Semi-Annual Progress Report for University Transportation Centers

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  United States Department of Transportation, Office of the Assistant Secretary for Research and Technology

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

- **Program Director (PD) Name, Title, and Contact Information**
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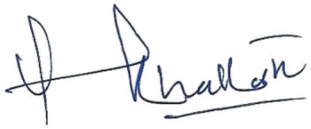
- **Signature of Submitting Official (signature shall be submitted in accordance with agency- specific instructions)**



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 year 1 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	100%
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	0%
Post Research Project Descriptions on MATC Website	In Process	0%
Semi-Annual UTC Program Progress Performance Report	In Process	0%
Annual Performance Indicators Report	In Process	0%
Additional USDOT OST-R Requirements:		
Annual Progress Meetings	In Process	0%
UTC Director's Meetings	In Process	0%

Participate in UTC Symposiums	In Process	0%
Maintain Website (personnel directory, research pages and reports)	In Process	50%

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 four (4) ongoing USDOT funded projects, supported by six (6) PI's and Co-PI's. The University of Kansas (KU) currently has four (4) ongoing USDOT funded projects, supported by seven (8) PI's and Co-PI's. The Missouri University of Science & Technology (MS&T) currently has four (4) ongoing USDOT funded projects, supported by four (4) PI's and Co-PI's. The University of Missouri-St. Louis (UMSL) currently has five (5) 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 a report 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 project titled *Transportation Barriers to Vision Care for the Visually Impaired,* Dr. Abigail Cochran and her team initiated the interview-based research activities associated with the project. Specifically, Dr. Cochran and her Graduate Research Assistant, Aysan Esmaely, completed 21 semi-structured, in-depth interviews with individuals with visual impairments living in Nebraska and caregivers. Recruiting participants and conducting the interviews, cleaning the interview transcripts, and beginning to analyze the data were the primary activities of the reporting period.

An objective of the project is to answer the following research question: *How do transportation-related barriers pose obstacles to seeking low vision rehabilitation services among rural residents with visual impairments in Nebraska?* By collecting data from 21 in-depth, semi-structured interviews with Nebraska residents with visual impairments, many living in rural areas, the research team can begin answering this question by elucidating understanding of the nature and consequences of transportation barriers to low vision care. The research team will continue analyzing the interview data in the coming months and begin preparing academic abstracts and a manuscript to be submitted for eventual publication.

With the help of Dr. John Shepherd, Director of the University of Nebraska Medical Center's Weigel Williamson Center for Visual Rehabilitation, project personnel recruited 20 patients seeking low vision care (and 1 caregiver) to participate in semi-structed, in-depth interviews on their experiences accessing transportation to care. Furthermore, the team successfully conducted interviews with these 21 subjects, completed data cleaning, and initiated writing and other activities to begin synthesizing and disseminating findings.

In this study, preliminary analysis enabled the research team to identify common transportation barriers and explored their impacts, paying particular attention to how these barriers affected people's ability to access low vision rehabilitation and other health care services. Their findings revealed variations in how barriers were experienced across different demographics, households, and spatial characteristics. Notably, respondents belonging to certain groups, such as older adults (over age 65), individuals with low incomes, people living in rural areas, and individuals who cannot drive themselves or who do not own a personal vehicle, frequently reported experiencing transportation barriers that affected their ability to access timely care. Given the profound impact of visual impairment on one's ability to drive, most respondents reported a cessation of driving. Following cessation, they emphasized feelings of diminished autonomy and independence. Employing thematic analysis enabled us to categorize and characterize identified barriers, offering deeper insights into individuals' experiences with transportation and enriching our understanding of the challenges they face in accessing health care. Dr. Cochran and her team propose recommendations for transportation and health care professionals to address transportation barriers to care, enhance access conditions for people with vision disabilities, and improve accessibility in transportation planning, particularly in rural settings.

In a project titled *Advancement of Gender Equity in Transportation Safety, Design, Development, and Evaluation of Roadside Safety Hardware,* Dr. Mojdeh Pajouh and her team began exploring male and female LS-DYNA dummy crash test models and collecting past studies using these models. In the following phases, the focus would be on running simulations using female and male LS-DYNA crash test models in vehicle-barrier crashes and investigate potential differences.

The ultimate objective of this project is to investigate the suitability of the Manual for Assessing Safety Hardware (MASH) impact safety requirements for a diverse range of motorists, in particular female drivers/passengers, and recommending necessary adjustments and considerations. Over the reporting period, relevant research papers and reports were collected and reviewed, specifically those studies that compared female and male differences in real-world vehicle crashes. The variations in female/male vulnerability and injury risks in vehicle crashes were identified. Also, the current safety criteria were reviewed and current occupant risk measures such as Occupant Impact Velocity and Ridedown Acceleration were reviewed.

The key outcome for this reporting period was to gather and analyze the literature relevant to female and male differences in terms of risk injuries 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 in lower body extremities. This finding was linked to driver height as such drivers with shorter height would experience higher likelihood of injuries in crashes, which are more predominately female drivers. Additionally, the review revealed that women tend to sit closer to the vehicle steering wheel, which can affect their crash injury severity. 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.

In a project titled *Rural Transportation System Design for Omnichannel Healthcare*, Dr. James Campbell and his team explore an aspect of omnichannel healthcare delivery that can improve patient access by using telehealth kiosks/booths (TKBs) that are in rural areas to reduce rural patient travel distance and time. This research models transportation and locational aspects associated with publicly available telehealth kiosks/booths to evaluate impacts on access to healthcare, efficiency, and equity. Fundamentally, adding TKBs to a healthcare system brings healthcare closer to patients in rural areas, but with increased costs from deploying a network of TKBs. We also consider some aspects of using drones (UAVs) to deliver health care items in conjunction with TKBs.

Key outcomes include 1) verification of the new opportunities and potential benefits to use TKBs to improve rural healthcare; 2) verification that such systems are not currently in use on a regular basis in the rural US; 3) verification that delivery drones have been successfully used in healthcare in a variety of settings, with increasing use in the USA, and; 4) identification of some potential barriers to use of TKBs and drones for rural healthcare.

The accomplished objectives of a project led by Dr. Shakiba Enayati titled *Collaborative Last-Mile Delivery with Drones in Rural America*, includes identifying gaps in the literature and locating complementary works that establish the foundation for this research. Additionally, the preliminary design of the optimization framework was delineated, laying the groundwork for its implementation and evaluation. Realistic datasets pertinent to the project's theme were identified, setting the stage for thorough testing and refinement of the framework.

The major development has been the creation of a pioneering optimization model designed to seamlessly incorporate drone technology into the logistics of distributing health supplies. This model is carefully crafted with essential factors in mind: considering drone capabilities to fine-tune routing and scheduling, utilizing a hub-and-spoke network for streamlined operations, blending drone with ground transportation for comprehensive coverage, and prioritizing the delivery of critical medical supplies. We are currently in the stage of processing and analyzing real-world data sets through our partnership with the Shield Illinois testing centers (also referred to as SHIELD), which are instrumental for the model's practical application, ensuring our strategies are grounded in reality and ready to address urgent healthcare logistics challenges, including those presented by a pandemic.

Through the development of a cutting-edge optimization model, they've laid the groundwork for transforming the delivery of medical supplies, especially crucial during pandemic scenarios. They have verified that delivery drones have been successfully implemented in various healthcare settings, with their utilization steadily increasing across the USA. Their 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.

The primary goal in a project led by Dr. Trilce Encarncion titled *Optimal Design of Inland Waterway System to Enhance Intermodal Transportation*, is to address the challenges hindering the full potential of inland waterway freight transport in the United States and realize its environmental advantages. The research approach involves a combination of in-depth interviews and surveys to comprehensively explore the barriers to adoption and collaboration strategies that can lead to prioritized investments in infrastructure, enhanced intermodal connectivity, and awareness about the environmental benefits and long-term sustainability of water transportation.

The overall goal of a project led by Dr. Andrea Hupman titled *Decision Support for Dynamic Risks to Improve Supply Chain Resilience*, is to examine the effect of variations in risk over time on the management of transportation and supply chain networks with the goal of creating enhanced decision support tools. Key outcomes of the research include compiling several tables and synthesis matrices describing the methods and contributions of papers addressing transportation and supply chain risk mitigation, as well as the categorization of risk types and the categorization of decision models by their respective time horizons.

Education and Outreach Activities

MATC has implemented several educational outreach programs in support of USDOT's Strategic Plan and the center's mission to increase the number of students from underrepresented groups in STEM education and transportation-related careers. Descriptions of each educational program and the activities that took place during June 1, 2023 – March 31, 2024, are detailed below.

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

MATC's after-school program combines the talents of middle school teachers and the MATC Education and Outreach Program Manager to educate the diverse leaders of tomorrow about STEM principles. Each participating school offers the club for an hour every week. Teachers present on an engineering or transportation-related topic and lead students in an interactive activity that encompasses the concepts of the lesson. Examples of activities include constructing bridges and conducting strength tests, creating towers that can withstand simulated earthquakes, and building racecars powered by potential energy stored in a rubber band.

During the academic year portion of the reporting period of June 1, 2023 – March 31, 2024, a limited number of sites implemented RRRC on a weekly basis with materials supplied by MATC staff. The programming details are as follows.

Fall 2023 and Spring 2024 Roads, Rails, and Racecars (RRRC) Programming

During the reporting period October 1, 2023 – March 31, 2024, RRRC programming occurred at three (3) participating sites in Lincoln, Nebraska; Park Middle School, Mickle Middle School, and Culler Middle School for students in grades 6, 7, and 8. Topics and hands-on activities included civil engineering and towers and bridges; engineering and art; city planning and skylines; city planning and transportation systems; city planning and levees; bridges and roadways; electricity and circuits; paper airplane; paper and straw rockets; building cars; Duct tape bridges; hot wheels racetrack loops; and designing cars from pop sticks and straws.

The after-school program at Park Middle School was offered on Mondays from 3:15 PM – 4:15 PM. The total attendance of students was 68 students (39 female and 29 male) who attended 10 sessions.

The after-school program at Culler Middle School was offered on Wednesdays from 3:15 PM – 4:15 PM. The total attendance of students was 28 students (24 male and 4 female) who attended 9 sessions.

The after-school program at Mickle Middle School was offered on Thursdays from 3:15 PM – 4:15 PM. The total attendance of students was 26 students (15 female and 11 male) who attended seventeen (17) sessions.

MATC 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 2023 Sovereign Native Youth Leadership Academy took place at the University of Nebraska-Lincoln campus from Sunday, June 18, 2023 – Thursday, June 22, 2023. High School students from High Schools in Nebraska were invited to attend. The program featured Engineering lab tours and activities, a Plant Science activity, and a GIS Story Mapping activity. Thirty-three students completed the program. A full program of the event can be found at: https://matc.unl.edu/2023-academy.

The 2024 Sovereign Native Youth STEM Leadership Academy is expected to occur at the University of Nebraska–Lincoln campus from Sunday, June 23, 2024 – Thursday, June 27, 2024. The program requirements, policies, and procedures can be found at https://matc.unl.edu/about-sovereign-native-youth-stem-leadership-academy.

We are currently receiving 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. To date, 24 students have applied for this opportunity.

Activities for the 2024 program include Engineering lab tours and activities, a food sovereignty activity, and a GIS Story Mapping activity. These activities aim to build students' interest and awareness of the engineering and transportation field. Further, students will participate in a leadership activity game called StarPower. The goal of this game is to learn both about the abuse of power and powerlessness. Finally, students will attend activities at Nebraska Innovation Campus to learn about and use various high technology and hands-on maker space equipment.

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

MATC Scholars Program
The MATC Scholars Program is a multi-day conference that brings students from underrepresented groups together with diverse faculty. MATC's Scholars Program fills an existing gap for minority students by encouraging them to attend graduate school and teaching them necessary skills to succeed in obtaining graduate degrees in their chosen STEM-related fields. Students from historically black colleges

and universities, tribal colleges, and other minority-serving institutions across the country are given the valuable opportunity to network and attend seminars led by experienced faculty members and educational administrators at the University of Nebraska-Lincoln campus.

The Fall 2023 Scholars Program for Tribal College and University (TCU) students was postponed due to staffing shortfall within MATC.

MATC Intern Program

The MATC Intern Program partners with private companies, local government, and academia to provide undergraduate students with paid summer internship opportunities in the transportation and engineering fields. During this 12-week program, students gain hands-on experience in their area of interest under the mentorship of a professional. Students work 40 hours per week while experiencing the day-to-day tasks and responsibilities of their desired career. The program culminates in a written paper and presentation detailing the student's internship experience.

Recruitment for the 2024 Summer Program began in October 2023 with three (3) students applying for positions. To date, none of the students have yet accepted internship positions.

MATC Research Experience for Undergraduates (REU)

MATC 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 2024.

How have the results been disseminated?

MATC staff maintain individual project records on the Transportation Research Board's Research in Progress (RiP) database. MATC web development staff are working diligently to bring MATC's online database at http://matc.unl.edu/research/research_search.php up to UNL security standards so that the pages can be shared publicly. Soon, links to the individual RiP and TRID records will be provided on their corresponding project page in the MATC 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 University of Missouri – St. Louis, researchers completed the following activities during this reporting period that allowed them to share the project and its goal with relevant stakeholders:

- Discussions with the Directors of the University of Missouri Rural Health Research Center (RHRC) and the Missouri Practice-Based Innovations Network (MO-PIN).
- Travel to the University of Missouri - Columbia to participate in 3rd Annual Rural Health Research Center Summit on December 1, 2023. At this event, researchers made a presentation and moderated a discussion on "Use of Medical Assess" in which details for the project titled *Rural Transportation System Design for Omnichannel Healthcare* was shared with about 60 practitioners from rural Missouri.
- Meetings with University of Missouri Health Science and Medical School faculty Julie Kapp and Rachel Mutrux.

Additionally, Dr Li held a podcast with Inbound Logistics to share the research on modern transportation in a connected economy on March 18, 2024:

- Inbound Logistics Podcast: "Modern Transportation Systems in a Connected Economy", March 18, 2024. https://www.inboundlogistics.com/podcast/#170

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
Roads, Rails, and Race Cars Program (RRRC)	Culler Middle School	Lincoln	NE		X	X		
RRRC	Mickle Middle School	Lincoln	NE		X	X		
RRRC	Park Middle School	Lincoln	NE		X	X		
RRRC	Umó^{N}ho^{N} Nation Public School	Macy	NE	X	X	X	X	
RRRC; Academy	Lincoln Public Schools	Lincoln	NE	X			X	
RRRC; Academy	Winnebago Public School	Winnebago	NE	X	X	X	X	
RRRC; Academy	Santee Community School	Santee	NE	X	X	X	X	
RRRC; Scholars	Nebraska Indian Community College	Macy	NE	X			X	
Academy	Claire M. Hubbard Foundation	Omaha	NE	X				

Research	University of Nebraska Medical Center	Omaha	NE				X	
Research	University of Missouri Rural Health Research Center (RHRC)	Columbia	MO				X	
Research	Missouri Practice-Based Innovations Network (MO-PIN)	Columbia	MO				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	UI Hydroinformatics Lab	Ames	IA				X	
Research	CEMATRIX Inc.	CANADA			X		X	
Research	Tensar International Corp.	Alpharetta	GA		X		X	

3. OUTPUTS

Publications, conference papers, and presentations

Journal Publications

1. Hupman AC, Li H, Zhuang J, Subramaniam J. (under review) "Predicting Pharmaceutical Supply Chain Disruptions Before and During the COVID-19 Pandemic." Risk Analysis; yes (acknowledgment of Federal support)
2. Enayati, S. and Özaltın, O.Y.; Supplier selection under disruption risk with hybrid procurement; Computers & Operations Research; 2024; p.106593; published; yes.
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; published; yes.
4. Velásquez, N., Krajewski, W.F. Effect of streamflow measurement error on flood frequency estimation. Stoch Environ Res Risk Assess (2024). https://doi.org/10.1007/s00477-024-02707
5. Mantilla, R., Fonley, M., Velásquez, N. Testing the connection between hillslope-scale runoff fluctuations and streamflow hydrographs at the outlet of large river basins. Hydrology and Earth System Sciences 28 (6), 1373-1382 (2024). https://doi.org/10.5194/hess-28-1373-2024
6. Velásquez, N., Krajewski, W.F., Seo, B.C. Assessing the Impact of Radar-Rainfall Uncertainty in Streamflow Prediction. Water Resources Research (submitted)
7. Parveg, A. S., & Ratner, A. (2023, October). Droplets Combustion Characteristics Comparison of Single Component and Multicomponent Diesel Surrogates with Petroleum-Based Commercial Diesel Fuel. In ASME International Mechanical Engineering Congress and Exposition (Vol. 87646, p. V007T08A019). American Society of Mechanical Engineers.
8. Shi, Z., Mohammed, Y.M., Uddin, N., Chen, G. A vehicle-bridge interaction model considering contact patch size and vehicle self-generated excitation – A theoretical study. Engineering Structures 298: 117079, January 1, 2024. https://doi.org/10.1016/j.engstruct.2023.117079

Conference Papers

Presentations

1. Esmaely, A., Cochran, A.L. 2024. "Addressing Transportation Barriers to Low Vision Care in Nebraska." Submitted April 9, 2024, for consideration for publication at the ACSP 2024 Annual Conference.
2. Campbell, J.F., Enayati, S., Kara, B., Peker, M., Li., H., Akenroye, T. Optimizing Vaccine Delivery with Drones for Hard-to-Reach Regions, Proceedings of the 57th Hawaii International Conference on System Sciences (HICSS-57), HICSS (Hawaii International Conference on System Science, 2024), 3354-3363, 2024.
3. Penagos, P., Encarnacion, T., Gonzalez-Calderon, C.A., Enz, M. Consumers' Intention to Adopt Parcel Lockers as an Alternative for Last-Mile Delivery in Emerging Economies. Presented at 103rd Annual Meeting of the Transportation Research Board (TRB), Washington, D.C., U.S., 2024.
4. Hupman, A. (Accepted) "Risk Prediction & Mitigation in a Dynamic Environment," 2024 Supply Chain & Analytics Annual Applied Research Symposium. Saint Louis, MO, April 18, 2024.
5. Hupman, A. (Accepted) "Constructing Ensemble Estimates for the Risk Averse Decision Maker," 2024 Advances in Decision Analysis Conference, Helsinki, Finland, July 10-12, 2024.

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

MATC maintains five online sites that distribute information utilizing the internet. Links to each site as well as report period information can be found below.

MATC Website

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

SlideShare

Below is a snapshot of MATC's SlideShare activity and the link to view the page: https://www.slideshare.net/matcRegion7UTC/presentations/. MATC had 329 more SlideShare views than the last reporting period.

Total Views: 636	New Uploads: 0	Downloads: 0	Favorites: 0

Facebook

Metrics for the MATC Facebook page can be viewed below, and the page can be accessed by clicking on the following link. MATC's total page likes increased by 298 and gained 8 followers since the last reporting period.
https://www.facebook.com/pages/Mid-America-Transportation-Center-MATC/141238439284182.

Total Page Followers: 449	Reach: 1,7,30	Content Interactions: 133

Twitter

MATC's Twitter handle is @MATCNews. The page can be viewed by clicking the following link: https://twitter.com/MATCNews. The highlighted numbers for MATC's Twitter activity can be seen below. There were 93 more post impressions than the last reporting period.

New Followers: 3	Tweet Impressions: 601	Profile Visits: 64	Tweets: 4

YouTube

MATC's YouTube feed can be viewed by clicking the following link: http://www.youtube.com/user/midamericatrans?feature=results_main. MATC's views increased by 571 and minutes watched increased by 2,226 since the last reporting period.

New Videos: 2	Views: 1,263	Minutes Watched: 3,972	New Subscribers: 6

4. OUTCOMES

In the project titled *Transportation Barriers to Vision Care for the Visually Impaired,* Dr. Cochran and her team 1) increased understanding of the nature and consequences of transportation barriers to health care encountered by individuals seeking low vision rehabilitation services in Nebraska; (2) saw an overall increase in the body of knowledge of transportation-related obstacles (or barriers) to seeking health care, which can contribute to poor health outcomes and exacerbate health disparities and; (3) saw an enlargement of the pool of researchers trained in ethical research protocols; specifically, GRA Esmaely completed required human subjects training through the Collaborative Institutional Training Initiative (CITI).

In the project titled *Rural Transportation System Design for Omnichannel Healthcare*, Dr. Campbell and his team generated increased awareness and understanding of the transportation impacts from using technology to address rural healthcare. While healthcare academics and practitioners are aware of the transportation challenges faced by rural patients (e.g., lack of access to automobiles or public transportation), the broader issues related to how technology and new forms of transportation (e.g., drones) could positively impact rural healthcare are not well understood or well appreciated. Effective and efficient transportation and supply chain management, in conjunction with digital sensing and communication technologies, may provide new opportunities to improve rural healthcare.

5. IMPACTS

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

In the project titled *Transportation Barriers to Vision Care for the Visually Impaired,* Dr. Cochran believes that anticipated outcomes of the research might contribute to improving operations and effectiveness of rural transit systems and non-emergency medical transportation (NEMT) services, in particular. Specifically, providing integrated NEMT services in rural areas, i.e., using NEMT reimbursements to subsidize the rural transit operations budget that also serves general purpose trips, could be an innovative and effective way to address transportation barriers to low vision and other specialty care facing rural Nebraskans.

In the project titled *Advancement of Gender Equity in Transportation Safety, Design, Development, and Evaluation of Roadside Safety Hardware*, Dr. Pajouh believes her project helps promote gender equity in transportation system and create a safer and more inclusive transportation system for everyone. By addressing potential shortcomings in the existing safety criteria, this project contributes to improving the safety of all road users, including female drivers and passengers, and reducing the risk of injuries and fatalities in highway crashes.

In the project titled *Rural Transportation System Design for Omnichannel Healthcare*, Dr. Campbell expects impacts will include enhancements to the effectiveness of the rural transportation system by reducing travel times for rural patients accessing healthcare. Strategic placement of TKBs is anticipated to decrease the need for long-distance travel to healthcare facilities, thus alleviating congestion and wear on rural transportation infrastructure. This project assesses these impacts by collecting and analyzing data on travel times before and after TKB implementation, aiming to demonstrate a quantitative reduction in travel times and corresponding increases in healthcare accessibility. Additionally, reduced travel requirements are likely to lower transportation costs for patients, improving economic efficiency in healthcare delivery and enhancing patient compliance with treatment due to easier access. Ultimately, the integration of TKBs is expected to improve both the operational efficiency of the transportation system and the health outcomes for rural communities.

In the project titled *Collaborative Last-Mile Delivery with Drones in Rural America*, Dr. Enayati believes that expected impact of our research on the transportation system's effectiveness in rural healthcare logistics includes:

- Operational Efficiency: Implementing optimized drone routing and scheduling is projected to enhance the efficiency of medical supply logistics significantly, reducing operational costs and delivery times, thereby improving the overall service level of the transportation system.

- Responsiveness: By employing drones for last-mile delivery, we anticipate a considerable increase in the system's ability to quickly respond to emergencies and pandemics, directly contributing to better health outcomes through faster delivery of critical medical supplies.
- Cost-Effectiveness: The project aims to achieve cost savings by optimizing drone utilization and minimizing transportation expenses, making drone deliveries an economically viable option that contributes to the sustainability of the healthcare logistics chain.
- Integrated Network: Enhanced collaboration across different modes of transportation is expected to lead to a more cohesive, multi-modal logistics network, improving the system's resilience and adaptability to operational challenges and varying demands.

Data-driven assessments from real-world rural scenarios will underpin these projections, with findings set to underscore the substantial benefits of integrating drone technology into rural healthcare logistics, aiming to improve accessibility and efficiency in delivering vital medical supplies.

In the project titled *Optimal Design of Inland Waterway System to Enhance Intermodal Transportation*, Dr. Encarnacion feels that her project will have an impact on 1) Infrastructure improvement by identifying current limitations within the U.S. inland waterway system, this research will guide investment in critical infrastructure improvements. This could involve upgrading locks and dams, enhancing port facilities, and improving connectivity with other transport modes, thereby increasing the overall capacity and reliability of inland waterways; 2) Policy development by providing policymakers with data-driven insights into the economic, environmental, and social impacts of inland waterway transport. This could lead to better-informed policies and regulations that support the growth and sustainability of this transport mode; 3) Stakeholder collaborations will identify strategies to improve collaboration among various stakeholders, including shippers, carriers, policymakers, and environmental groups, leading to more cohesive and effective approaches to managing and utilizing inland waterways; 4) Environmental sustainability because inland waterways offer a more environmentally friendly alternative to road and rail, as they generally produce lower emissions per ton-mile of cargo transported. This research aims to enhance this advantage by identifying strategies to shift to this mode and 5) Cost reduction through water transport is often more fuel-efficient and can handle larger volumes of cargo per journey compared to other forms of transport. This project helps in identifying strategies to leverage the inland waterway system to reduce operational costs by improving logistics transport efficiency.

In the project titled *Decision Support for Dynamic Risks to Improve Supply Chain Resilience*, Dr. Hupman believes that the expected impacts of this research include increased economic strength and global competitiveness, increased safety, and increased societal equity.

Decision support tools for transportation and supply chain risk mitigation will support enhanced decision making in the face of dynamic risks that will improve the operation of transportation and supply chain networks. Because transportation and supply chain networks are essential for economic activity, these advancements will promote both economic strength and global competitiveness.

Disruptions of critical supplies can pose safety risks to society, as illustrated by the difficulty that healthcare providers experienced in obtaining PPE during the COVID-19 pandemic. Disruptions can also negatively impact transportation networks, contributing to unbalanced loads across the network, leading to potential safety issues. Improving the response to dynamic risk that occurs in transportation and supply chain networks therefore also promotes safety.

Vulnerable and disadvantaged populations are often disproportionately impacted by supply chain disruptions, especially as they have fewer resources to pay increased prices or to find alternate supplies of essential goods. Thus, improving the operation of transportation and supply chain networks throughout systemic shocks and disruptive events alleviates the negative impacts on disadvantaged populations and promotes greater equity.

In the project titled *Intelligent Transportation Network Decision Support with Real-time Routing and Data Analytics*, Dr. Ibrahim Demir believes 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.

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?

At the University of Missouri-St. Louis, Dr. Campbell's research is poised to make an impact on both commercial technology and public healthcare practices by identifying optimal locations and functionalities for TKBs, thus improving transportation-related performance measures. By developing novel models and software implementations for optimally locating TKBs under diverse objectives and conditions, this project provides valuable tools that can be transferred to government or industry entities, enhancing rural healthcare logistics. These advancements not only improve healthcare access in underserved areas but also create opportunities for commercialization, potentially leading to partnerships or start-ups focused on healthcare infrastructure development. Such outcomes encourage the adoption of new practices within healthcare and transportation sectors and facilitate the standardization of technology use in rural healthcare provision, influencing broader policy and operational decisions.

Dr. Enayati's research on new practices and the potential for start-up initiation spans several key areas:

- Industry and Government Transfer: Our drone-based optimization framework for rural healthcare delivery is set to be adopted by both government and industry sectors, enhancing public health logistics and supply chain efficiency.
- Commercialization Potential: The research outcomes hold promise for commercialization, encouraging the emergence of start-ups focused on drone logistics for healthcare, offering innovative solutions for efficient and cost-effective medical supply delivery.
- New Practices Adoption: Demonstrating the efficiency of drone logistics is expected to inspire new operational models within logistics and healthcare sectors, promoting innovative supply chain management and integration strategies.
- Technology and Public Use Impact: The practical application of our findings is likely to advance drone operations and logistics software, improving rural healthcare accessibility and fostering a reduction in delivery times for essential medical services.

In essence, her research serves as a catalyst for transformative changes in logistics and healthcare delivery, bridging the gap between academic findings and their practical, real-world applications.

Dr. Hupman's decision tools that will be made possible through this research will improve operational efficiency of transportation and supply chain networks, increasing value to the organizations, making them targets of commercialization. Specifically, the decision support models developed could be integrated in software for use in commercial organizations.

Dr. Li's 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.

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 the project titled *Transportation Barriers to Vision Care for the Visually Impaired,* Dr. Cochran feels her project will contribute to planning and operating a more equitable, inclusive transportation system by identifying and seeking to address the transportation needs of rural residents with visual impairments. This work will have broad implications for improving access to transportation and health care among transportation-disadvantaged populations (i.e., the elderly, people with disabilities) in underserved rural communities. This work will also contribute to training future transportation professionals in ways to identify and address the transportation needs of vulnerable road users living in rural communities. Furthermore, this project will train and encourage students to participate in interprofessional collaborations with planners, engineers, and medical professionals to promote transportation equity and safety.

In the project titled *Advancement of Gender Equity in Transportation Safety, Design, Development, and Evaluation of Roadside Safety Hardware*, Dr. Pajouh feels the project results will question the historical safety measures outlined in the current manual for assessing safety hardware (MASH 2016), which were developed using only male crash test dummies, ensuring transportation safety for all users including females.

At the University of Missouri – St. Louis, Dr. Campbell believes his research is enriching the body of scientific knowledge, particularly within the fields of operations research and health sciences. By investigating patient travel patterns for healthcare in rural areas and the integration of new technologies like TKBs, the study provides deeper insights into addressing healthcare shortages and disparities in these underserved areas. This research has developed and refined models that not only enhance our understanding of transportation logistics to healthcare facilities but also improve methods for optimizing the locations of these facilities. As a result, this work is poised to influence both theoretical approaches and practical applications in the disciplines of operations research and health science, introducing new techniques that can be adopted to streamline healthcare delivery and improve access. These advancements help bridge the gap in healthcare service provision, offering scalable solutions that can be adapted across various geographic and socio-economic settings, thus broadening the impact on global health systems and policies.

Dr. Enayati believes that the expected impact of this project on the field of logistics and supply chain management, with a focus on integrating drone technology for healthcare delivery, can be summarized as follows:

- Knowledge Expansion: We anticipate this research will broaden the existing knowledge base in logistics, particularly by illustrating how drone technology can optimize healthcare delivery in

rural areas. This should provide valuable insights into overcoming logistical challenges associated with remote healthcare access.

- Technique Innovation: The development of new optimization algorithms for drone routing and scheduling is expected to introduce innovative techniques within the logistics discipline. These methodologies aim to enhance the precision and reliability of drone deliveries, considering variables like weather conditions and payload limitations.
- Educational Influence: Our findings are poised to enrich logistics and supply chain management education, offering new case studies and data sets that reflect the complexities of integrating drone technology into healthcare logistics. This is expected to prepare students more effectively for the evolving challenges in the field.
- Cross-disciplinary Impact: While primarily beneficial to logistics and supply chain management, the project's outcomes are also expected to influence adjacent fields such as healthcare management, public policy, and drone technology. This could foster a more integrated approach to solving healthcare delivery problems, encouraging innovation across disciplines.

Dr. Encarnacion believes that an 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.

Dr. Hupman feels that the models developed within this research project will contribute to the base of knowledge in the field of operations research. This field is primarily concerned with improving processes and improving decision making for increased operational effectiveness. The issue of timing is an important one when operating a large system, particularly as system performance can change over time. This project will improve the evaluation of predictive models by better identifying the point in time at which a decision should be made based on the available decision alternatives and the quality of the predictions at that time.

Dr. Li feels that the game-decision-theoretic models and algorithms developed in this project is an innovative technical approach to handle a distributed manufacturing system with the needs of both decentralized autonomous decision-making and centralized coordination decision-making. The outcomes of this project are expected to be published in quality academic journals in Transportation, Supply Chain and/or Operations Management. They are also expected to provide a data-driven decision-support tool for practitioners to better design and operate a distributed manufacturing system.

Further, Dr. Li's podcast with the Inbound Logistics published on March 18, 2024, has increased awareness of the challenges and opportunities of modern transportation systems in a connected economy. It had more than 500 downloads two weeks after its release.

What is the impact on transportation workforce development?
MATC's research and education 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.

MATC research being conducted by Dr. Abigail Cochran at the University of Nebraska-Lincoln will provide opportunities to engage students in transportation research by supporting a Graduate Research Assistantship (GRA) position as well as hourly student work. In this way, the project will train and encourage students to participate in interprofessional collaborations with planners, engineers, and medical professionals to promote transportation equity and safety.

MATC research being conducted by Dr. James Campbell at the University of Missouri – St. Louis has involved (and funded) one master's student who has received considerable exposure to the role of transportation in rural healthcare. This experience enhances their understanding and skills in integrating transportation solutions with healthcare delivery, preparing them for advanced roles in transportation research and application. Through this practical involvement, the project also contributes to broader educational and professional opportunities in transportation and related disciplines, enriching the field with fresh perspectives and expertise.

MATC research being conducted by Dr. Andrea Hupman at the University of Missouri – St. Louis has contributed to the training of a graduate student from underrepresented groups (female, racial minority), increasing her research skills and knowledge, and improving her access to potential future career paths in transportation research and related professions.

6. CHANGES/PROBLEMS

Due to the lateness of the award, recruitment of graduate research assistants was delayed until January 2024.

7. SPECIAL REPORTING REQUIREMENTS

Nothing to report.