6 students). The total number of sessions for this school during this reporting period was 13 sessions.

The following activities were covered: Articulated Grabber, Arts and engineering, Parachute, Balance and Mobile, Crane for lifting, Go Fly A Kite, Mechanical Hand, Trigger Launcher Easy Craft Stick Launcher, O-Wing Airplane (Glider), Paper Airplane Activity, Rubber Band Car, and Paper windmill activity.

Schoo Middle School, Lincoln, NE:
The total number of students were 19 (10 male and 9 female); 7th Grade (17 students) and 8th Grade (3 students). The total number of sessions for this school up to this point was eight sessions.

The following activities were covered: Spaghetti towers challenge, Knex catapult, Glider plane activity, Popsicle stick bridge, and Rubber band Cars.

Dawes Middle School, Lincoln, NE:
The total number of students were 21 (10 male and 11 female); 6th Grade (20 students) and 7th Grade (1 student). The total number of sessions for this school up to this point was 17 sessions.

The following activities were covered: Edible Cars, Noodle and marshmallow Towers, Fan Car, Suspension Bridge, Getting to Know, Bridge, Wind Turbine Part 1 and 2, Solar Updraft Tower, Paper Roller Coaster, and Tissue Paper Parachute.

MATC STEM Academy

The MATC STEM 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 program is open to any high school student in Federal Region VII.

The 2025 STEM Academy is expected to occur at the University of Nebraska–Lincoln campus from Sunday, June 8th, 2025 – Thursday, June 12th, 2025. The program requirements, policies, and procedures can be found at STEM Academy | Mid-America Transportation Center | Nebraska.

We are currently receiving applications from high school students from across Nebraska. We plan to admit 30 – 35 students to this year's academy.

Activities for the 2025 STEM Academy program include Chemistry lab tours, a library survey and activities, a tour to Spring Creek Prairie Audubon Center, Nebraska Innovation Center activities, Strategic Air Command and Aerospace Museum tour, and activities, Mahoney State Park science activities and tours, and other activities.

The activities aim to build students' interest and awareness of the STEM, engineering, and transportation fields. Further, students will participate in a cultural activity game called BAFA BAFA. This game aims to learn about the importance of culture in human life. It will also allow the participants to refrain from criticizing and ethnocentrism to understand people and their culture and way of life better. Finally, students will also attend one of our public speaking presentations, and the goal will be to plan better and organize what we say. This activity will also allow them to see what the other speakers and presenters used to organize their speeches.

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

MATC Intern Program

MATC 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.

MATC advertised several times but were unable to find any sponsors able to participate in Summer 2025.

MATC Research Experience for Undergraduates (REU)

MATC will continue to support academic year undergraduate research assistantships and summer research opportunities. At the graduate level, this will occur through participation in MATC 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 consortium university.

MATC supported one REU student (Caitlin Keathley) 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 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 presented 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 showcased 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	University of Southern California	Los Angeles	CA				X	
Research	Northern Illinois University	DeKalb	IL		X		X	
Research	St. Louis University	St. Louis	MO		X		X	
Research	Cass Information Systems	St. Louis	MO		X			
Research	South China Agricultural University	CHINA					X	
Research	Tianjin University of Commerce	CHINA					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	Mid-America Transplant	St. Louis	MO		X			
Research	University of Arizona						X	
Research	Yantai University	CHINA					X	
Research	Entanglement, Inc.	Miami	FL		X			
Research	University of Colorado-Denver	Denver	CO		X			
Research	Food Shippers of America	Geneva	IL				X	
Research	St. Louis Agribusiness Club	St. Louis	MO				X	
Research	City of Lincoln	Lincoln	NE		X			
Research	Nebraska Department of Transportation	Lincoln	NE				X	
Research	Kansas Department of Transportation	Topeka	KS		X		X	
Research	Seatbelts Are For Everyone (SAFE)		KS				X	
Research	University of Kansas Medical Center	Kansas City	KS		X			
Research	University of Ulsan	SOUTH KOREA					X	

3. OUTPUTS

Publications, conference papers, and presentations

Journal Publications

1. Esmaely, Aysan, Ciara Nelson-Forcade, John D. Shepherd, and Abigail L. Cochran. 2024. "Addressing Transportation Barriers to Low Vision Care Among Individuals with Visual Impairments in Nebraska." Journal of Transport & Health; under review; acknowledgment of Federal/MATC support: yes.
2. Ciara Nelson-Forcade, Esmaely, Aysan, John D. Shepherd, and Abigail L. Cochran. 2024. "Clinicians' Perspectives on Transportation Barriers to Low Vision Care in the Rural Midwest." Transport Findings; under review; acknowledgment of Federal/MATC support: yes.

3. Hupman AC, Li H, Zhuang J, Subramaniam J. (Published in December 2024) "Predicting Pharmaceutical Supply Chain Disruptions Before and During the COVID-19 Pandemic." Risk Analysis, 44(12): 2797-2811; yes (acknowledgment of Federal support)

Conference Papers

1. Abstract and paper accepted for presentation at the International Conference on Urban Affairs (ICUA) 2025 Annual Conference: Aysan Esmaely, Ciara Nelson-Forcade, John D. Shepherd, and Abigail L. Cochran. 2024. "Addressing Transportation Barriers to Low Vision Care in Nebraska."

Presentations

1. Hupman AC (October 2024) "Wealth, Preferences, and the Value of Information," presented at the 2024 INFORMS Annual Meeting, Seattle, WA; yes (acknowledgment of Federal support)

Patent Applications

1. Dr. Haitao Li of the University of Missouri-St. Louis reported that an invention disclosure titled Centralized Autonomous Coordination Scheme (CACS) for Production Planning of Distributed Manufacturing was submitted on Jan 14, 2025.

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

MATC intends to continue maintenance of five online sites that distribute information utilizing the internet. Links to each site can be found below.

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.

Additional Partner Websites

Several MATC Principal Investigators created websites to share information about their research projects. The links to these websites are provided in Table 3 along with the corresponding MATC project.

Table 3: Websites for Individual MATC Research Projects Created by Principal Investigators

Project Title	Principal Investigator	Website Link
Development of a Real-Time Flood Forecasting System for Railroad Crossings in the Midwest	Witold Krajewski Nicolas Velasquez	https://github.com/nicolas998/network_conditioning https://github.com/nicolas998/asynch/tree/distv2
Understanding Moving/Damage Mechanism of Vehicles under Tornadoes for Enhancing Vehicle/Driver Safety	Grace Yan	http://hmcr.mst.edu/ https://sites.google.com/a/mst.edu/wham/home

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?

In the project titled *Intelligent Transportation Network Decision Support with Real-time Routing and Data Analytics* at the University of Iowa, Dr. Demir and his research team indicated that the proposed decision support system 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 simulated what-if flood scenarios to identify vulnerable areas and populations to aid in decisions for mitigation, planning, response, and recovery activities.

In the project titled *Development of a Real-Time Flood Forecasting System for Railroad Crossings in the Midwest* at the University of Iowa, Dr. Krajewski and his team have noticed that the generated streams network is considering more places where floods can happen along the railroad system. An eventual development of a flood system with this detail level will allow to forecast floods in many points of interest that are currently not considered.

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. Albert Ratner of the University of Iowa believes that the droplet combustion process and its underlying thermo-physical mechanisms in his project titled *Use of Carbon Dots to Boost Energy Content of Biodiesel to Enable Next-Generation Hybrid Heavy Vehicles for Ground Transportation While Improving Safety* are anticipated to significantly influence the science of combustion and ignition, particularly for nanofuels and alternative fuels. Modifying liquid fuel combustion characteristics through nano-additives holds significant promise for enhancing fuel efficiency. Identifying optimal concentrations of additives that optimize combustion characteristics and stability periods of nanofuels could lead to cost savings during future industry technology implementation.

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 several 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

Initial delay in recruiting Graduate Research Assistants for multiple projects. We are seeing some resolution with the start of several new students working on various projects during the reporting period.

7. SPECIAL REPORTING REQUIREMENTS

Nothing to report.