


<b>Federal Agency/Organization</b>	U.S. Department of Transportation
<b>Federal Grant Number</b>	Grant No: 69A3551747120
<b>Project Title</b>	Freight Mobility Research Institute (FMRI)
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<b>Submission Date</b>	04/30/2022
<b>DUNS/EIN Number</b>	004147534/ 65-0385507
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<b>Project/Grant Period (start – end)</b>	11/30/2016 – 9/30/2022
<b>Reporting Period End Date</b>	9/30/2021 – 3/31/2022
<b>Report Term or Frequency (e.g. annual, semi-annual, quarterly)</b>	Semi-Annual report for FMRI – UTC. This report covers the period from September 30, 2021 to March 31, 2022, per Exhibit B, Grant Deliverables and Requirements for UTC Grants (November 2016)
<b>Signature of Submitting Official</b>	

## Accomplishments

### What are the major goals of the program?

The Freight Mobility Research Institute (FMRI) has been promoting strategic transportation policies, investment, and decisions that has brought lasting and equitable economic benefits to the U.S. and its citizens. The center's mission is to continually address critical issues affecting the planning, design, operation, and safety of the nation's intermodal freight transportation and logistics system. Our consortium of universities, together with partnerships with state transportation agencies, metropolitan planning organizations (MPOs), and industry partners, forms a comprehensive network. Efficient supply chain and safe freight movements is inextricably linked to the economic vitality of a local area, state, region, and beyond. In consultation with state agencies and local stakeholders, as well as USDOT's strategic priorities, as expressed in the "FAST Act Improving Mobility of People and Goods priority" and the known exclusive topic areas established by the Secretary of Transportation, we have been focusing and will continue to focus on the research and improve freight mobility and improve supply chain efficiency. The focus will dive into ***improvement of freight transportation through information technology, freight modeling and operations, intermodal logistics, as well as freight and supply chain sustainability and resilience***. This intended research and development will help promote:

- Smart transportation
- Improvement on multimodal connections, system integration, and security
- Data modeling and analytical tools to optimize freight movements and improve transportation efficiency and resilience

It will also help advance regional planning and setting of transportation priorities that deliver higher practice, economic growth, and enhance productivity.

### ***Please see below for essential center activities:***

**Advanced & Applied Research Improving Freight Mobility:** FMRI is well-poised to address a variety of issues directly applicable to the USDOT strategic goal of economic competitiveness. In consultation with our respective state DOTs and metropolitan planning organizations, as well as USDOT strategic priorities, our operations focus on improving freight fluidity, and mobility in four major research areas:

- *Information Technology*
- *Freight Network Modeling and Operations*
- *Intermodal Logistics*
- *Freight and Supply Chain Sustainability and Resilience*

Our aim is to address state, regional and national significant transportation issues pertinent to economic competitiveness to improve supply chain, transportation operations, and provide practice-ready solutions. We have assembled top experts on supply chain and logistics, freight transportation and resilience, network modeling, sustainability, and Intelligent Transportation Systems (ITS) from consortium institutions and collaborative partners from academia and industry. These experts represent leading universities across the nation with deep connections to local, state, and regional communities. The Freight Mobility Research Institute (FMRI) is also continue to aim to promote strategic transportation policies, investment, and decisions that will bring lasting and equitable economic benefits to the U.S. and its citizens. The additional year of the grant will help expand above and beyond advance and applied research across the center and consortium members. With new projects to look into additional research relate to economic growth, transportation equity and equity to promote improvement of freight mobility through information technology, freight modeling and operational intermodal logistics, as well as freight and supply chain sustainability and resilience. The new research projects by the center will help promote: Smart cities, and Smart transportation on multimodal connections, system integration, equity, and analytical tools to optimize freight movements. In addition, during the pandemic, the center had the opportunity focusing and make progress on transportation equity and Artificial Intelligence as promising tool to improve transportation safety and innovation. This will promote collaboration between the center and agencies that will improve transport efficiency, first- and last- mile efficiencies, sustainability, traffic mitigation, freight transportation resilience, equity, and development of tools and procedures to ensure interoperability today and in the future.

**Education, Workforce Development, Technology Transfer, & Diversity:** FMRI's educational goal is to foster and training to produce the next generation of academic scholars, professionals, and skilled workers. The consortium is committed to providing high-quality transportation education and workforce development programs for a broad and diverse audience. The center's efforts will support the development of a critical transportation knowledge base and a transportation logistics workforce that is prepared to design, deploy, operate, and maintain the complex transportation systems of the future.

FMRI's effort towards educational K-12 initiatives include the following:

- Increased minority focus of students' participation in transportation education and outreach.
- Workforce development and increased minorities participation in transportation field.
- Educated High School teachers as well as students in logistics and supply chain management.
- Developed virtual Summer camps with a hand-on immersive learning experience.
- Conduct a comprehensive workforce development program.

### **Purpose of additional year funding: FY 2022 – FY2023**

The Freight Mobility Research Institute (FMRI) will continue to aim to promote strategic transportation policies, investment, and decisions that will bring lasting and equitable economic benefits to the U.S. and its citizens. The center's mission will continue to proceed to address critical issues affecting the planning, design, operation, and efficiency of the nation's intermodal freight transportation system. The additional year of the grant will help expand above and beyond advance and applied research across the center and the centers consortium partners. With new projects to look into additional research to promote improvement of freight mobility and equity through information technology, freight network modeling and operations, intermodal logistics, as well as freight and supply chain sustainability and resilience. This research will help promote: smart cities, Improvement on multimodal connections, system integration, security, data modeling, and analytical tools to optimize freight movements with respect to transportation equity.

### **Review on the life of the grant: FY2016 – FY2021**

The Freight Mobility Research Institute (FMRI) has successfully continued to promote advanced and applied research to improve freight mobility, education, workforce development, technology transfer, and diversity through its various research projects and collaboration with the Center's partners the last five years. Although the COVID-19 pandemic has caused disruptions to the technology transfer activities and dissemination of research findings, FMRI's researchers have continued to work on their research and educational projects as evidenced by progress reports and technical presentations. Also due to the pandemic, all in person educational activities and conferences had to be put on hold due through FY21 and FY22. Nevertheless, channels of communication and relationship building among consortium member has been a task that the center has been committed to and keeps improving on daily. Currently, the consortium members maintain a quality research and educational activities that impacts our society in the area of freight mobility and supply chain management. The numbers of students joining transportation workforce within the universities of our consortium members has increased since the pandemic and the center is hopeful that it will keep improving.

### **What has been accomplished under these goals?**

In the year five cycle, the center applied the procedures that have been established for inviting research and educational proposals. The center applied the conducted review process involving advisory board members and local stakeholders. This process was based on external peer review and advisory board members approval. The process that was implemented helped construct a functional way for the center's executive committee to approve peer review recommendations and provided funding for essential research. Research that successfully contributed to our strategic plan. The FMRI research program aims to generate a body of knowledge that makes a significant contribution to solving freight transportation problems and improve freight mobility, logistics and supply chain management. The fourth -year research projects are soon to be completed, results from available data have been recorded, tested and/or deployed by the engaged stakeholders. In addition, please find listed below a brief the fifth-

year cycle projects that have been awarded by the FMRI in Fall 2021. For final reports regarding the third-year – fourth year project projects, please explore the FMRI website, for center research activities and final reports.

### **Fifth Year Cycle Research Projects**

**FMRI Y5R1-21:** Modeling the adoption, distribution, and utilization of autonomous delivery robots and delivery lockers in the aftermath of the COVID-19 pandemic (PI: Dr. E. Kaisar, Florida Atlantic University, PI: Dr. M. Figliozi, Portland State University, Co-PI: Dr. M. Golias, University of Memphis, Co-PI: S. Mishra, University of Memphis)

**FMRI Y5R2-21:** Quantitative Evaluation of Truck Caravanning (PI: Dr. M. Golias, University of Memphis, Co-PI: S. Mishra, University of Memphis, Co-PI: J. Hourdos, University of Minnesota)

**FMRI Y5R3-21:** An Interactive Platform for Large Scale Truck Activity Detection and Analysis using Connected Vehicle Data – Phase 2 State (PI: Dr. E. Kaisar, Florida Atlantic University, Co-PI: Dr. P. Edara, University of Missouri)

**FMRI Y5R4-21:** Management of Supply Chain Disruption of Freight Network using Advanced Algorithms (PI: Dr. E. Kaisar, Florida Atlantic University)

**FMRI Y5R5-21:** Coordinated Intersection Control through Reinforcement Learning with Special Consideration of Freight Traffic (PI: B. Wang, Texas A&M University, Co-PI: Dr. Y. Zhang, Texas A&M University)

**FMRI Y5R6-21:** Coordination of Connected and Automated Trucks for Platooning Considering Turning Along an Arterial Corridor (PI: Dr. Y. Zhang, Texas A&M University, Co-PI: B. Wang, Texas A&M University)

### **Six Year Research Projects**

For the Six-year cycle (June 1<sup>st</sup>, 2021 – May 31<sup>st</sup>, 2022) the center developed in Spring 2022 a Request for Proposals (RFP) for research projects. The center developed the RFP after various discussions with local stakeholders and advisory board members. These proposals were sent for full external peer review process. A peer review in which each project will have at minimum of three external reviewers. Each project will be revised based on the review comments from each peer reviewer. Once revised by the PI, and resubmit it for second and/or third review from the external reviewers, these projects will be reviewed by the Advisory Board members and changed accordingly, as needed. The selected projects will be approved by the FMRI executive committee were executed by May 31<sup>st</sup>, 2022. For further details, you may find the overview of these projects listed on the FMRI website in Summer 2022. The proposals that passed the centers screening process and sent it for review are as follows:

**FMRI Y6R1-22:** Concept of Operations for Heavy Truck Operations in/Around the Ports to Improve Efficiency and Support Climate Solutions (PI: E. Kaisar, Florida Atlantic University)

**FMRI Y6R2-22:** Modeling Household E-commerce Delivery Rates and Assessing their Equity and Freight Travel Impacts (PI: S. Mishra, University of Memphis, Co-PI: M. Golias, University of Memphis, Co-PI: E. Kaisar, Florida Atlantic University, Co-PI: M. Figliozi, Portland State University)

**FMRI Y6R3-22:** Data Analytics and Support Tools for Inland Waterways (PI: M. Golias, University of Memphis, Co-PI: S. Mishra, University of Memphis, Co-PI: J. Hourdos, University of Minnesota, Co-PI: E. Kaisar, Florida Atlantic University)

**FMRI Y6R4-22:** Sequential Synchronization Control Scheme for Freeway Truck Platooning Formation (PI: Lili Du, University of Florida, Co-PI: S. Washburn, University of Florida)

**FMRI Y6R5-22:** Control of Automated Trucks Considering Stochastic Behaviors of Human-driven Vehicles in Mixed Traffic (PI: Dr. Y. Zhang, Texas A&M University, Co-PI: B. Wang, Texas A&M University)

**FMRI Y6R6-22:** Developing a New Algorithm for Network Signal Control Considering Truck Traffic (PI: B. Wang, Texas A&M University, Co-PI: Dr. Y. Zhang, Texas A&M University)

The FMRI executive committee is looking forward to approve for the Six-year cycle two major collaborative projects between three consortium partners that brings partnerships that take advantage of the different skills expertise and resources. Collaboration between our partners was well established in many research and educational projects, but the research and innovation proved their value during the life of the grant. Our executive committee believes that the collaboration is a driving process, and this research year the center is focusing in e-commerce and transportation equity. Our researchers working with advance algorithms, machine learning and artificial intelligence to improve mobility, e-commerce, transportation equity and provide tools for transportation agencies. The center and its consortium members believe that the apply and advance research will serve to promote and expand its mission to continue to proceed to address critical issues affecting the planning, design, operation, and safety of the nation's

intermodal freight transportation system. Collaborative projects are really important for the center strategic plans because they promote communication and team work across the consortium partners and the stakeholders. The two collaborative project descriptions for the year six cycle projects that has been proposed from the partners are as follows:

**FMRI Y6R2-22: Modeling Household E-commerce Delivery Rates and Assessing their Equity and Freight Travel Impacts** (PI: S. Mishra, University of Memphis, Co-PI: M. Golias, University of Memphis, Co-PI: E. Kaisar, Florida Atlantic University, Co-PI: M. Figliozi, Portland State University)

Over the last five years, e-commerce induced last-mile delivery has increased unprecedentedly, primarily due to the COVID-19 pandemic. For instance, in the US, the proportion of packages in total postal volume increased to 70% from 5% during the pandemic. However, the same pattern is expected to continue post-pandemic. As per the most recent Quarterly Retail E-Commerce Sales Report, e-commerce sales increased by 7% in 2021 Q3 compared to 2020 Q3. Americans prefer faster deliveries (same or next-day) as online shoppers' share of same-day delivery increased to 36% from 24% and 26% from 14% from web-only and store-based merchants, respectively (Statista, 2022). The rapid increase in package delivery volume in the near and long-term future raises concerns about exceeding the capacity of delivery networks at different stages of the supply chains. The last mile of delivery is an area of increasing concern for stakeholders involved in freight and logistics. Such stakeholders plan to utilize emerging technologies for last-mile delivery to meet the growing demand and delivery constraints. In this direction, autonomous technologies like robots and drones can play an important role in efficient package deliveries. Increase in e-commerce sales calls for a need to quantify the package delivery demand at a disaggregated level (households, census blocks). The data on goods delivery at disaggregated geographic levels is either non-existent or confidential. Hence, government agencies struggle to estimate potential future demand as well as how these growths may vehicle miles traveled and congestion not only on local streets and arterials but also at the curb. In the private sector, existing or new firms must conduct their own demand estimations before proposing an efficient and cost-effective delivery system. Therefore, the key objective of this proposal focuses on quantifying the disaggregated demand of delivery packages and exploring the potential of autonomous delivery robots in meeting these demands. In addition, two additional key objectives (aligned with FMRI advisory council priority research topics) include the estimation of household deliveries freight vehicle miles travelled on local routes as well as the identification of potential accessibility and equity issues associated to e-commerce household deliveries in urban areas.

**FMRI Y6R3-22: Data Analytics and Support Tools for Inland Waterways** (PI: M. Golias, University of Memphis, Co-PI: S. Mishra, University of Memphis, Co-PI: J. Hourdos, University of Minnesota, Co-PI: E. Kaisar, Florida Atlantic University)

The United States inland waterways system (also known as the backbone of the transportation logistic system) directly connects 28 states and plays a crucial role in our nation's competitiveness and economic growth supporting efficient, safe, and sustainable transport for multiple commodities including agriculture, chemicals, and building materials. The cost to transport commodities on the inland waterways is roughly half the cost to ship by rail. Estimated transportation cost savings, according to the United States Army Corps of Engineers (USACE) and the U.S. Chamber of Commerce range from \$7 billion (bn) to \$9 bn annually. By 2045, it is expected that the U.S. Inland Waterways System (IWS) will contribute (in)directly \$121-bn in economic output, 450 thousand jobs, and \$62.3-bn in GDP. Furthermore, inland waterway transportation provides effective means of expanding capacity with less environmental and funding issues compared to other modes of transportation. Unfortunately, lagging infrastructure maintenance and improvement have resulted in frequent delays, with the percentage of delayed vessels increasing from 35% in 2010 to 53% in 2017. A closer look at our current IWS conditions, connectivity, operations, and redundancies is warranted. As a country we need the tools and data to identify areas to invest (capital and operational) to take full advantage of the available capacity, increase efficiency, safety, and resiliency, and reduce externalities from freight movements. The objective of this research is to develop a knowledge bank on best practices on inland waterway programs, web-based and desktop Data Analytics and Decision Support (DADS) tools that analyze and synthesize the available data on IWS and its assets (e.g., ports, terminals, locks, etc.) into a set of performance stressors, metrics, and indices. Achieving these objectives will allow State DOTs and other public



agencies (e.g., USACE) to: 1) Perform in-house analysis of IWS commodity flows through its ports, terminals, and other intermodal facilities, 2) Identify stressors of IWS and its assets, and 3) Identify and prioritize investments to accommodate current and projected growth of critical commodities favorable for waterway transport and modal shift (from truck/rail)

### **Education and Workforce Development:**

As we have discussed in previous reports, FMRI's educational goal is to foster education and training to contribute to the development of the future transportation workforce. There are numerous educational activities such as online graduate courses, and the FMRI certificate program, a program that offers transportation specialization courses in undergraduate and graduate level. Our approach is multi-disciplinary, and under this grant we are developing a series of education activities, from K-12 to graduate level. These programs were built on the education and training programs available at the consortium universities. For our fourth-year educational projects that supposed to offered in Summer 2021, because of the pandemic, the center did not offer in person any educational activity but for the fifth year the center is involved in many educational activities and developed educational projects that were completed and/or are in progress at our consortium locations: Hampton University, University of Florida, University of Memphis and Florida Atlantic University. These projects are going to help develop promote technology transfer with in-person and virtual camps and expand curriculum in order to strengthen the intermodal transportation skills of faculty and students while helping to meet the need for professionals, particularly minorities and women, qualified and interested in transportation careers. These projects will help re-vamp the activities across the center, activities that were on hold due to the pandemic.

### **Virtual Education Camp (PI: S. Maheshwari, Hampton University; Co-PIs: S. Washburn, University of Florida; and Co-PI: Dr. E. Kaiser, Florida Atlantic University)**

A summer transportation virtual education camp is proposed for high school students. Camp activities will involve project-based learning at home. Project material will be delivered to the participating students. Every activity will be divided into two parts. Part 1 will be instructions and part 2 will be hands-on activity. Each project activity will be explained with some scientific idea. After that participants will then carry out a project which could be computer simulation, hands-on modeling, or combination of two. Participants will make a virtual presentation of their activity at the end. The camp is planned from June 21 – July 2, 2021, with an extension on Summer 2022. Target audience will be rising 9,10, 11 or 12 graders. Camp will be open to 30-35 participants. Three university partners are involved in this educational activity and we hope that we will engage more consortium partners and schools from different states than Florida and Virginia.

### **Transportation Education and Workforce Development Project (PI: S. Maheshwari, Hampton University)**

The U.S., logistics and transportation industry had accounted for approximately \$1.3 trillion annual gross domestic product (GDP), about 8.5% of overall GDP in 2011. Furthermore, transportation network and systems are getting highly sophisticated. Analysts predict that up to 50% of the current transportation workforce will retire in the next decade. All of these factors are creating a need of highly trained transportation professionals. To meet this challenge, Hampton University, as a member of the Freight Transportation Research Institute is proposing an education and workforce development project by integrating existing transportation curriculum. The objective of the Transportation Education and Workforce Development Project is to strengthen the intermodal transportation skills of faculty and students while helping to meet the need for professionals, particularly minorities and women, qualified and interested in transportation careers.

Continuing the pursuit of the Transportation and Workforce Development Project, the FMRI has accomplished the items listed below:

Major educational and outreach activities:

1. Webinars related to Transportation Management and Logistics from the FMRI Consortium Partners
2. High School Teachers Virtual Workshop on Transportation Planning and Logistics
3. K-12 Student Transportation Essay Competition

4. Expand scholarship opportunities for minority students
5. Mentoring K-12 Students
6. Participating in K-12, and State Colleges Engineering week, Engineering judges

#### Specific Centers Educational Objectives:

1. Minority student education—2, 4, 5, and 6 above
2. Increase minority participation—1 through 6 above
3. Increase K-12 participation –1 through 6 above

#### Significant results:

1. Minority student education—Mentoring, Virtual Lectures, Webinars
2. Increase minority participation and interest in the field—Internship, scholarships
3. Increase K-12 participation –Webinars

During this period, the center offered in the Fall 2021 hybrid the TTE 6651 Sustainable Public Transportation course that included an overview and analysis of concepts and designs for sustainable transportation in multimodal corridors. From both a global and local level, this interdisciplinary course explores public transportation and the issues with freight transportation on multimodal corridors. The Sustainable Transportation course also addresses economic and environmental factors with a strong focus on equity. This course is an in-depth, hands-on complete streets and transportation network design projects, conducted in partnership with the consortium members and local stakeholders. In the Spring 2022, the TTE 6501 Transportation Systems Analysis and TTE 4005 Transportation Planning and Logistics courses. These courses were designed to model transportation network and freight movements using engineering software's to assist in development of efficient transportation distribution facilities. Also, this course focused on optimization software's that will help the students to utilize skills in operation research and transportation logistics applications. Mr. Charles Edwards, our FMRI Advisory member oversee the NCHRP problem statement as part of the graduate course assignment. Another milestone the center has been working is the summer camps in Transportation, Logistics and Supply Chain Management as part of the collaborative center activities for K-12 students to expand their knowledge on technical skills of transportation engineering and Logistics. Also, we had the first students registered in our certificate program that has a strong connection with the logistics industry of Southeast Florida.

As part of the FMRI/STEM education initiative the center is planning to conduct transportation education camp for K-12 students in collaboration with consortium partners. Camp activities involved project-based learning at home. Every activity was divided into two parts, part 1: instructions and part 2: hands-on activity. In addition, the center is planning to have a summer camp in collaboration with University of Memphis and Oak Ridge National Laboratory focusing on transportation data, simulation, and route choice. The FMRI center on the educational summer camps activities collaborated with the FAU College of Engineering and Computer Science at FAU in order to execute this initiative. The center also will receive help and advice from Dr. Sharad K Maheshwari, Professor in the Department of Business Administration at Hampton University, and FMRI Associate Director of Education. The hands-on activities for the K-12 students will be on Transportation Planning Operation and Logistics. In addition, Hampton University is proposing for this year cycle an education and workforce development project by integrating existing transportation curriculum. The objective of the Transportation Education and Workforce Development Project is to strengthen the intermodal transportation skills of faculty and students while helping to meet the need for professionals, particularly minorities and women, qualified and interested in transportation careers.

#### **FAU Institute of Transportation Engineers (ITE) and Women Transportation in Society (WTS) Student Chapters Webinar series at Florida Atlantic University**

The FMRI aims to contribute to the life-long learning of transportation engineering. Along with classroom experiences, educational initiatives sponsored by the FMRI in different campuses would provide opportunities to students to become familiar with numerous fields of transportation engineering and gain practical experience and knowledge. The center is a proud affiliate of the Institute of Transportation Engineering (ITE), and the Advancing Women in transportation Society (WTS) at FAU, and other ITE student chapters from the consortium members. The

FAU ITE and WTS Student Chapters are actively collaborating with the FMRI to organize a virtual educational lecture series as part of the center's technology transfer program. Below are the listed lectures from this reporting period:

**October 14, 2021** - Ms. Thuha Nguyen, President, via planning, Inc. "What to Expect in your First Few Years as a Transportation Professional".

**November 10, 2021** - Dr. Dimitrios Dimitriou, Associate Professor, Democritus University of Thrace, Greece. "Measuring Performance and Economic Impact in Transportation".

**November 19, 2021** - Dr. Zahra Pourabdollahi, Transportation Development Engineer, RS&H. "The Promises and Perils of Data for Travel-Activity Behavior Analysis".

**December 15, 2021** - Dr. Zhao Lei, Associate Professor, Tsinghua University, China. "Dynamic Intra-Cell Repositioning in Free-Floating Bike Sharing Systems".

**February 9, 2022** - Mr. Charles H.W. Edwards, Professor of the Practice, UNC-Chapel Hill. "Where is my Shipment and when will I Get it?".

**February 23, 2022** - Dr. Ziyuan Pu, Assistant Professor, Monash University, Australia. "Novel Traffic Sensing Methods and Technologies for Non-Motorized Traffic Monitoring under Challenging Scenarios".

**March 2, 2022** - Dr. Lóránt Tavasszy, Professor, Delft University of Technology, The Netherlands. "Logistics Innovations and Freight Modeling: A Future-Oriented Research Agenda".

### **7th Annual UTC Conference for the Southeastern Region at Boca Raton, FL, March 24-25, 2022**

The Freight Mobility Research Institute (FMRI) at Florida Atlantic University was glad to sponsor the 7th Annual University Transportation Center Conference for the Southeastern Region at Boca Raton, FL, on March 24-25, 2022. The 7th Annual UTC Conference brought together transportation professionals, faculty, and students to disseminate the most recent transportation research innovations and encourage collaboration on future projects. In addition, the conference intends to bring together academic, public, and private sectors in order to foster collaborative activities. The FMRI was delighted with the participation of faculty and students and would like to thank the conference planning committee from Clemson University, University of Florida, Florida State University, Florida International University, and North Carolina A&T State University for their efforts. We would also like to thank our co-sponsors, which include FIU/ABC/UTC Clemson University, NCA&T, The Citadel, USF/NICR, UF/STRIDE, FDOT, AECOM, JACOBS, and WGI.

The event's theme was **Emerging Technologies towards Smart and Sustainable Cities: The future of Transportation and Logistics**. The conference featured keynote speakers from state and federal agencies, a state DOT panel, workshops, ITE/WTS student chapter sessions, exhibits, and research demonstrations. We are absolutely ecstatic that renowned instructors and students from 29 universities attended the conference, as well as the fact that nearly 280 people registered for the event. On the first day of the conference, March 24, the director of FMRI, Professor Dr. Evangelos Kaisar, started the conference with a speech, followed by the UTC Program address, Cesar Singh, Director, University Grant Programs, USDOT.

Following that, the technical presentations of the various Sessions were held. On the first day of the conference, a total of three sessions were held, each conducted by a different moderator. The first session began with four segments on Freight Logistics, followed by Connected and Autonomous Vehicles, Transportation Safety, and Smart Technologies. Session 2 then began with presentations on Connected and Autonomous Vehicles, Smart Infrastructure, Transportation Data, and Modeling. The Connected and Autonomous Vehicles session featured presentations on coordination of Connected and Automated Vehicles (CAV) for truck platooning allowing turning along an arterial corridor, platoon formation strategy with CAVs, and the effect of CAV on freeway operations, among other topics.

Session 3 included a Workforce Development Workshop with panelist from State Dots, and the discussion focused on how engineering education in classrooms promotes early exposure of young students to the engineering and logistics fields, provides industry and academic internships, and promotes interest in transportation engineering as a potential career choice in the future. Also, the session concluded with presentations about Supply Chain Resilience, ITE & WTS Student Chapters Workshop which included a total of three presentations about Overview of a PD&E



Study along a segment of I-95 from Miami-Dade/Broward Co. Line to N of Hollywood Blvd in Florida, followed by Automated Curb Management system and ITE & WTS Student Chapters Workshop.

Following the afternoon break, there were a student poster exhibit and transportation demonstrations. A total of 22 posters were presented by students from various universities for the poster presentations and the transportation demonstrations were held in Florida Atlantic University at Boca Raton campus. The demonstrations were attended by four different groups. One of the demonstrations was about connected automated vehicles presented by the department of Civil, Environmental, and Geomatics Engineering faculty and his research group. They collected data using a level 2 Automated Car. There was an OBD || data logger, which was used to collect speed data and then calculate spacing, headway, density, and flow, and a GPS unit, which was used to collect latitude and longitude data and then convert it to spacing and headway. Another group of faculty and students from Clemson University demonstrated Transportation Cyber-Physical-Social Systems applications such as pedestrian at signalized crosswalk warning, resilience against adversarial attacks, and virtual traffic light. This application presented a vision-based pedestrian warning system that can detect pedestrians at a signalized crosswalk using real-time video data obtained from a traffic camera, as well as how to make a hybrid quantum-classical neural network model resilient against adversarial attacks on the image classification model. Another demonstration was about drones and smart deliveries by FAU researchers. USF faculty and researchers demonstrated Connected Autonomous Vehicle capabilities using their equipment. The second day of the conference began with Dr. Evangelos Kaisar FMRI director, presenting student awards and their scholarships for the poster presentations. We were delighted to announce the first, second, and third place student awards for the poster session at the 7th Annual UTC Conference for the Southeastern Region

First Place was awarded with a scholarship of \$500 and the paper was:

**Analyzing the Benefits of Connected Vehicle Applications During Incidents on Freeways and Diversion Strategies Implementation** presented by Francisca Kasubi, Florida International University, Thobias Sando, University of North Florida, Priyanka Alluri, Florida International University.

Second Place was awarded with a scholarship of \$250 and the paper was:

**Preferences Towards Augmented Reality Technologies for Pedestrian Navigation** presented by Victoria Alejandra Diaz, Rodrigo-Mesa-Arango, Florida Institute of Technology.

Third Place was awarded with a scholarship of \$100, and the paper was:

**Freight Disaggregation Tool for Commodity Movement in Tennessee** presented by Mitra Esfandarani, Mihalios Golias, Sabyasachee Mishra, University of Memphis

The main program then began with the Keynote Address given by Laura Chace, President and CEO, of Intelligent Transportation Society of America, in which she discussed making transportation safer, smarter and greener using the ITS technology. And after that the technical presentations Session 4 started followed by Session 5. Session 4 featured presentations on Sustainable Transportation, Smart Infrastructure, and Smart Cities, as well as a workshop on Automated Connected Electric, and Shared Vehicles (ACES). The goals of this workshop were to create an initial inventory of past, current, and planned Automated, Connected, Electric, and Shared (ACES) initiatives in Florida; to provide an educational/technology transfer forum and graphical interface to share data, findings, and best practices among transportation agencies, the private sector, and colleges and universities; to leverage expertise and funding across multiple jurisdictions and sectors, and to encourage a culture of innovation.

Finally, in Session 5, there were presentations on Transportation Operations, Transportation Safety, and Multimodal Transportation, followed by a workshop on Developing a Systematic Method for Identifying, Ranking, Examining, and Mitigating Freeway Bottlenecks. This workshop presented a systematic data analytics-based approach to evaluating freeway performance, locating and ranking bottlenecks, and examining and mitigating bottlenecks. It takes into account the intensity and dependability dimensions of traffic congestion. A case study based on vehicle probe data collected on four interstate freeways in Mecklenburg County, North Carolina, exemplifies this method. Despite the fact that two freeway segments have nearly identical reliability values, their intensity levels can differ significantly. The findings can help decision-makers and transportation professionals systematically assess traffic

conditions along with freeway segments, as well as objectively locate and rank freeway bottlenecks, mitigation strategies, and more efficient funding allocation.

After the conference, Professors and students from different Universities in the region became very interested in visiting and exploring the research laboratories of Florida Atlantic University, as well as visiting the FMRI Facilities. And Faculties and students were ecstatic to be on FAU campus and astonished by the FMRI activities.

Recent efforts aim to transform urban environments into smart and sustainable cities in which data collection and analysis are used efficiently to improve safety, optimize transportation networks, increase freight mobility, and resilience, and save resources. Thus, 7<sup>th</sup> UTC Conference for the Southeastern Region helped to provide an opportunity to share the most recent transportation research innovations while also focusing on how emerging technologies play a role in the smart city concept and how to further its development.

FMRI held its Fall Advisory Board meeting in December 2021 via video conference. The meeting allowed FMRI provide updates on the center activities and discussed about the six-year RFP. The annual meeting held in Boca Raton, FL on March 23<sup>rd</sup> 2022 in hybrid format in conjunction with the 7<sup>th</sup> UTC Conference for the Southeastern region. The meeting was well attended by FAU officials and centers stakeholders. Also, the meeting allowed FMRI to provide updates on its research, education and outreach activities. Innovate research topics and workforce development activities were presented to the board. Additionally, the meeting allowed for discourse between the board and the center students, which will inform future center student activities.

### How have the results been disseminated?

The center project reports are published to the FMRI website, uploaded to the government database, distributed through the FMRI newsletters and also presented at the FMRI webinar series, which are open to the public and the stakeholders. Preliminary results are often presented at peer review conferences (due to COVID-19 was virtual) and various virtual stakeholders' meetings. From January 2022, the center participating in person activities. All research projects are expected to result in refereed journal publications. In addition, dissemination is conducted via new graduate courses and developed certificate programs, internship assistance, employment opportunities, professional development virtual workshops, webinars, and at our center website. Furthermore, the FMRI webinars serve as a forum for faculty, industry, and graduate students to present their research findings. In academic year 2021-2022 we are planning to re-established the FMRI lecture series in person and the Brown bags meeting with stakeholders at the FMRI facilities. Dr. Bill Eisele, head of the mobility division at TTI and a Chair of the TRB Urban Freight Transportation Committee is planning to visit the center facilities in Boca Raton, FL, and he is going to give a lecture to the students, faculty and industry practitioners about urban freight challenges and smart solutions. Webinars take place during Fall and Spring semesters, open to stakeholders, and are well-attended. Facebook, Twitter, and LinkedIn have been used to share our news, events, workshops, and other content. The center is using social media to drive more traffic to the website.

Other ways in which results have been disseminated is through the preparation and execution of conferences that have provided opportunities for students to share and elaborate on their research and innovations. In regards to conferences, the FMRI organized the "Seventh Annual UTC Conference for the Southeastern Region" on March 24-25, 2022 in Boca Raton, Florida. This annual regional conference was established in 2013 by a consortium of University Transportation Centers (UTCs) to bring together transportation professionals from both the private and public sectors, faculty, and students from all over the Southeastern region. The theme of the "Seventh Annual Regional UTC Conference" was on Emerging Technologies towards Smart and Sustainable Cities: The Future of Transportation and Logistics. This event was an opportunity for people from academia, agencies and industry to convey the most recent research innovation on how technologies play a role on the smart city concept. Originally, the conference was scheduled to take place on March 2020, but in view of the great global concerns in regards to the pandemic the conference was postponed for Spring 2022. The conference was registration free and open to faculty, staff, students, practitioners, and public agencies in the Southeast region. We planned for sixteen different sessions consist of 70+ podium presentations who shared with audience of 250 participants and more about their

research findings. The conference was also incentivized students by promoting awards for the best three poster presentations based on research quality and student presentation skills. In addition, the FMRI continue to publish monthly newsletter with a focus on the presentation of research findings, educational activities, and accomplished center milestones. Through peer review conferences, the center was participated in virtual and in-person workshops and co-sponsorship throughout this period. The purpose of these workshops was to disseminate our center research findings and to encourage collaboration between different agencies and institutions.

### What do you plan to do during the next reporting period to accomplish the goals?

The FMRI six-year projects are in progress and research findings will be disseminated as needed. The FMRI year five-year research cycle were awarded back in Fall 2021, and the projects will resume in May/Summer 2022. Our FMRI executive committees has quarterly conference calls and virtual meetings to oversee the center's operations and activities and many times monthly conference call with FMRI Director. The center's Advisory Board oversaw the centers activities and conducted quarterly conference calls with the executive committee to discuss the progress of the center activities. In order to plan ahead into the sixth-year cycle, the Advisory Board discussed the sixth-year problem statements in the Advisory Board meeting that took place virtually in December 2021. In the next quarterly conference call late spring, the advisory board will review the FMRI proposals that passed the peer review and will send their recommendations to our executive committee for the final approval.

In addition, the center will continue their relationship with local stakeholders and State DOTs in regards to cost-share projects and other collaborative efforts in order to successfully deploy technology transfer to the community. The center will also explore collaborative opportunities with industry in order to develop needed freight and logistics related research. The FMRI will develop in-person community educational and technology transfer efforts to advance the knowledge on transportation supply chain management, logistics, and transportation operations. The center will focus especially how to rebuild our supply chains as a result of the pandemic, and bring down costs for the American people as part of our center goal.

For the educational initiative, the FMRI plans are to:

1. Implement the approved Five-year projects, --More K-12 involvement;
  - a. An additional virtual and in person workshop focusing in smart transportation and logistics for K-12 teachers;
  - b. In person workshops on preventing supply chain disruption during pandemic crisis, focusing in the local industry;
  - c. Virtual and in person Essay Competitions;
  - d. in person Transportation & Logistics Science Fair;
  - e. Virtual and in person Logistics & Transportation Summer Camps & Invite guest speakers from the Industry;
  - f. Virtual and in person High School Presentations and Volunteer Participation as Judges in STEM competition;
  - g. Internship for minority students with local stakeholders, and the center;
  - h. Hybrid courses in new technologies and transportation management for Summer 2022
  - i. Transportation Curriculum discussion
2. Begin the fifth -year RFP educational projects, to build on the continuing educational project;
3. Continue dissemination of research results via our website, professional presentations to stakeholders, technical workshops and our seminar and webinar series.

## Participants & Collaborating Organizations

### What organizations have been involved as partners?

The FMRI works with multiple partners from academia, industry and state agencies on main projects, as well as cost-share projects to help further economic development. The center has developed multiple interdisciplinary research all these years. Please find below the collaborative projects between the consortium members and collaborators for the four and fifth year that is in progress and the proposed projects of the six-year cycle.

**FMRI Y4R1-20: Evaluating the Adoption and Impact of Autonomous Delivery Modern Technologies** (PI: Sr. S. Mishra, University of Memphis, Co-PI: Dr. E. Kaisar, Florida Atlantic University, and Co-PI: Dr. M. Figliozi, Portland State University)

**FMRI Y4R2-20: Evaluating Dynamic Curb Management Strategies in Urban Environment** (PI: Dr. E. Kaisar, Florida Atlantic University, and Co-PI: Dr. M. Figliozi, Portland State University)

**FMRI Y4R3-20: Determination of Position and Operation Analysis of Emergency Freight Parking in Florida State** (PI: Dr. E. Kaisar, Florida Atlantic University, and Co-PI: Dr. E. Akcali, University of Florida)

**FMRI Y4R4-20: Optimal Refueling Gas Station Locations in Post-Evacuation Conditions** (PI: Dr. E. Kaisar, Florida Atlantic University, Co-PI: Dr. M. Golias, University of Memphis, and Co-PI: Dr. J. Hourdos, University of Minnesota)

**FMRI Y5R1-21: Modeling the Adoption, Distribution, and Utilization of Autonomous Delivery Robots and Delivery Lockers in the Aftermath of the COVID-19 Pandemic** (PI: Dr. E. Kaisar, Florida Atlantic University, Co-PI: Dr. M. Figliozi, Portland State University, Co-PI: Sr. S. Mishra, University of Memphis, and Co-PI: Dr. M. Golias, University of Memphis)

**FMRI Y5R2-21: Truck Transportation, Truck Platooning, Caravanning, Mathematical Modeling, Optimization, Simulation** (PI: Dr. M. Golias, University of Memphis, Co-PI: Sr. S. Mishra, University of Memphis, and Co-PI: Dr. J. Hourdos, University of Minnesota)

**FMRI Y5R3-21: An Interactive Platform for Large Scale truck Activity Detecting and Analysis using Connected Vehicle Data-Phase 2** (PI: Dr. E. Kaisar, Florida Atlantic University, Co-PI Dr. P. Edara, University of Missouri)

**FMRI Y6R2-22: Modeling Household E-commerce Delivery Rates and Assessing their Equity and Freight Travel Impacts** (PI: S. Mishra, University of Memphis, Co-PI: M. Golias, University of Memphis, Co-PI: E. Kaisar, Florida Atlantic University, Co-PI: M. Figliozi, Portland State University)

**FMRI Y6R3-22: Data Analytics and Support Tools for Inland Waterways** (PI: M. Golias, University of Memphis, Co-PI: S. Mishra, University of Memphis, Co-PI: J. Hourdos, University of Minnesota, Co-PI: E. Kaisar, Florida Atlantic University)

In addition, the FMRI works closely with the various state agencies such as the Florida Department of Transportation, Tennessee Department of Transportation, Minnesota Department of Transportation and industry in a common internship program that offers students an exciting opportunity to work with professionals in real life projects. This is a great opportunity for our students to develop the necessary skills and techniques directly applicable to their professional development.

Education also plays a crucial role in collaborative efforts. Hampton University, the center's educational partner, works with multiple agencies, companies, and academia to develop and implement virtual workshops. These partners include Newport News School District, Hampton School District Logistics Academy member, Virginia Department of Transportation, and US Maritime Administration (MARAD). In addition, FAU and the University of Memphis works with local port authorities and logistics companies to develop student internships with local stakeholders. In addition, the FMRI works with State DOTs and other entities, including the Florida Department of Transportation, Minnesota Department of transportation, Portland Bureau of Transportation, Center for Urban Transportation Research at University of South Florida, Minnesota Department of Transportation, America Transportation Research Institute, and Tennessee Department of Transportation for their cost-share efforts towards freight mobility projects.

Florida Atlantic University is currently working with the Palm Beach Chamber of Commerce, and Florida Department of Transportation towards research collaboration, discussion of research gaps and contributions to the new Florida

Freight Mobility and Trade Plan. University of Memphis with the University of Tennessee, Knoxville, and American Transportation research institute are working to provide guidance to Tennessee Department of transportation on truck parking issues. In addition, Florida Atlantic University, University of Memphis and University of Minnesota collaborating with International Association of Maritime and Port Executives (IAMPE) a non-profit membership association dedicated to developing and maintaining professional standards in the maritime industry.

Regarding cost share projects, University of Minnesota is working with the Minnesota Department of Transportation on the following project:

- Minnesota Department of Transportation. "Identifying and Optimizing Electric Vehicle Corridor Charging Infrastructure for Medium and Heavy-Duty Trucks."
- Minnesota Department of Transportation. "Impact of Transit Ways on Travel on Parallel and Adjacent Roads and Park-and-ride Facilities."

### Have other collaborators or contacts been involved?

Department of Transportation is involved in the **FMRI Y4R7-20: Identifying and Optimizing Electric Vehicle Corridor Changing Infrastructure for Medium and Heavy-Duty Trucks**. (PI: Dr. J. Hourdos, University of Minnesota) as a major stakeholder. In addition, Florida Trucking Association is involved in the **FMRI Y4R3-20: Determination of Position and Operation Analysis of Emergency Freight Parking in Florida State**. (PI: Dr. E. Kaisar, Florida Atlantic University). Interactions with Florida Trucking Association and Florida department of Transportation have been helped developed stronger collaborative relationships between university researchers and industry to address important challenge to support freight truck operations.

### Outputs:

Outputs	Target	Progress
# of proposals/projects with collaborative efforts	6 collaborative proposals/projects	4 Projects in Year 4 3 Projects in Year 5 2 Projects in Year 6
# of website page views	2,500 page views	3,125 pages views
# of conference presentations	10 conference presentations	36 conference presentations
# of peer-reviewed papers	6 peer-reviewed papers	15 peer-reviewed journal papers 1 under review, in preparation

### Publications, conference papers, and presentations

#### Journal publications

1. Talebian, A., and Mishra, S. (2022). Unfolding the state of the adoption of connected autonomous trucks by the commercial fleet owner industry. *Transportation Research Part E: Logistics and Transportation Review*. Volume 158, February 2022, 102616.
2. Pani, A., Mishra, S., and Sahu, P. (2022). Developing Multi-Vehicle Freight Trip Generation Models Quantifying the Relationship between Logistics Outsourcing and Insourcing Decisions. *Transportation Research Part E: Logistics and Transportation Review*. Volume 159, March 2022, 102632.
3. Samani, A.\*, Mishra, S., and Dey, K. (2022). Assessing the Effect of Long-Automated Driving Operation, Repeated Take-Over Requests, and Driver Characteristics on Commercial Motor Vehicle Drivers Driving Behavior and Reaction Time in Highly Automated Vehicles. *Transportation Research Part F: Traffic Psychology and Behaviour*. Volume 84, January 2022, Pages 239-261.
4. Samani, A. R., Mishra, S., Lee, D. J., Golias, M. M., & Everett, J. (2022). A new approach to develop large-scale land-use models using publicly available data. *Environment and Planning B: Urban Analytics and City Science*, 2399808321999399.



5. Wang, Y., Mishra, S., Jin, Y., Wu, B., and Zou, Y. (2022). Integrated Travel Demand and Accessibility Model to Examine the Impact of New Infrastructures Using Travel Behavior Responses. *Journal of Transportation Engineering Part-A: Systems*. 148(1), 05021009.
6. Haque, K.\*, Mishra, S., and Golias, M. (2021). Multi-period transportation network investment decision making and policy implications using econometric framework. *Research in Transportation Economics*. Volume 89, November 2021, 101109.
7. Simpson, J. R.\*, & Mishra, S. (2021). Developing a methodology to predict the adoption rate of Connected Autonomous Trucks in transportation organizations using peer effects. *Research in Transportation Economics*, 90, 100866.
8. Figliozzi, M., & Unnikrishnan, A., Exploring the impact of socio-demographic characteristics, health concerns, and product type on home delivery rates and expenditures during a strict COVID-19 lockdown period: a case study from Portland, OR. *Transportation Research Part A: Policy and Practice*. (2021).
9. Liu, D., Deng, Z., Yan, P., Wang, Y., Kaisar, E. I., Physical Internet-enabled E-grocery Delivery Network: A Load-dependent Two-echelon Vehicle Routing Problem with Mixed Vehicle. *International Journal of Production Economics*. (Final Review).
10. Liu, D., Deng, Z., Wang, Y., Kaisar, E. I., Hybrid Artificial Immune Algorithm for Optimizing a Van-Robot E-grocery Delivery System. *Transportation Research Part E: Logistics and Transportation Review*. 2021(154):102466.
11. Zhang Y., Khani A., 2021. Integrating transit systems with ride-sourcing services: A study on the system users' stochastic equilibrium problem. *Transportation Research Part A: Policy and Practice* 150, 95-123.
12. Kumar P., Khani, A., 2021. An algorithm for integrating peer-to-peer ridesharing and schedule-based transit system for first mile/last mile access. *Transportation Research Part C: Emerging Technologies* 122, 102891.
13. Ma, C., Peng, Y., Wu, L., Guo, X., Wang, X., & Kong, X. (2022). Application of machine learning techniques to predict the occurrence of distraction-affected crashes with phone-use data. *Transportation research record*, 2676(2), 692-705.
14. Guo X., and Zhang Y., 2022, "A Review of the Six-year Autonomous Vehicle Tester Program: Maturity in Automated Driving on Public Roads," *Transportation Research Record*
15. Wei Z.\*, Das S., and Zhang Y., 2022, "[Short Duration Crash Prediction for Rural Two-lane Roadways: Applying Explainable Artificial Intelligence](#)," *Transportation Research Record*
16. Kong X.\*, Zhang A., Xiao X.\*, Das S., and Zhang Y., 2022, "Work from home in the post-COVID world," *Case Study on Transportation Policy*. DOI: [10.1016/j.cstp.2022.04.002](https://doi.org/10.1016/j.cstp.2022.04.002)

### **Books or other non-periodical, one-time publications**

Nothing to Report

### **Identify for each one-time publication**

Nothing to Report

### **Other publications, conference papers and presentations**

1. Liatsos V., Golias M., Misha S., Hourdos J., "Optimizing and Quantifying Benefit of Truck Caravanning" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
2. Machado Al., Kaisar E., "Identifying Critical Freight Corridors using Spatial Decision Support System" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
3. Xiao X., Zhang Y., Wang B., "Coordination of connected and automated Vehicles for Truck Platooning Allowing Turning Along an Arterial Corridor" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
4. Xiao X., Zhang Y., Wang B., "Artificial Intelligence Design for Trucks Passing Signalized Intersection Along a Corridor with Significant Freight Traffic" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
5. Adu-gyamfi Y., Edara P., Sun C., Kaisar E., "Interactive Web-based" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.

6. Khani A., Enami B., "Toward Electrification of Freight Transportation: An Overview of the Barriers and Opportunities" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
7. Machado A., Khoshgoftaar T., Kaisar E., Lisa-Baquero B., "Predicting Traffic Incidents in Road Networks Using Vehicle Detector Data" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
8. Tabassum A., Ardalan T., Kaisar E., Al-Ghandour M., "Evaluation of the Performance Measures of Two-Lane Roundabouts and Turbo Roundabout with Varying Truck Percentages" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
9. Antonoglou V., Hickey S., Koliou K., Kaisar E., Akcali E., Washburn S., "Operational Analysis Emergency Freight Truck Parking Facilities in Florida" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
10. Antonoglou V., Kaisar E., "Last-Mile Delivery Scheduling for Minimizing the Autonomous Delivery Robots Logistic Cost" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
11. Liatsos V., Mannarino M., Golias M., Kaisar E., Misha S., "Optimal Refueling Gas Station Location in Post-evacuation Conditions" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
12. Venthuruthiyil S., Figliozzi M., Misha S., Kaisar E., Golias M., "Forecasting Market Penetration trend for Autonomous Delivery robots in the Post-COVID World" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
13. Esfandarani M., Golias M., Misha S., "Freight Disaggregation Tool for commodity Movement in Tennessee" presented at the 7<sup>th</sup> UTC Conference for the Southeastern Region, Boca Raton, FL, March 2022.
14. Koliou, K., Parr, S., and E. Kaisar "Analysis of Hurricane Evacuation Data by Vehicle Classification." Submitted for presentation and publication at 8th Road Safety & Simulation International Conference, June 2022.
15. Koliou, K., Antonoglou V., and E. Kaisar "Operational Analysis of Emergency Truck Parking in Florida State under Emergency" Submitted for presentation and publication at 9<sup>th</sup> METRANS International Urban Freight Conference, June 2022.
16. Tabassum, A.\*, Liu, D., Mishra, S., and Kaisar, E. I. (2021). "An Optimization Model for Determining Optimal Fleet Size for a Robot-Sharing System". ASCE-International Conference in Transportation & Development 2022.
17. Liu, D., Tabassum A., and Kaisar, E. I., "Hybrid Artificial Immune Algorithm for Optimizing a Van-Robot E-grocery Delivery System". The Institute for Operations Research and the Presented at Management Sciences (INFORMS) Annual Meeting, Virtual Conference, October 2021.
18. Schaefer J., Figliozzi M., "Spatial Accessibility and Equity Analysis of Amazon Parcel Lockers Facilities", INUF METRANS - Spring 2022.
19. Khani A., Hourdos J., "Electrification on the freight Systems in Minnesota: Barriers, Opportunities and Multicriteria Planning Tool" American Trucking Association, Technical Advisory Group Meeting #203, Orlando, FL, March 2022.
20. Takhtfiroozeh, H., Machado, A., Golias, M., Hourdos, J., Kaisar, E., and Mishra, S. (2022). Identifying Critical and Vulnerable Freight Routes in the State of Florida. Presentation at 101st Annual Board Meeting of Transportation Research Board, National Research Council, Washington D.C.
21. Liatsos, V., Giampouranis, D., Golias, M., Hourdos, J., and Mishra, S. (2022). Optimizing and Quantifying Benefits from Truck Caravanning. Presentation at 101st Annual Board Meeting of Transportation Research Board, National Research Council, Washington D.C.
22. Thapa, D., Mishra, S., Dey, K., Golias, M., and Md. T. (2022). Recreational Travels During the COVID-19 Pandemic: An Analysis of Antecedents and Necessary Conditions. Presentation at 101st Annual Board Meeting of Transportation Research Board, National Research Council, Washington D.C.
23. Md. T. , Thapa, D., Dey, K., Mishra, S., and Golias, M. (2022). Integrating Tourism Travel with Transportation Planning and Project Development Process: A survey of State DOTs and Tourism Departments. Presentation at 101st Annual Board Meeting of Transportation Research Board, National Research Council, Washington D.C.

24. Sharma, I., and Mishra, S. (2022). Quantifying the Consumers Dependence on Different Information Sources on Acceptance of Autonomous Vehicles. Presentation at 101st Annual Board Meeting of Transportation Research Board, National Research Council, Washington D.C.
25. Samani, A., and Mishra, S. (2022). Assessing Commercial Motor Vehicle Drivers Driving Styles after Transition from Automated to Manual Driving in Highly Automated Vehicles. Presentation at 101st Annual Board Meeting of Transportation Research Board, National Research Council, Washington D.C.
26. Ngo, H., and Mishra, S. (2022). Optimal Dispatching and Repositioning Strategy for Autonomous Taxi Using Reinforcement Learning. Presentation at 101st Annual Board Meeting of Transportation Research Board, National Research Council, Washington D.C.
27. Thapa, D., Paleti, R., and Mishra, S. (2022). Predicting Future Crashes Using a Discretized Duration Modeling Approach. Presentation at 101st Annual Board Meeting of Transportation Research Board, National Research Council, Washington D.C.
28. Shahpasand, R., Talebian, A., and Mishra, S. (2022). Investigating the Impacts of 3D Printing Technology on Efficiency of Supply Chain: The Case of Tire Production. Presentation at 101st Annual Board Meeting of Transportation Research Board, National Research Council, Washington D.C.
29. Sharma, I., Pani, A., and Mishra, S. (2022). Mobility Inequalities in Food Desert Communities and the Acceptance for Autonomous Delivery: What Does Automation Mean for the Marginalized? Presentation at 101st Annual Board Meeting of Transportation Research Board, National Research Council, Washington D.C.
30. Figliozi, M., Mishra, S., and Kaisar, E. (2022). A Study of Factors Affecting Commercial Vehicles Permits, Loading Zones, and Double-Parking Fines. Presentation at 101st Annual Board Meeting of Transportation Research Board, National Research Council, Washington D.C.
31. Machado A, and Kaisar E., "Identifying Critical Freight Corridors using a Spatial Decision Support System". Presentation at the Poster Session 1315. 101st TRB Annual Meeting, January 9-13, 2022, Washington D.C.
32. Tabassum a., Kaisar E., and Liu D., "Optimization of a Robot-sharing Last Mile Delivery Network: A Dynamic Fleet Assignment Model". Presentation at the Poster Session 1391. 101st TRB Annual Meeting, January 9-13, 2022, Washington D.C.
33. Liu d., Antonoglou V., and Kaisar E., "New Mobility Assist E-grocery Delivery Network; A Load depended Two-echelon Vehicle Routing Problem with Mixed Vehicles". Presentation at the Lectern Session 1406. 101st TRB Annual Meeting, January 9-13, 2022, Washington D.C.
34. Golias M., "Current Research Related to Ports and Channels". Presentation at the Poster Session 1242. 101st TRB Annual Meeting, January 9-13, 2022, Washington D.C.
35. Xiao, X., Zhang, Y., Wang, X. B., Guo, X. (2022). Mixed Traffic Stabilization and Optimization with Automated Cars and Trucks: An Adaptive Headway Control Algorithm [Conference presentation]. TRB 2022, Washington, D.C, United States. <https://annualmeeting.mytrb.org/OnlineProgram/Details/17527>
36. Hourdos J., When the cars start talking are the drivers going to start listening? 7th Intelligent Transport Systems, ITS Hellas. Athens, Greece. December 2021.

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

The Freight Mobility Research Institute's official website is [fmri.fau.edu](http://fmri.fau.edu), and has been redesigned. Please find below project websites pertaining to technology transfer and research project findings:

- FMRI Y1R3-17: Enhancement of Transportation Network Analysis Tools for Truck-Related Planning and Operations - Part B (PI: Washburn, UF). Software and user guide will be published at: <https://github.com/swash17>
- FMRI Y2R3 – 18: Disaggregation of Freight Flows for Tennessee – (PI: Golias, University of Memphis). Software and user guide will be published at: <https://sites.google.com/view/res2019-14/home>
- FMRI Y2R4 – 18: Truck Parking Needs in Tennessee - (PI: Golias, University of Memphis). Software and user guide will be published at: <https://sites.google.com/view/res2019-16/home>

## Technologies or techniques

The project titled “An Interactive Platform for Large Scale Truck Activity Detection and Analysis using Connected Vehicle Data – Phase 2” (Y5R3-2021) the goal is to explore new opportunities for freight activity monitoring by integrating this rich dataset with existing public and private freight datasets to quantify truck activity across the State. In Phase 1 of the project, a spatio-temporal conflation framework that enable of three key freight data sources including: weigh-in-motion (WIM), freight facility, and traffic flow data was developed. A massively parallel database was then designed to store the integrated data on a cluster of servers enabled with Graphical Processing Units (GPUs). While emerging CV data could provide valuable insights into truck activity patterns, the sheer volume and speed of this data can be overwhelming and challenging to mine with conventional data processing pipelines. The need for frameworks that are able to leverage recent advances in big data and cloud computing to integrate, analyze and interactively visualize freight activity patterns from these new technologies is therefore crucial. The objectives of this study are therefore to: 1). Develop a set of routines for integrating connected vehicle data with traditional freight data sources to detect and analyze freight activity patterns on a large scale, 2). Leverage high-performance computing to develop a scalable database for storing and retrieving integrated datasets, and, 3). Deploy an interactive, web-based data visualization3 platform for exploring freight activity pattern.

Florida Atlantic University, is working with local stakeholders to implement research findings for project (Y4R1- 2021) titled “Evaluating the Adoption and Impact of Autonomous Delivery Modern Technologies”. The purpose of the project is to promote technology-driven innovations to address the inefficiencies in last mile deliveries. This project has also prompted e-commerce companies, retail chains, logistic providers and technology start-ups to invest in sidewalk autonomous delivery robots (SADRs) and road autonomous delivery vehicles (RADRs). The growing appeal for utilizing SADR and RADR technologies arises from the increased demand for same-day deliveries in business to consumer (B2C) e-commerce and the associated challenges for logistics providers (Cárdenas et al., 2017; Jennings and Figliozi, 2019; Wang et al., 2016). Apart from improving the delivery efficiency, autonomous vehicles have the potential for initiating a more sustainable, and customer focused delivery practice with limited externalities on road congestion, noise and CO2 emissions. Due to the rapid advancements sensing technology and artificial intelligence algorithms, large-scale deployments of autonomous delivery vehicles are on the verge of becoming a reality in some delivery scenarios with known and repeatable routes. SADRs and RADRs developed by Amazon, FedEx, Starship, and Nuro are already deployed and being tested in multiple U.S. cities.

## Inventions, patent applications, and/or licenses

Nothing to Report

## Outcomes

Outcomes	Target	Progress
# of workshops/seminars/ developed	13 workshops/webinars/seminars	1 research workshop/Conference 2 educational workshops/seminars 7 ITE/WTS lecture series events
# of features articles of FMRI research	5 featured articles	10 articles accepted 4 under review
# of organizations participating in consortium activities	4 organizations	5 research-related organizations 4 educational organizations
# of attendees to seminar/webinar/outreach activities	304 attendees	765 research-based attendees 55 education-based attendees

## What outcomes has the program produced?

Under the research component, there is an increased understanding of adoption of smart technologies and their implications on Freight transportation and logistics to improve the nation's mobility of people and goods. The center focused on new technologies that have created opportunities to address critical freight transportation challenges across all modes in urban, suburban and rural areas. Some examples of new technologies include expansion of e-commerce, last mile deliveries by unmanned aerial vehicles (UAVs) or delivery robots, and potential applications of automated and connected vehicles in freight transportation (e.g. truck platooning). These new technologies are also influencing consumer behavior and thereby reshaping freight supply chains at the urban, regional, and international level. The center is developing diffusion of innovation-based models to predict how the adoption of autonomous technologies will be in the future by freight and state organizations, and how we can make the supply chain more stable and efficient. In addition, to how be able to bring down the cost for American families.

Under the educational component, the following outcomes have been achieved:

- Virtual lectures on High School campuses, Fall 2021.
- More than ten female and minority students were placed in the industry and state agencies as staff, interns, or continuing their studies in different universities.
- The center hosted the 7<sup>th</sup> UTC Conference for the Southeastern Region.

## How are the research outputs described in section (3) above being used to create outcomes?

The center is actively working with stakeholders, collaborators and consortium partners to improve technology transfer activities throughout the center webinar series, hybrid meetings with the industry partners and other state and federal agencies. The examples below demonstrate the initiatives the center has developed for the first four years completed projects. The application of the proposed approach of autonomous vehicles is to be used in many other innovations such as: drones, collaborative and shared logistics, and eco-signals.

## Impacts

Impacts	Target	Progress
# of methodologies, models, and tools developed	5 models developed	8 methodologies, models, and tools developed
# of partnerships from industry, agencies and academic institutions	8 partnerships	9 partnerships
# of adopted methodologies, models, and tools	2 adopted models	3 adopted models

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

The impact on educational efforts consist of K-12 students' exposure to various transportation fields that have led students to choose a career in transportation engineering and logistics. The center will continue to promote transportation engineering and logistics careers and systems through graduate courses, lecture series, field trips, essay competitions, transportation science fairs, and high school teacher's workshops.

All of the FMRI research products are made available to the public. Our research can have an immediate impact on the body of scientific knowledge and can be applicable to the State transportation operations. Under the research effort as an example, the project Y5R4\_FMRI "Management of Supply Chain Disruption of freight Network using Advanced Algorithms" objective is to develop algorithms focusing on prediction accuracy of freight on-time performance under major disruptions. The investigation across different machine learning methods and the application of big data is expected to expand the understanding of the applicability of this technology to freight network design problems. It will also cover the sensitivity of these methods regarding different data types, problem



complexities, and solution outcomes. This research will also explore a case study with a database and the benefits it will produce to the freight business and the nation's economy.

### 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?

The work produced under the following projects have impacted the adoption of new practices:

**“Y4R6-20 Artificial Intelligence Design for Trucks Passing Signalized Intersections along a Corridor with Significant Freight Traffic”**

- This project has developed algorithms that ensure collision avoidance for all the vehicles. In addition to that basic requirement, other optimal performances are targeted. The expected outcome for this project is to develop well-trained AI model and it will let trucks drive in behaviors that meet these requirements and performance objectives.

**“Y4R8-20 Identifying and Optimizing Electric Vehicle Corridor Changing Infrastructure for Medium and Heavy-Duty Trucks”**

- This project study freight volume and e-truck implications on freight traffic, and the characteristics of power grid from conventional and renewable sources. By developing a database of various infrastructures, energy demand and supply, and conducting geo-spatial analyses, candidate corridors for e-truck infrastructures will be identified and discussed with a technical advisory panel

**“Y5R1-21 Modeling the Adoption, Distribution and Utilization, of Autonomous Delivery Robots and Delivery Lockers in the Aftermath of the Covid-19 Pandemic”**

- This research attempted to address the urgent research need during the pandemic because last-mile delivery is a service that depends on responding promptly to consumer needs, and consumer expectations drive companies' business, logistics decisions and transportation state agencies support. We have received enough interested by agencies to use our models.

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

For the project Y4R6\_FMRI “COVID-19 Transmissibility on a Multimodal Freight Network” the impact will be on how COVID-19 transmits on networks. Freight network is a subnetwork of it that transmits the coronavirus through the direct and indirect contacts between freight operators and cargo packages. Different types of contact (or contact in close proximity) have different probability of transmission. A large portion of the people's activities in close proximity of each other have to do with their freight/consumable's activities. Therefore, it is important to study the freight network COVID-19 transmissibility as well as study the freight network effect on the entire human network of COVID-19 transmissibility. This study is timely and meaningful considering the nation as well as the worldwide effort to reopen the businesses while keeping the pandemic from growth. The goal of this project is to study a general, applicable theory and methodology in order to impede or contain the spread of the coronavirus COVID-19.

The impact for project Y4R3\_FMRI “Determination of Position and Operation Analysis of Emergency Freight Parking in Florida State” were the two specific objectives: 1. Conduct a statewide study to (i) assess the supply and demand for emergency truck parking, (ii) developed metrics to assess the safety and economic impact of emergency truck parking network, and (iii) build a prototype web-based tool or mobile app to guide truck drivers to emergency parking locations in Florida. 2. Develop simulation models to (i) analyze the performance of alternative emergency parking networks and (ii) generate insight into the impact of truck driver behavior on the expected performance of alternative emergency parking networks. Consequently, this research reduced travel time and improved safety which the cost saving can be spent on building new infrastructure. Furthermore, by directing trucks out of the network in a shorter time and preventing the illegal parking the mobility of other vehicles improved and the risk of accidents reduced. The results of this project served for protecting, managing, and organizing the freight movement in various critical/emergency situation.

The impact for the project Y5R6\_FMRI “Coordination of Connected and Automated Trucks for Platooning Considering Turning Along an Arterial Corridor” will be how the agencies adopted our decision-making strategy that

allows CAV trucks to move in person in the platoon and make turns with safe and time-efficient scheduling. This method will lead to an improvement in the operation of the overall traffic flow in a truck heavy freight corridor in an urban area. As a result, the safety and mobility of the local corridor are improved.

### What is the impact on transportation workforce development?

The impact on the transportation workforce development has been greatly influenced by the efforts of the FMRI research and educational activities through the COVID-19 pandemic. Various research opportunities under the FMRI center has promoted collective efforts among research associates, post-doctoral researchers, graduate research assistants, and undergraduate student assistants. These efforts have provided opportunities for: research, teaching, and training in transportation and logistics fields. Currently, there are more than twenty staff, graduate and undergraduate students who are actively involved in FMRI research and educational activities. Training courses and certificate programs have increased the expertise of transportation professionals. For example, Ms. Shannon Hickey from UF, has been awarded a position with the United States Department of Homeland Security for the 2022 Homeland Security Professional Opportunities for the Student Workforce to Experience Research (HS-POWER) program primarily based on her qualitative research capabilities she developed within the scope of this project. In addition, FMRI provides support to ITE/WTS student chapters to FAU and FMRI consortium members. Previous K-12 initiatives have also exposed many non-engineering college majors to the transportation and logistics engineering field. Graduate Courses were developed and will continue to be developed based on FMRI research findings. For the Summer of 2022 the center will organizing summer camps with OAK Ridge National Laboratory Collaboration base on visualization and data analytics, simulation and route choice. The center will continue to promote technology transfer and outreach through hybrid research and educational activities.

### Changes/Problems

#### Changes in approach and reasons for change

The center is now slowly going back to normal operations, and most of our faculty and staff work on campus and most of our facilities are open for research activities. In addition, our center's educational activities are conducted hybrid and will continue to do so until the end of Spring 2022. All the center's lecture series, meetings with stakeholders, and other educational activities is conducted in person, on top of the FMRI webinars.

#### Actual or anticipated problems or delays and actions or plans to resolve them

During Fall 2021, Florida Atlantic University has returned to normal operations and our center meetings and events in Spring 2022 are in person or hybrid.

#### Changes that have a significant impact on expenditures

Nothing to Report

#### Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards

Nothing to Report

#### Change of primary performance site location from that originally proposed

Nothing to Report