FREIGHT MOBILITY RESEARCH INSTITUTE
FLORIDA ATLANTIC UNIVERSITY

Semi-Annual Progress Report

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Project Title	Freight Mobility Research Institute (FMRI)
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Signature of Submitting Official	

Accomplishments

What are the major goals of the program?

The FMRI aims 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 is to address critical issues affecting the planning, design, operation, and safety of the nation's intermodal freight transportation system, in order to strengthen our nation's economic competitiveness. Efficient and safe freight movement is inextricably linked to the economic vitality of a local area, state, region, and beyond. In consultation with 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 will focus on the research and development of freight mobility. The focus will dive into ***improvement of freight mobility through information technology, freight network modeling and operations, intermodal logistics, as well as freight and supply chain sustainability.*** The intended research and development will help promote:

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

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: Our research activities are multimodal/intermodal and multidisciplinary in scope. Our aim is to address regional and national significant transportation issues pertinent to economic competitiveness to improve supply chain, and provide practice-ready solutions. We have assembled top experts on supply chain and logistics freight transportation, network modeling, sustainability, and Intelligent Transportation Systems (ITS) from consortium institutions. These experts represent leading universities across the nation with deep connections to local, state, and regional communities. Each of the FMRI consortium universities has an established transportation research center/lab with top quality faculty conducting cutting-edge research. We are motivated to embrace innovative research projects, train the current and future transportation leaders and workforce, and engage with the industry to enhance collaboration between agencies. Collaboration between agencies will be promoted by improving transport efficiency and safety, first- and last- mile efficiencies, sustainably, traffic congestion reduction, and develop tools and procedures to ensure interoperability today and in the future.

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 first years of operation will focus on improving freight fluidity in four major research areas:

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

Education, Workforce Development, Technology Transfer, & Diversity: 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 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.

What has been accomplished under these goals?

In the second year, the center developed guidelines and procedures for inviting research and educational proposals. The center has created a review process involving advisory board members and local stakeholders. This process is based on external peer review and advisory board approval. Implemented process will help construct a functional way for the center's executive committee to approve peer review recommendations and provide funding for essential research. Research that will contribute 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 third-year research projects are to be soon completed, results from available data have been recorded, tested and/or deployed by the engaged stakeholders. In addition to the review of our third-year projects, please find listed below a brief description of the four-year projects that have been awarded by the FMRI.
For final reports regarding the second and third-year projects, please explore the FMRI website, final reports will be published by Fall 2020.

Third Year Research Projects:

For the third-year period (April 2019 - October 2019), the center has developed Request for Proposals (RFP) for research projects through discussion with the advisory board members and industry, and with local and state stakeholders. These projects were conducted during late Fall 2019 and/or Spring 2020 depending when the project amendment was signed. For further details, you may find the overview of these projects listed on the FMRI website.

FMRI Y3R1-19: Analysis of Freight Movement Within Regional Evacuations (PI: Dr. E. Kaisar, Florida Atlantic University, Subcontractors: Dr. S. Parr, Embry-Riddle Aeronautical University)
FMRI Y3R2-19: Identification and Evaluation of Critical Urban Freight Corridors (PI: Dr. E. Kaisar, Florida Atlantic University)
FMRI Y3R3-19: Integrate Autonomous Delivery Vehicle into Sustainable Urban Logistics Planning and Optimization (PI: Dr. E. Kaisar, Florida Atlantic University)
FMRI Y3R4-19: Managing the Growth of Last-mile Deliveries and Curb Space Demand (PI: Dr. M. Figliozzi, Portland State University, C0-PI: Dr. A. Khani, University of Minnesota)
FMRI Y3R5-19: Fathoming the Maximum Potential for Freight Sensitive Intersection Control (PI: Dr. B. Wang, Texas A&M University)
FMRI Y3R6-19: Optimal and Robust Control of vehicle Platooning on Signalized Arterial with Significant Freight Traffic (PI: Dr. Y. Zhang, Texas A&M University)
FMRI Y3R7-19: Identifying Critical and Vulnerable Freight Routes in Roadway Networks: A Game Theory Frameworks and Application in the State of Florida (PI: Dr. M. Gkolias, University of Memphis; Co-PI: Dr. E. Kaisar, Florida Atlantic University, Co-PI: Dr. J. Hourdos, University of Minnesota)
FMRI Y3R8-19: Incorporating Freight Regional Land Use Planning Models (PI: Dr. S. Mishra, University of Memphis)

Four Year Research Projects

For the fourth-year period (March 2020 - September 2020), the center has developed 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 had at minimum of three external reviewers. Each project was revised to reflect the comments from each peer reviewer. Once revised by the PI, and resubmit it for second review from the external reviewers, these projects were viewed by the Advisory Board and changed accordingly, as needed. The selected projects approved by the FMRI executive committee will be executed by October 2020 depending on when the project amendment will be signed.

Below please find a brief description of the fourth-year projects:

FMRI Y4R1-20: Evaluating the Adoption and Impact of Autonomous Delivery Modern Technologies (PI: Dr. S. Mishra, Co-PI: Dr. E. Kaisar, Florida Atlantic University, and Co-PI: Dr. M. Figliozzi, Portland State University)
The tremendous potential of technology-driven innovations to address the inefficiencies in last mile deliveries has 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. 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. This research aims to fill this gap by developing a new multi-objective formulation as well as heuristics-based algorithms. Also, we apply our heuristics to several scenarios with different demands and time limits to evaluate the economics and environmental performance of delivering with TADV and with truck-only delivery. This research might shed light on the development of model and method of sustainable urban logistics planning.

FMRI Y4R2-20: Evaluating Dynamic Curb Management Strategies in Urban Environment (PI: Dr. E. Kaisar, Florida Atlantic University, Co-PI: Dr. M. Figliozzi, Portland State University)
City curbs and sidewalks are becoming ever more crowded as ride-hail companies and delivery businesses compete for pick-up and drop-off locations, and bike-share programs and dockless scooters are present in abundance in the communities across the nation. The demand for curb has grown so rapidly that local land-use planners and regulators are struggling to create policies to keep the pace of new mobility and increased delivery needs. Advancing technology innovation, growing frustration with congestion, and increasing environmental regulation have congregated to create a demand for a wider range of services with new approaches to meet urban mobility needs. As a response to this problem, some cities have chosen to dedicate more curb spaces for pick-up and drop-off locations, but the static allocation of space is inefficient when demand types and rates fluctuate hourly and daily. This work will study the effectiveness of a robust dynamic curb management environment in urban areas to reduce urban congestion and increase mobility and accessibility. Another key objective of this study is to develop a traffic simulation module that incorporates a parking choice model to select suitable parking facilities for all the modes and further finds the optimal allocation of the curb space for various uses that the overall transportation system performance can be enhanced.

FMRI Y4R3-20: Determination of Position and Operation Analysis of Emergency Freight Parking in Florida State (PI: Dr. E. Kaisar, Florida Atlantic University, Co-PI: Dr. E. Akcali, University of Florida)
Florida is extremely vulnerable to many natural disasters such as flooding and hurricanes. Due to its several miles of coastline, significant drainage systems, and relatively low elevations, the entire state is especially susceptible to flooding at any time of the year. Extreme disruptions to the transportation networks and communications is one of the impacts of flooding and any kind of natural disaster or emergency situation. Hence, the importance of an integrated, comprehensive approach to disaster loss reduction is not neglectable. The transportation system in Florida needs to overcome many disruptions during the hurricane season caused by the heavy rains, strong storms, and many other local events. In these critical situations, the safe, fast, and reliable shipment of cargo is vital to ensure the continuation of the demands for society. Above that, the safety of truck drivers at all conditions remains the first priority. Therefore, this research focuses to support the design and operation of the emergency truck parking network (ETPN) for freight operations in the State of Florida. The research team will focus on the opportunities and challenges associated with the design and operation of the ETPN in Florida, and also, will focus on developing decision-making support for and managerial insight into the design and operation of such networks. Specifically, the two specific objectives of this project are: 1. Conduct a statewide study to (i) assess the supply and demand for emergency truck parking, (ii) develop 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 can reduce travel time and improve 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 will be improved and the risk of accidents will be reduced. The results of this project will be served for protecting, managing, and organizing the freight movement in various critical/emergency situation.

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)

Florida State is vulnerable to various forms of natural disasters including hurricanes, tropical storms, tropical depressions, tornadoes, wildfires, and floods. These events regularly affect Florida's residents, visitors, and Florida's economy. Therefore, it is of great importance to plan thoroughly in advance of happening any of the natural disasters. Natural disasters are effective and influential sectors for direct and indirect releases of hazardous material (hazmat). Preparedness is the process of turning awareness of the natural hazards and risks faced by a community into actions that improve its capability to respond to and recover from disasters. Recent disasters illustrate the destructive potential of natural hazards and the long-term societal disruption that is felt well beyond the boundaries of the communities that are affected. Directed refueling process of gas stations is one issue that has been the focus for many years because of its importance and its complexity. The main concern for the petroleum supply chain during a natural disaster is its adjustment to the highly increased fuel demand before and after an evacuation. This research will focus on the process of fuel distribution after a disaster, taking into consideration the changes in the supply chain and roadway network. The ultimate goal of this research is the development of an integrated model that considers the interaction between the decision problems in all the following objectives tasks simultaneously. The approach of the problem is a combination of the Gas Station Replenishment Problem (GSRP), and the Multi-Compartment Vehicle Routing Problem (MCVRP) with time windows, to account for objectives, assumptions, and constraints of a post-evacuation network condition. The research team proposes a mathematical model optimizing the fuel distribution process, to address increased demand and decreased resources, after the disaster in specific time windows. The extension of the classic GSRP by limiting the available fuel inventory and the multi-compartmental truck fleet is the primary approach. The research goal is to maximize the number of gas stations served (i.e. maximize the met demand) under timing and cost constraints.

FMRI Y4R5-20: Modeling a Cooperative Location-routing Problem under Multi-echelon Supply Chain Disruption Risk (PI: Dr. E. Kaisar, Florida Atlantic University)

Increasing concerns about supply chain disruptions caused by unplanned events, such as pandemics, requires advanced models for improving the supply chain resilience. A challenging task is to make plans for the unplanned events in advance because the service capacity of each supplier–distributor varies randomly due to a variety of possible disruptions. Horizontal collaboration can take advantage of the multiechelon supply chain network itself and include satisfying demand from an alternate location in the network, or transportation from an alternate source or route. Our interest in this study is to analyze the benefits of horizontal collaboration with multiple suppliers and distributors by developing a decision support model that can address these concerns. The problem is formulated as mixed-integer linear programs (MILPs) related to the Capacity Location Routing Problem (CLRP) and a new hybrid heuristic is designed to find near-optimal solutions for large-sized instances. The goal is to determine the location, allocation, and routing decisions that minimize the cost of location, routing, and the disruption penalty. Furthermore, the proposed approach is applied to scenarios analysis. Numerical experiments will test the aggregated total cost and disruption penalty from cooperation, which is compared to the case where horizontal collaboration does not exist. Objective (s): This proposal is motivated by the supply chain disruption caused by the COVID-19 pandemic, and the theoretical gap existing in the present literature. This study will develop a cooperative multi-echelon supply chain network to minimize the total operation cost and the risk of the supply chain disruption. A mixed-integer linear program (MILPs) is proposed to capture the characteristics of all transportation activates throughout the network. The transportation activities can be classified into three aspects: (i) Sharing warehouses, (ii) selection of transportation services, and (iii) arrangement of vehicles.

FMRI Y4R6-20: Artificial Intelligence Design for Trucks Passing Signalized Intersections Along a Corridor with Significant Freight Traffic (PI: Dr. Y. Zhang, Texas A&M University)

Freight traffic, particularly when it's significant in proportion, affects the performance of the road network in a more sensitive and significant way compared to other type of traffic, in the aspects of mobility, environment, and safety due to the complexity of characteristics of the resulting mixed-class traffic. Trucks need extra distance and time for deceleration and acceleration, and their interactions with conventional vehicles can present more uncertainty to the traffic due to their lengths and speeds. Therefore, a traffic bottleneck appears more easily on a road segment or intersection where freight traffic is significant, and therefore the research insight into the control and operation of significant freight traffic is necessary. It has been shown in the research of FMRI's first-year project that the coordination of signals fails when the demand is composed of a large portion of trucks. Strategies have been developed in a FMRI second-year project to formulate multiple trucks' trajectories to pass consecutive signals individually and cooperatively considering mixed traffic conditions. The stability problem of vehicle streams has been studied in the third-year project.

With the development of artificial intelligence technologies such as reinforcement learning series, intelligent agents can learn from historical experiences by exploring the knowledge in their environment. Some researchers have also implemented reinforcement learning series methods to learn driving behaviors. A research question is: Other than applying active control, as we did in the previous research, is it possible for autonomous vehicles to learn from the experiences, while reaching the optimal performances in our concerned scenarios? Therefore, a piece of exploratory research is proposed to operate vehicles (trucks) using artificial intelligence technologies. The objectives of the research are to improve the mobility of truck-car mixed traffic by saving average travel time, reducing emissions, and pollutions for trucks as much as possible though imitation learning, and the experience for the learning is from the results of optimized models we have developed so far. As a basic requirement, safety is the priority. The developed algorithm must ensure collision avoidance for all the vehicles. In addition to that basic requirement, other optimal performances are targeted. The expected output is a well-trained AI model and it will let trucks drive in behaviors that meet these requirements and performance objectives.

FMRI Y4R7-20: Identifying and Optimizing Electric Vehicle Corridor Changing Infrastructure for Medium and Heavy-Duty Trucks. (PI: Dr. J. Hourdos, University of Minnesota)

Transportation counts for approximately two thirds of Greenhouse gas (GHG) emission. In Minnesota, about three thousand deaths are attributed to air pollution annually. Electric vehicles (EV) have emerged in the last few years with promise to provide less noisy and cleaner transportation systems. Minnesota Statute 174.01 directs MNDOT to reduce GHG from transportation sector. To this end, personal EVs are penetrating the market and electric buses are being adopted by transit agencies, both with some levels of power infrastructure. However, electric trucks are still in the prototype stage and very little effort has been put on studying their infrastructure needs nationwide. In order to address the lack of infrastructure planning for e-trucks, this project will investigate the infrastructure needs for e-trucks in the future. The research team will 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. With the objective of providing required charging service at minimum capital and operating cost, an optimization model will be developed to determine the location, type, and capacity of charging facilities on the identified corridors. Along with the optimal infrastructure planning, renewable energy sources such as solar and wind will be considered for supplementing the conventional grid. The results of this study will provide guidelines and suggestions for long term decisions toward clean freight transportation in and through Minnesota.

Education and Workforce Development:

FMRI's education goal is to foster education of future transportation professional's trough curriculum development, training and the development of the transportation workforce trough the research. 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

third-year and four-year educational projects, the center was involved in many educational activities and developed two educational projects that were completed and/or are in progress at our consortium locations: Hampton University, University of Florida, and Florida Atlantic University.

Curriculum Development for Highway Freight Transportation (PI: S. Washburn, University of Florida; Co-PIs: L. Du, University of Florida; and Dr. E. Kaisar, Florida Atlantic University)

Coverage of freight transportation in a university curriculum is rarely comprehensive, instead it usually consists of sprinkling a few related topics throughout a range of courses within the broader curriculum. A challenge when offering a focused and comprehensive course on highway freight transportation is the dearth of the curriculum material across the full range of relevant topics. The objective of this project is to develop curriculum content that can be used for an entire 1-semester course focused on highway freight transportation. The focus of the curriculum will be on providing a fairly high-level overview of the transportation of goods via commercial trucking. The focus leans more towards breadth than depth. The primary format of the material will be PowerPoint slides, but a number of example problems and active learning exercises will also be developed.

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

The expanding transportation industry in the U.S has a growing need for professionals qualified to manage advanced transportation systems. With up to 50% of the current workforce expected to retire in the next ten years, the industry faces a challenge of finding replacements. The overall goal of the proposed Education and Workforce Development Project is to attract and educate the next generation of transportation professionals through well-designed program of coursework, guest lectures, case studies, and experiential learning that reinforces classroom knowledge. The transportation education project will incorporate related programs offered by various departments within the University integrating research results into courses to produce a well-trained, effective, and efficient workforce. The partnerships with the transportation industry will offer students experiential learning through co-ops and internships. Special focus will be placed on K-12 education. Based on first and second year connections, the K-12 programs will be expanded.

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

Major Activities:

1. Lecture Series and Webinars related to Transportation Management and Logistics from the FMRI including Consortium Partners
2. Student Internships during Spring 2020 focusing on minorities
3. High School Teachers Workshop on Transportation Planning and Logistics
4. K-12 Student Transportation Essay Competition
    a. Bethel High School, Hampton, VA
    b. Heritage High School, Newport News, VA
5. Expand scholarship opportunities for students
6. K-12 visited FMRI facilities and were mentored by the FMRI Staff
    a. FAU High, Boca Raton, FL
    b. Suncoast Community High, West Palm Beach, FL
7. K-12 Transportation Science Fair program
    a. Bethel High School, Hampton, VA
    b. Heritage High School, Newport News, VA

Specific Objectives:

1. Minority student education—2, 4, 5 and 7 above
2. Increase minority participation—1 through 7 above
3. Increase K-12 participation –1 through 7 above

Significant results:

1. Minority student education—Lectures, Webinars, Workshops
2. Increase minority participation and interest in the field—Internship, scholarships and field trips
3. Increase K-12 participation –Lectures, Workshops, Field Trips, Essay and Science Fair

The development and implementation of online graduate courses in our consortium continues, as an example TTE 4105/5935 Transportation Operations and Logistics management has played a key role in education and workforce development for the summer semester in 2020 at Florida Atlantic University. The course was offered virtually with many benefits to the consortium members. A total of 36 students enrolled in the courses. The topics covered in the course include: transportation economics (supply, demand, equilibrium), constrained optimization, travel demand modeling, network equilibrium, and decision analysis/risk and uncertainty. In addition, the instructor invited a guest speaker, Dr. Dan Liu from the Freight Mobility Research Institute (FMRI) to speak about freight transportation network. In addition, the center offered in the Spring 2020, the TTE 6272 Intelligent Transportation Systems, and TTE 4005 Transportation Planning and Logistics. These courses focused on modern technologies and their applications, rail and marine transportation, designed and delivered to meet the needs of working professionals. Transportation system management and operations strategies provide multimodal solution that relieve congestion, optimize infrastructure investments, promote travel options, and reduce greenhouse gas emissions. Modeling of complex interactions and causal relationships among current issues. These hybrid courses had the opportunity for interaction between a group of students and faculty. Courses consisted of different technical modules and were presented in an integrated, indiscipline and industry relevant approach.

Another milestone for the center was to establish a certificate in Transportation, Logistics and Supply Chain Management curriculum provided by the FMRI permits graduate students to expand their knowledge on technical skills of transportation engineering and analytical business decision-making skills of supply chain management. This certificate program has a strong connection with the logistics industry of Southeast Florida. The center is also working to establish a new certificate program with collaboration of the department of Urban and Regional Planning at FAU. The Freight Mobility Research Institute (FMRI) in collaboration with the College of Engineering at FAU, will sponsor a virtual STEM initiative with numerous high schools throughout the state of Florida. Our plan is to provide an Overarching Transportation Problem with sub-problems that incorporates a specific engineering discipline. Our plans received an excellent response and strong interest from high schools in the state of Florida. The response was influenced by the fact that many schools specialize in one area or a few of the engineering disciplines. Being able to present a "Sub-Problem" that incorporated either: Electrical Engineering, Computer Engineering, or Civil Engineering was very appealing to the high schools.

Please find below the sub-problems presented for the initiative:

- **Car to Car Communication (Wireless Vehicular Sensor Networks)**

Engineering Discipline: Electrical and Computer Engineering/Computer Science
Objective: Design and build a prototype car that is able to communicate with other cars/pedestrian/infrastructure to solve a related traffic issue. Student groups will research and define a problem, then design and create a solution.

> Example: Send a wireless message to vehicles ahead of approaching an emergency vehicle. Clear the road for this emergency vehicle to proceed without delay.

Detail: Student groups build a sensor application using a radio chip, microprocessor boards, wires, and a battery-operated vehicle.
Presentation of Project: Student groups will present a 15-minutes PowerPoint presentation of the project results including a video of the final product.

- **Automated Ground Delivery Devise (Last Mile Delivery)**

Engineering Discipline: Computer, Electrical and Mechanical Engineering/Computer Science
Objective: Design and build an Automated Guided Cart (AGC) or devise that delivers short-distance deliveries of small orders. Student groups will research and define a problem, design and create a solution.

> Example: Student groups build an automated devise to deliver educational equipment/supplies from a storage location to a classroom.

Detail: Student groups build a sensor-based navigation system for a mechanical devise to assist the movement of goods from a central warehouse hub to its destination. Student groups will research and define a problem, design and create a solution.
Presentation of Project: Student groups will present a 20-minute PowerPoint presentation of the project results including a video of the process and outcome.

- **Improve Urban Infrastructure (Design and Use of Advanced Materials to Improve Transportation)**

Engineering Discipline: Civil and Mechanical Engineering (CAD Design)
Objective: Design an integrated (multimodal) transportation system hub in your community where various modes (rail, bus, cars, walking and bicycle) all conveniently meet.
Detail: Design a paved area of your school or city using pavement materials that reduce overhead temperatures and that are permeable to allow rainwater to reach the ground water table beneath. (Green Infrastructure)
Presentation of Project: Student groups will present a 20-minute PowerPoint presentation of the project results including a video.

- **Vulnerable Transportation Routes Due to Natural Disaster**

Engineering Discipline: Civil Engineering, Computer Science (CAD Design)
Objective: Student groups will Identify the vulnerable and critical links and routes in the transportation network for any unforeseen event in their local area and develop solutions to mitigate the traffic in the bottlenecks during a natural disaster event.

> **Example:** Mandatory hurricane evacuations cause traffic congestion and reduce the performance of transportation networks.

Detail: Student groups will research and define the problems and design/create solutions to increase the efficiency of transportation networks caused by large scale evacuations.
Presentation of Project: Student groups will present a 20-minute PowerPoint presentation of the project results including a video.

Our Engineering and Technology Camps for students from middle schools across Palm Beach and Broward counties that were scheduled to take place face to face or virtually in June and/or July 2020 were not able to be offered due to the pandemic. However, as part of the FMRI/STEM education initiative we are proposing a semester long transportation education camp for K-12 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 and participants will then carry out a project which could be a computer simulation, hands-on modeling, or combination of the two. Participants will make a virtual presentation of their activity at the end. The camp is planned to take place on Spring Semester 2020-2021. The target audience will be rising 9, 10, or 11 graders. The FMRI center will be collaborating with Jessica Hibberd and George Edmonds of the FAU College of Engineering and Computer Science in order to execute this initiative. The center will also count with the help from Dr. Sharad K Maheshwari, Professor in the Department of Business Administration at Hampton University, and FMRI Associate Director of Education.

Other educational activities include the visit of FMRI faculty and staff to High Schools in order to demonstrate our research findings in early Spring 2020. In addition to the visits, high school students have been invited to visit the state of the art FMRI facilities. During these visits, the students engaged in undergraduate research process by conducting small transportation studies on the FMRI facilities and the surrounding area. Also, the FMRI faculty and engineering staff served as judges for STEM completions. Lastly, other consortium members have participated in educational summer activities for the respective universities, such as Hampton University, University of Florida, University of Memphis, University of Minnesota and Texas A& M University.

FAU ITE and WTS Student Chapter Lecture 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 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), the recently established Advancing Women in transportation (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 an educational lecture series. Below are the listed lectures from this reporting period.

May 6, 2020 - Taraneh Ardalan, Graduate Assistant, Florida Atlantic University. *"Development of Guidelines for Implementation of Freight and Transit Signal Priorities in Urban Corridors".*
May 28, 2020 - Mr. Jeffrey Paniati, Executive Director and CEO, Institute of Transportation Engineers. *"A Discussion on Transportation Post COVID-19".*
(TranSet) June 10, 2020 - Dr. Sabya Mishra, University of Memphis. *"Adoption of highly automated vehicle technologies by individuals and organizations".*
June 25, 2020 - Dr. Sharad K Maheshwari, Professor, Hampton University. *"Supply Chain Disruptions: Lessons Learned from Previous Natural Disasters".*
July 9, 2020- Dr. Miguel A. Figliozzi, Professor, University of Portland. *"Last-Mile Delivery Innovations".*
August 19, 2020 - Dr. Sabya Mishra, Associate Professor, and Faudree Professor, University of Memphis. *"Industry Perceptions of Highly Automated Technologies for Trucks".*
September 9, 2020 - Dr. Mihalis Golias, Professor, University of Memphis. *"Using GPS data to Predict Truck Parking Needs".*

How have the results been disseminated?

The project reports are published to the FMRI website and presented at the FMRI lecture series, which are open to the public. Preliminary results are often presented at peer review conferences and various stakeholders' meetings, such as the Brown Bag meeting with the local state agencies, and the metropolitan planning organizations (MPO). 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 seminars and distinguish lecture series, and at our website. Furthermore, the FMRI research seminars and webinars serve as a forum for faculty, industry, and graduate students to present their research and work. Seminars and lecture series take place during Fall and Spring semesters, open to public, 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.

The FMRI is working on organizing the "Seventh Annual Regional UTC Conference" in Spring/ Summer 2021 in Boca Raton, Florida. This annual 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" is on Connected Vehicles in Smart Cities: The Future of Transportation and Logistics. We were hoping that this conference would provide an opportunity to convey the most recent autonomous transportation research innovation and focus on how connected and autonomous vehicle 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 has been postponed to the next year. In addition, the center is working on the "Regional UTC Student Spotlight" in Fall 2020, focusing on current challenges in transportation and logistics, for the southeastern region. This virtual workshop will provide opportunity for students in the southeastern region to present recent research and innovations and share how their contribution can play a role on the smart city concept.

In addition, the FMRI has been publishing and will continue to publish monthly newsletters with a focus on the presentation of research findings, educational activities, and accomplished milestones. Through peer review conferences, the center has held virtual workshops and co-sponsorship throughout this period. The purpose of these workshops were to disseminate our research findings and to encourage collaboration between different agencies and institutions:

***Smart Initiatives to Improve Last-Mile and 50 Feet Logistics to Improve Freight Fluidity, IEEE Intelligent Transportation Systems Conference- ITSC 2020, Rhodes, GR* – September 2020**. This workshop aimed to address critical issues affecting planning, design, operation, and safety. It also focused on identifying innovative strategies and technologies which are being developed to facilitate 'last-mile' delivery challenges.

The FMRI center is also planning to conduct a virtual workshop entitled "**"Freight Planning & Operational Logistics for the New Normal"** for the virtual Transportation Research Board Annual Meeting that will take place in January, 2021. This workshop will discern the most pressing needs for freight transportation and logistics research, and pilot investigation concerning the structure and operations of international and domestic supply chains in the 'New Normal' environment. Also, the workshop break-out sessions will engage participants and facilitate research-oriented discussions.

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

The FMRI third-year projects are all almost completed and research findings will be disseminated as needed. The FMRI four-year Research RFP projects will be awarded in Fall 2020. Our FMRI executive committees has monthly conference calls to oversee the center's operations and activities. The center's Advisory Board oversaw the review process and we were planning to have a quarterly conference calls to discuss the progress of the four-year projects in December 2020. In order to plan ahead into the fifth-year projects, the Advisory Board will also discuss the fifth-year problem statements in the quarterly call that will take place in December 2020. In the fifth-year, request for proposals will focus on the stated theme as well as high priority needs expressed by our public and private sector partners. For example, these days our nation has major issues in regards to the pandemic, the pandemic has popularized the term supply chain management due to the unprecedented, rapid and devastating effects. Many US companies have reported significant disruption to their supply's chains due to the coronavirus pandemic.

The center will continue their relationship with their 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 local private and public sector entities in order to develop needed freight related research.

The FMRI will also develop local community educational and technology transfer efforts to advance the knowledge on transportation supply chain management, logistics, and operations. The center will focus especially in the challenges we're all facing as a result of the pandemic.
For the educational initiative, the FMRI plans are to:

1. Implement the approved third-year projects, --More K-12 involvement
    a. An additional workshop for K-12 teachers;
    b. Workshops on preventing supply chain disruption during pandemic crisis;
    c. Essay Competitions;
    d. Transportation & Logistics Science Fair;
    e. Participating in INFORMS Annual Meeting;
    f. Virtual Logistics & Summer Camps & Invite guest speakers from the Industry;
    g. High School Presentations and Volunteer Participation as Judges in STEM competition;
    h. Internship for minority students with local stakeholders;
    i. Curriculum planning
2. Begin the third-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

In addition, the FMRI has a new pre-collegiate effort that we are preparing to launch this fall. FMRI is planning to work with select high schools that have comprehensive Engineering/STEM Programs. We will reach out to these teachers to engage their students through a unique project that they would work on throughout the Fall semester. Then, in February 2021-during Engineers Weeks, we would bring these students to the consortium members campuses and engage them in a full day where these students present their projects in front of a panel of industry partners, stakeholders and consortium members, and FMRI alumni. We plan to incorporate facility tours, hands on activities, and experiments that can be related to the FMRI theme.

Participants & Collaborating Organizations

What organizations have been involved as partners?

The FMRI works with multiple partners from academia and industry 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 for the second, third, and four-year.

FMRI Y2R1-18: Interactive Web-based Platform for Analyzing Freight Data – Phase I (PI: Dr. Kaisar, Florida Atlantic University, Subcontractors: Dr. Edara, University of Missouri)
FMRI Y2R2-18: Sustainable Urban Freight Mobility through Optimization of Logistics Facility Locations (PI: Dr. Kaisar, Florida Atlantic University; Co-Investigator: Dr. Du, PhD, University of Florida)
FMRI Y2R7-18: Next Generation of Freight Planning and Operation Models To Incorporate Emerging Innovative Technologies (PI: Dr. Figliozzi, PhD, Portland State University, Kaisar, PhD, Florida Atlantic University; Dr. Gkolias, PhD, University of Memphis; and Dr. Mishra, PhD, University of Memphis)
FMRI Y2R9-18: Truck Parking Needs in Tennessee (PI: Dr. Gkolias, University of Memphis, Subcontractors/Co-PIs: Mr. Murray, American Transportation Research Institute; Dr. Kohls, University of Tennessee, Knoxville; and Dr. Cherry, University of Tennessee, Knoxville)
FMRI Y3R1-19: Analysis of Freight Movement within Regional Evacuations (PI: Dr. Kaisar, FAU; Co-PI: Dr. Dhanak, FAU; Subcontractor: Dr. Parr, Embry-Riddle Aeronautical University
FMRI Y3R4-19: Managing the Growth of Last-Mile Deliveries and Curb Space Demand (PI: Dr. Figliozzi, PSU; and Dr. Khani, UMN)
FMRI Y3R7-19: Identifying Critical and Vulnerable Freight Routes in Roadway Networks: A Game Theory Framework and Application in the State of Florida (PI: Dr. Gkolias, UM; Co-PIs: Dr. Mishra, UM, Dr. Kaisar, FAU, and Dr. Hourdos, UMN)
FMRI Y4R1-20: Evaluating the Adoption and Impact of Autonomous Delivery Modern Technologies (PI: Sr. S. Mishra, Co-PI: Dr. E. Kaisar, Florida Atlantic University, and Co-PI: Dr. M. Figliozzi, Portland State University)
FMRI Y4R2-20: Evaluating Dynamic Curb Management Strategies in Urban Environment (PI: Dr. E. Kaisar, Florida Atlantic University, Co-PI: Dr. M. Figliozzi, 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, 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)

In addition, the FMRI works closely with the various states such as the Florida Department of Transportation 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 for student internships.

In addition, the FMRI works with State DOTs and other entities, including the Florida 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.

Portland State University is currently working with the Portland Bureau of Transportation, and Oregon Department of Transportation towards research collaboration, discussion of research gaps and contributions to the new Portland Freight Master 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, the University of Minnesota is working on a Minnesota Department of Transportation project, providing matching funds through various projects such as the project "Impact of Transitways on Travel on Parallel and Adjacent Roads and Park and Ride facilities".

Regarding cost share projects, Florida Atlantic University is working with the Florida Department of Transportation and City of Dania Beach, FL on the following project:

- "City of Dania Beach - Mobility Study."

University of Memphis is currently working with the Tennessee Department of Transportation on the following projects:

- Tennessee Department of Transportation. "Impact and Adoption of Connected and Autonomous Vehicles."
- Tennessee Department of Transportation. "Planning Guidebook for Commodity and Freight Movement in Tennessee."

Have other collaborators or contacts been involved?

The American Transportation Research Institute is involved in the FMRI Y2R9-18 project: "Truck Parking Needs in Tennessee" as a partner.

Outputs

Outputs	Target	Progress
# of proposals/projects with collaborative efforts	5 collaborative proposals/projects	4 Projects in Year 2 3 Projects in Year 4 4 Projects in Year 4
# of website page views	2,500 page views	3,280 pages views
# of conference presentations	10 conference presentations	4 conference presentations
# of peer-reviewed papers	6 peer-reviewed papers	12 peer-reviewed journal papers 4 under review, in preparation

Publications, conference papers, and presentations

Journal publications

1. Liu, D., Deng, Z., Pu, Z., Wang Z., and Kaisar, E. I., "Clustering Method for Truck Tonnage Estimation Using Weigh-in-Motion (WIM) Data". Measurement. Under review.
2. Liu, D., Yan P., Deng, Z., Wang Y. and Kaisar, E. I., "Sustainable Two Echelon Vehicle and Autonomous Delivery Robots Routing for E-Grocery Operations". Transportation Research Part C: Emerging Technologies. Under review.
3. Liu, D., Deng, Z., and Kaisar, E. I., "Method for Identifying Truck Traffic Site Clustering Using Weigh-in-Motion (WIM) Data". IEEE ACCESS. Under review.
4. Liu, D., Deng, Z., Zhang W., Wang Y., and Kaisar, E. I., "Design of Sustainable Urban Electronic Grocery Distribution Network". Alexandria Engineering Journal, 2020, 7.
5. Liu, D., Yan P., Deng, Z., Wang Y. and Kaisar, E. I., "Collaborative Intermodal Freight Transport Network Design and Vehicle Arrangement with Applications in the Oil and Gas Drilling Equipment Industry". Transportmetrica A: Transport Science, 2020, 16, 1574-1603.
6. Liu, D., Deng, Z., Mao, X., Yang, Y., and Kaisar, E. I., "Two-echelon Vehicle Routing Problem: Optimization of Autonomous Delivery Vehicle Assisted E-Grocery Distribution", IEEE ACCESS, 2020,

7. Figliozzi, M.A., 2020. “Carbon emissions reductions in last mile and grocery deliveries utilizing air and ground autonomous vehicles”. Transportation Research Part D: Transport and Environment, 85, p.102443.
8. Amini M., Bienstock C, Golias M., “Management of supply chains with attribute-sensitive products: a comprehensive literature review and future research agenda”. International Journal of Logistics Management. (In print)
9. Paleti R., Mishra, S., Haque*, K., Golias, M. (2020) “Latent class analysis of residential and work location choices”. Transportation Letters. https://doi.org/10.1080/19427867.2020.1783610
10. Sharma I., Mishra S., Golias M., Welch T., Cherry C. (2020) “Equity of transit connectivity in Tennessee cities”. Journal of Transport Geography”. (In print)
11. Bhattarai, S., Golias, M., Mishra, S., Talebian, A. (2020) “Multidimensional resource allocation for freight transportation planning”. Transportation Research Part-A: Policy and Practice. (In print)
12. Sharma, I., & Mishra, S. (2020). “Modeling consumers' likelihood to adopt autonomous vehicles based on their peer network”. Transportation Research Part D: Transport and Environment, 87, 102509.
13. Li, L., Cao, M., Yin, J., Wang, Y., & Mishra, S. (2020). “Observing the Characteristics of Multi-Activity Trip Chain and Its Influencing Mechanism”. KSCE Journal of Civil Engineering, 1-14.
14. Ngo, H., Kumar, A., & Mishra, S. (2020). “Optimal positioning of dynamic wireless charging infrastructure in a road network for battery electric vehicles”. Transportation Research Part D: Transport and Environment, 85, 102385.
15. Simpson, J. R., & Mishra, S. (2020). “Developing a methodology to predict the adoption rate of Connected Autonomous Trucks in transportation organizations using peer effects”. Research in Transportation Economics, 100866.
16. A. Mahmoudzadeh*, M.Khodakarami, C. Ma*, K. Mitchell, X. Wang, and Y. Zhang. “Waterway Maintenance Budget Allocation in A Multimodal Network”. 2020. Transportation Research Part E. Under review.

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. Liu, D., and Kaisar, E., “Autonomous Delivery Vehicle in Urban E-Grocery Delivery: A Two-Echelon Vehicle Routing Problem”. The 23nd IEEE International Conference on Intelligent Transportation Systems, Rhodes, GR, September, 2020 (virtual).
2. Ardalan, T and Kaisar E., “Evaluation of Freight and Transit Signal Priority Strategies in Multi-Modal Corridors: Development of FSP and TSP Guidelines”, The 23nd IEEE International Conference on Intelligent Transportation Systems, Rhodes, GR, September, 2020 (virtual).
3. Iqbal, S., Ardalan, T., Hadi, M., Kaisar, E., “Developing Guidelines for Implementing Transit Signal Priority (TSP) and Freight Signal Priority (FSP) Using Simulation Modeling and Decision Tree Algorithm”. To be presented at 100th Annual Meeting of the Transportation Research Board, Washington, D.C., January 2021.
4. Liu, D., Ardalan, T., Kaisar, E. I., Zhong M., “Clustering Method for Truck Tonnage Estimation Using Weigh-in-Motion (WIM) Data”. Under review for the at 100th Annual Meeting of the Transportation Research Board, Washington, D.C., January 2021
5. Figliozzi, M., “Last Mile Delivery Innovations,” Portland freight Committee, Portland, Oregon, May 6, 2020.
6. Figliozzi, M., “Last Mile Modeling Challenges,” Oregon Modeling Users Group Meeting, Portland, Oregon, May 16, 2020.

7. Liatsos V., Giampouranis D., Golias M., Mishra S., Nalim R., Frohlich M., Nicolas C. "Evaluating Cost Savings of Truck Caravanning". 100th Annual Meeting of the TRB. Washington, DC, 2021.
8. Takhtfiroozeh H., Golias M., Mishra S. "Topological-Based Measures with Flow Attributes to Identify Critical Links in a Transportation Network". 100th Annual Meeting of the TRB. Washington, DC, 2021.
9. Samani A., Mishra S., Lee D., Golias M., Everett J. "A New Approach to Develop Large Scale Land Use Models Using Open Source Data". 100th Annual Meeting of the TRB. Washington, DC, 2021.
10. Sharma I., Mishra S., Golias M. "Quantifying the Adoption of Highly Automated Technologies by Rural Population: A Case Study of Tennessee". 100th Annual Meeting of the TRB. Washington, DC, 2021.
11. Pani A., Mishra S., Golias M., Figliozzi M. "Valuing Public Acceptance of Autonomous Delivery Robots During COVID-19Pandemic: Consumer Heterogeneity in Attitudes, Trust and Willingness to Pay". 100th Annual Meeting of the TRB. Washington, DC, 2021.
12. Thapa, D., Gabrhel, Vit, and Mishra, S. "Investigating User Intentions of AV Use While Impaired". 100th Annual Meeting of the TRB. Washington, DC, 2021.
13. Ashraf, M., Dey, K., and Mishra, S. "Extracting Rules from AV involved Crashes by applying Decision Tree and Association Rule Methods". 100th Annual Meeting of the TRB. Washington, DC, 2021.
14. Keeling K, Schaefer J, Figliozzi M. "Potential for Common Carrier Parcel Lockers at Transit Facilities in Portland, Oregon". 2020. To be presented at the 100th Annual Meeting of the Transportation Research Board, Washington, D.C., January 2021
15. Glick T, Figliozzi M, Unnikrishnan A. "A Case Study of Drone Delivery Reliability for Time-Sensitive Medical Supplies with Stochastic Demand and Meteorological Conditions". 2020. To be presented at the 100th Annual Meeting of the Transportation Research Board, Washington, D.C., January 2021
16. Figliozzi M, Unnikrishnan A. "The impact of product type on house deliveries: trends and factors affecting COVID-19 lockdown deliveries". 2020. To be presented at the 100th Annual Meeting of the Transportation Research Board, Washington, D.C., January 2021
17. Unnikrishnan A, Figliozzi M. "Analysis of Home Deliveries Before, During, and After COVID-19 outbreak lockdown". 2020. To be presented at the 100th Annual Meeting of the Transportation Research Board, Washington, D.C., January 2021
18. Pani A, Mishra S, Golias M, Figliozzi M. "Valuing Public Acceptance of Autonomous Delivery Robots During COVID-19 Pandemic: Consumer Heterogeneity in Attitudes, Trust and Willingness to Pay". 2020. To be presented at the 100th Annual Meeting of the Transportation Research Board, Washington, D.C., January 2021

Website(s) or other Internet site(s)

The Freight Mobility Research Institute's official website is fmri.fau.edu. Please find below other websites pertaining to technology transfer and research:

- 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

Technologies or techniques

The software product developed through the Enhancement of Transportation Network Analysis Tools for the Truck-Related Planning and Operations – Part B of the first-year project will help transportation agencies perform travel time reliability at a network level, which is also sensitive to the vehicle performance of commercial trucks. Software and user guide will be published at: https://github.com/swash17

Under Texas A&M University, the creation of optimal control and ACC (adaptive cruise control) technology for vehicles (trucks) approaching and passing multiple signalized intersections under mixed traffic conditions on the multimodal corridors will be shared in a published paper, and is under Texas DOT review. Under University of Minnesota, our consortium partner is part of the Eureka, which is a five-year summer and school program for female

students that are focusing on science, technology, engineering and mathematics. This program has giving the opportunity for female students grades 11 and 12 to experience campus life, while learning more about transportation and logistics and participating in lectures and career panel discussions. The program is currently on hold due to the pandemic.

Florida Atlantic University, is working with local stakeholders to implement our research findings. Implementation of new innovations, best practices and research findings occur regularly throughout FDOT. The assessment and utilization of new technologies, methods and procedures enable the Department to "provide the highest quality integrated transportation services for economic benefit and improved quality of life". New innovations are the result of many different efforts both in Florida and nationally. Project such BDV27 977-15 "Evaluation of Truck Tonnage Estimation Methodologies" contribute to the development and identification of new technologies and research methodologies. Our new approach has a better accuracy of clustering, which will bring promising potential to accurately estimate the statewide truck tonnage. The proposed clustering and new algorithm might shed light on the statewide performance evaluation of freight traffic with low computing cost.

Inventions, patent applications, and/or licenses

Nothing to Report

Outcomes

Outcomes	Target	Progress
# of workshops/seminars/ developed	8 workshops/webinars/seminars	1 research workshop 1 educational workshops/seminars 7 ITE/WTS lecture series events
# of features articles of FMRI research	5 featured articles	12 articles accepted 4 under review
# of organizations participating in consortium activities	4 organizations	7 research-related organizations 7 educational organizations
# of attendees to seminar/webinar/outreach activities	304 attendees	320 research-based attendees 16 education-based attendees

What outcomes has the program produced?

Under the research component, there is an increased understanding of adoption of new technologies and their implications on Freight transportation and logistics to improve the nation's mobility of people and goods. The center focused their study 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 trucks will be in the future by freight and state organizations.

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

- Virtual lectures on High School campuses and FAU High School FMRI Facilities, Spring 2020.
- More than twelve female and minority students were placed in the industry as interns, or continuing their studies in different universities.
- An essay competition among high school students was organized for two high schools, Spring 2020.

- K-12 Transportation Science Fair for Spring 2020.

As a result of the pandemic, the FMRI center has adjusted to the current situation by holding and sponsoring virtual workshops/conferences, and other virtual events. The FMRI along with the standing committees of the Freight Transportation Planning and Logistics, and Urban Freight Transportation, will present a virtual workshop on freight planning and operational logistics for the "new normal". The workshop analyzes the effectiveness and adaptiveness of the Freight Transportation System in the "New Normal", recognizing the needs, and investigation of solutions. The topics included are: freight traveler information systems, virtual TMCs, truck parking systems, digital logistics corridors, and more. In addition, the FMRI in conjunction with the "IEEE Intelligent Transportation Systems" conference, held a workshop on "Smart initiatives to improve last-mile and 50 feet logistics" to further develop freight fluidity. The workshop addressed critical issues affecting planning, design, operation, and safety. The workshop also focused on identifying innovative strategies and technologies which are being developed to facilitate 'last-mile' delivery challenges. The event consisted of break-out sessions that introduced participants with the concept of Smart Freight Mobility and it served information exchange of research accomplishments.

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

The center is actively working with stakeholders and academia to create technology transfer throughout the industry and other entities. The examples below demonstrate the initiatives the center has developed for the first and second-year 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, smart signals, and more.
The technologies used in the dynamic trajectory control and signal coordination are combined and applied in a coordinated way to complete the algorithm.

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	17 partnerships
# of adopted methodologies, models, and tools	2 adopted models	4 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 careers and systems through lecture series, field trips, essay competitions, transportation science fairs, and high school teacher's workshops.

The impact on research efforts are represented by the following projects conducted by the FMRI:
"Y3R4-19 Managing the Growth of Last-mile Deliveries and Curb Space Demand"

> The research outcomes will better inform cities regarding alternative options and policies to manage parking and curb space. The Cities of Portland and Minneapolis are both in the process of updating their Freight Master Plan and Transportation Action Plan respectively (see attached letters of support). Lessons learned from this project can be utilized by these planning agencies in the near-term, and other agencies in the future. This information can be used to update their policies and design appropriate infrastructure to accommodate upcoming demand changes by improving space management and designs to accommodate new delivery services. Residents would benefit from reduced freight VMT in their neighborhood and subsequent benefits such as improved safety and better air quality. Novel methodologies developed in this project will be disseminated to researchers and freight transportation practitioners.

"Y3R2-19 Identification and Evaluation of Critical Urban Freight Corridors"

The project focus on first-last mile connector routes in order to make an opportunity to improve the mobility of them. This could be accomplished by implementing the state-of-the-art intelligent transportation systems technologies such as Freight Signal Priority (FSP) technology on first-/last-mile links. The project looked to develop a model towards identifying critical freight urban corridors. This can potentially solve many of the problems encountered in mobility, congestion, accessibility, safety, economy, environmental impacts, and etc. The key components that are experiencing the largest benefit from this study are mobility and environmental impacts.

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:

"Y2R6-18 Modeling the Impacts of regulations and Safety Constraints on UAV's Costs and Emission"

Project modeled the allocation and benefits of a new delivery systems such as shared lockers to improve the last-mile efficiency. In addition, the researchers developed a model to utilize the existing parking and curb resources by different delivery environments, vehicles types and new delivery systems.

"Y3R8-19 Incorporating the "Freight in Regional Land Use Planning Models"

Project demonstrated how emerging themes and new evidences of relevant economic (e.g., firm life cycle stages, stockholding process), logistic (e.g., off-hour deliveries, consolidation strategies), social (e.g., labor market conditions, firm delivery behavior), and governmental factors (e.g., operational restrictions, emission tax) can be meaningfully integrated in the land use models. The application of this study encouraged the input of a more diverse set of variables in freight generation models without limiting their applicability to external data beyond the sample. The study findings may also be useful for policymakers to incorporate the inherent changes in land-use patterns when attempting to design freight transport policy interventions.

"Y3R7-19 Identifying critical and vulnerable freight routes in roadway networks"

Project improve and implement on a testbed in Florida mathematical models and tools developed by the center to identify critical and vulnerable links and/or paths with a focus on freight movements under. Transportation networks are by nature vulnerable to natural and man-made disasters (or incidents). Vulnerabilities of transportation networks have been widely studied in recent years and are gaining even more attention with the growing number of threats (e.g., climate change, man-made attacks). In the US the transportation network is one of the largest and oldest in the world making also one of the most vulnerable ones. As traffic demand increases (despite the decrease in vehicle miles traveled) decision-makers are faced with the important task of identifying the vulnerable and critical links and routes in the transportation network and making decisions on investment that will protect and fortify the network against attacks. Addressing network vulnerabilities of transportation assets, in general, will minimize impacts of disruption, reduce recovery time and improve on the region's resilience.

"Y3R6-19 Optimal and Robust Control of Vehicle Platooning on Signalized Arterial with Significant Freight Traffic"

Project developed models and algorithms that will potential save time and emissions costs for trucks by dynamically involving platoon. In addition, the stability of the platooning processes improves traffic safety. Improving the mobility and safety of truck-car mixed traffic by robust control, will also benefit the mobility conventional in efficiency.

"Y3R5-19 Fathoming the Maximum Potential for Freight Sensitive Intersection Control"

Project will provide the opportunity for agencies and industry to calculate intersection delay. This work will not give every freight vehicle an overwriting power to the signal, but it will allow to consider a combined, weighted value of traffic in each approach in order to make a reasonable decision. This work will help

stakeholders and consulting companies to improve their control algorithms and improve their practices.

What is the impact on the body of scientific knowledge?

The impacts on the body of scientific knowledge are listed below:

The proposed "Y2R1-18 Interactive Web-based platform for Analyzing Freight Data" project produced a nationwide integrated data warehouse from the public and private sector to improve the freight transportation system. In this ecosystem, decision makers will be able to leverage innovations in big data analytics to evaluate the performance of the state's freight transportation assets or system, and also assess the essential role of freight to the State's economy. The platform also provided a flexible, easy-to-use, interactive web interface which could be used by state agencies to quickly identify causes or trends, and perform impact analyses of decisions. This will enable leaders to easily comprehend and act on valuable information much more quickly.

The development of the methods in the "Y2R8-18 Dynamic Trajectory Control and Signal Coordination for a Signalized Arterial with Significant Freight Traffic" project used knowledge from the fields of optimization and control theory. The development of the dynamic system and application of theories have shown effectiveness to solving the problems by using that knowledge. The fastest way is applied by using the knowledge to solve the problems compared to previous research on similar topics.

The work produced under the "Y2R7-18 Next Generation of Freight Planning and Operation Models to Incorporate Emerging Innovative Technologies" project will inform how newer technologies will affect freight transportation. Lessons learned from this project can be utilized by state and local planning agencies in their decision making and in facilitating appropriate infrastructure to accommodate upcoming innovations for improved understanding of freight mobility.

The "Y2R5-18 Optimizing of Winter Maintenance Stations for Safe and Efficient Freight Transportation" project developed an optimization model for finding the optimal location of stations for new construction or capacity expansion, considering desired service quality for major freight corridors, followed by assignment of stations and trucks to service zones. Two key aspects of the study that distinguishes it from regular station location optimization are 1) determining the freight volume on the state road network and determining critical links or zones for prioritized maintenance, and 2) accounting for stochastic model parameters, e.g. snowfall amount and storm duration, and employing robust optimization to design reliable service for extreme conditions. A decision support system was developed based on mathematical programing and road network topology in GIS. The decision support system could benefit agencies from a financial perspective by reducing the winter maintenance operations cost, and the freight industry by safe and efficient freight transport in winter.

The "Y2R10-18 Two-lane Highway Analysis Methodology Enhancements Considering Commercial Truck" project aims to improve the state-of-the-art accounting impact of trucks on two-lane highway operations. The work was accomplished by building on the work that was done for NCHRP Project 17-65. The issues examined in this project are ones which are very difficult and/or very expensive to study in the field. Thus, the SwashSim simulation tool was utilized exclusively in this project.

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. 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 fourteen graduate and undergraduate students who are actively involved in FMRI research and educational projects. Previous K-12 initiatives have also exposed many non-engineering college majors to the transportation and logistics engineering field. Multiple Graduate Courses were

developed and will continue to be developed based on FMRI research findings. Research conducted under the supervision of consortium members have developed new research findings and techniques for classroom learning. These techniques include:

- Reliability issues related to freight new technologies
- New mathematic models and sound scientific research process on the area of network modeling, routing schedule, and logistics.

In order to give graduate and undergraduate students a real-world experience, virtual filed trips have been given to FMRI students to port facilities. Virtual webinars and workshops have been held at multiple universities due to the effects of the pandemic throughout this period. Transportation Camps have also been impacted by the pandemic and have been put on hold. However, the center continues to promote technology transfer and outreach through virtual research and educational activities.

Changes/Problems

Changes in approach and reasons for change

As the FMRI continues to adjust its operations in response to the pandemic, the health and safety of everyone associated with FMRI remains top priority. To that end, most of our faculty and staff work remotely. In addition, our center's educational activities are conducted remotely and will continue to do so until the end of Spring 2021. All the center's lecture series, meetings with stakeholders, and other educational activities will be conducted remotely until further notice.

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

Nothing to Report

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

Special Reporting Requirements

This 2018 Annual Report:

- Outlines the new technology transfer (T2) plan and reporting requirement to guide and strengthen the University Transportation Centers (UTCs) technology transfer activities;
- Discusses the Fixing America's Surface Transportation Act (FAST Act, 49 U.S.C. §5505 as amended by P.L. 114-94, Sec. 6016) requirement for a Regional Center to address transportation safety, congestion, connected vehicles (CV), connected infrastructure, and autonomous vehicles (AV);
- Highlights examples of ongoing or recently completed UTC research projects by each of the 32 Centers; and
- Summarizes UTC program-wide performance indicators used to measure productivity at individual UTCs.

Last updated: Tuesday, May 28, 2019