FAU FREIGHT MOBILITY RESEARCH INSTITUTE
FLORIDA ATLANTIC UNIVERSITY

Semi-Annual Progress Report

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Project Title	Freight Mobility Research Institute (FMRI)
Center Director Name, Title, and Contact Information (email/phone)	Evangelos I. Kaisar Professor & Director Freight Mobility Research Institute (FMRI) Geomatics and Transportation Engineering Program Florida Atlantic University 777 Glades Rd. Bldg. #36, Rm. 214 Boca Raton, FL 33431 Tel: 561 297 4084 ekaisar@fau.edu
Name of Submitting Official, Title, Contact Information (email/phone)	Beatriz E. Bresani, Research Programs/Services Coordinator (FMRI), bbresani@fau.edu, (561) 504 -0362.
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Recipient Organization (name/address)	Evangelos I. Kaisar Professor & Director Freight Mobility Research Institute ekaisar@fau.edu (561) 297-4084
Recipient Identifying/Account Number	
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Report Term or Frequency (e.g. annual, semi-annual, quarterly)	Semi-Annual report for FMRI – UTC. This report covers the period from April 1, 2019 to September 30, 2020, per Exhibit B, Grant Deliverables and Requirements for UTC Grants (November 2016)
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. This is done 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 year three cycle, the center applied the procedures that have been establish for inviting research and educational proposals. The center applied the established review process involving advisory board members and local stakeholders. This process is based on external peer review and advisory board approval. Implemented process helped construct a functional way for the center's executive committee to approve peer review recommendations and provided funding for essential research. Research that 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 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 fourth year and fifth year cycle projects that have been awarded by the FMRI.
For final reports regarding the third-year – fourth year project projects, please explore the FMRI website, final reports will be published by Summer2021.

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 needs to be 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)

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)

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

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)

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

Fifth Year Research Projects

For the fifth-year period (June 1st, 2021 – May 31st,2022) 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 need to be sent through the full external peer review process. A peer review in which each project has at minimum of three external reviewers. Each project needs to be 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.

Below please find a brief description of the fifth-year projects: (Tittle and Abstract)

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. Figliozzi, Portland State University, PI: Dr. S. Mishra, University of Memphis, PI: Dr. M Golias, University of Memphis)

The ongoing COVID-19 pandemic has created a surge in the public interest and demand for innovative last mile delivery mechanisms such as Autonomous Delivery Robots (ADRs), and delivery lockers. Both options can provide contactless delivery, a highly sought-after service under the directives of social distancing. As a result, consumers, businesses, and governments have switched from being cautious beta testers into eager early adopters. Despite this unprecedented requirement necessitated by the pandemic, various innovative delivery mechanisms need to be deployed by logistics service providers and government agencies conforming to the expectations, needs, and motivations of consumers. This project offers imperative needs to conduct micro-level behavioral research on user acceptance early in the deployment roadmap of delivery robots and utilization of delivery locker. To date, however, scientific investigations on ADRs and delivery lockers have focused on the technical and regulatory challenges, and little attention has been given to evaluating user acceptance and their distribution. The national freight mobility goals are met when movement of goods from origin to destination is done seamlessly with satisfaction to users and other stakeholders. This research project attempts 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.

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

Truck caravanning is defined as a hybrid platooning with only one truck driver per platoon, the leader. Truck caravanning, capitalizing on the availability of SAS Level 5 automated trucks, has the potential to extend the profit and service quality for freight business beyond and in addition to benefits achieved by truck platooning. To date, extremely limited number of research efforts have reported/explored the truck caravanning potential for monetary savings from the use of smaller number of truck drivers. Research in Truck platooning operational models in general, have solely focused on savings from fuel consumption and emissions reduction, which numbers found in the literature vary greatly and are questioned among researchers. The goal of this research is not to evaluate the technical feasibility of truck caravanning, but rather to develop and use mathematical models and sensitivity analysis to evaluate and estimate cost savings from freight operations employing truck caravanning. In this project, and unlike research published for truck platooning or caravanning to date, cost savings are easily verifiable as only driver compensation is considered. Any cost savings from fuel and/or emissions reduction are considered only at the general implementation level of the proposed operational model for completeness as well as to allow comparison of the different elements involved in the overall cost/benefit calculation

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

Freight movements are expected to increase by approximately 42 percent by 2040. Trucks are expected to show the largest increase in flows by 2040 across all freight modes. However, the ability for transportation agencies to understand and adequately plan for increased truck movement and related impacts is still limited due to a lack of data on truck travel patterns. The main sources of truck data are truck surveys and truck counts collected by infrastructure-embedded sensors. Although surveys provide detailed information (i.e., truck type, Origin-Destination, weight, and vehicle miles traveled) useful for understanding truck activity patterns, they cannot be utilized to quantify truck activity at the geographical level due to low response rates. Connected vehicle (CV) data availability has been exploding in recent years. This is as a result of the advent of OEMs, Telematics platforms, and other in-vehicle technologies, that are able to continuously stream high-resolution, reliable and accurate vehicle data. The goal of this study 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 enables seamless integration 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 visualization 3 platform for exploring freight activity patterns

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

Efficient movement of freight is vital to the economic advancement of urban areas. With enormous disruptions in today's supply and demand chains, it is essential to have an accurate and connected inventory, and data to guide business decisions. Nowadays, information technology (IT) is the fuel of most supply chain business. Traditional approaches for studying international freight network design often relies on prior assumptions, which are not always accurate or even available. This is particularly true when dealing with unprecedented events. In addition, data often have high dimensions and volume, and information is hard to extract. This makes it difficult to process using traditional data processing applications and existing data management tools. Big Data (BD) is an emerging set of techniques of global interest, especially within the transportation industry. Advances in data mining techniques to support intelligent transportation systems has become a strong tool, but still underexplored. There is evidence of the enormous potential to improve supply chain disruption of freight transportation modeling using these advanced computing techniques. The development and application of advanced Machine learning (ML) models depend critically on the availability of data in tackling the freight network design problem and major disruptions. Under global disruptions, this is an invaluable feature that increase both efficiency and profitability and ensure adequate supply

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

Freight logistics are critical to quality of life and economies. However, freight mobility, especially along major freight corridors in urban areas, rarely get special consideration in signal timing. The advent of the Internet of Things (IoT) makes vast information collection a reality. The rich data environment, combined with the boost in computational power, has brought unprecedented opportunities closer to reality than ever before for real-time, information-driven intersection traffic control under variants of traffic scenarios. The rich information collected through sensors and through inter-vehicle communication has enabled large scale application of machine leaning, a proven powerful tool for efficient and responsive decision making. This proposal will build a coordinated traffic control mechanism based on machine learning in the context of big data with a specific objective of improving freight mobility along corridors.
More specifically, this research will focus on developing a new traffic responsive network signal control in general, but with freight traffic considered in particular, and provide new measures for optimal switching points for network signal control by directly translating general delay minimization into maximization of intersection throughput, and thus provide a solid theoretical basis for the subsequent reward design of the reinforcement learning. Finally, combine transport theory with reinforcement learning methods to design highly efficient network control algorithms. Numerical test via simulation will be conducted to show the benefits of the developed model and algorithms under different scales of truck traffic.

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

Freight traffic affects the performance of the road network significantly. When truck traffic is significant, the coordination of signals could fail according to the research of FMRI's first-year project. Trucks need extra distance and time for deceleration and acceleration. A traffic bottleneck appears more easily on a road segment or intersection where freight traffic is significant. To address these problems, strategies have been developed in the FMRI first and the 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.

On an arterial corridor, when freight traffic is significant enough, a truck-only lane may be a good idea to reduce the negative impact on the traffic flow when trucks and passenger cars are mixed in the same lane, and trucks with connected and autonomous vehicle technologies with make truck platooning practical and operational efficient. This project investigates the method for truck platooning in a truck-only lane. Unlike the issue of truck platooning on a freeway, turnings could happen more frequently on an urban arterial corridor. Considering the turning vehicles that join or leave from the corridor either at a midblock or intersection is the main concern of this year's project and present a new challenge in research of truck platooning. To ensure the safe turning maneuver when truck platooning is on the corridor has led to a coordination problem for vehicle maneuvers. Current methods for coordinating CAVs at intersections do not consider the signals in urban intersections and the truck platoon in a truck-only lane. This research will model the maneuvers of CAVs as time-discrete events and provide an analytical solution that schedules the time of CAV trucks to pass an intersection or join the platoon in the corridor given their sequences.

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, four-year, and fifth- 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. Unfortunately, this project has been postponed due to the pandemic, the project will resume with the program on Fall 2021.

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, second, and third 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. Webinars related to Transportation Management and Logistics from the FMRI including Consortium Partners
2. High School Teachers Virtual Workshop on Transportation Planning and Logistics
3. K-12 Student Transportation Essay Competition
    a. Bethel High School, Hampton, VA
    b. Heritage High School, Newport News, VA
4. Expand scholarship opportunities for students
5. 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
6. 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
   Kaisar – to provide information about the courses.

(Include here course information from Dr. Kaisar)

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 the center worked on was 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 had 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, is currently sponsoring 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 Florida 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 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. Efforts are to be executed by April of 2021

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.

Virtual Education Camp: (PI: Dr. S Maheshwari, Hampton University, CO-PI: Dr. S. Washburn, University of Florida, CO-PI: Dr. E. Kaisar, Florida Atlantic University)
A summer transportation 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. Proposed activities are listed below. Camp will be open to 30-35 participants

Transportation Education and Workforce Development Project: (PI: Dr. 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 Intermodal Freight Transportation Institute Consortium 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.

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.

October 7, 2020 – Dr. Alireza Khani, Assistant professor, University of Minnesota. *"Last-mile Delivery Using Shared Lockers".*
October 21, 2020 - Paulo Jotz, GoAwake . *"A Comprehensive Solution to Mitigate Traffic Accidents".*
November 10, 2020 - Lori Treviranus, Vice President of Transportation, KEITH. "*The State of Mobility and Industry from the Private Sector's Perspective".*
November 17, 2020 - Dr. Yinhai Wang, Professor, University of Washington. *"Making Transportation Infrastructure Smarter Using IoT and AI Technologies".*
December 16, 2020 - Dr. Bruce Wang, Professor, Texas A&M University. "*Modeling Truck Parking on Highways*".
February 10, 2021 - Dr. Scott Parr, Assistant professor, Embry-Riddle Aeronautical University. "*Traffic Impacts of the COVID-19 Pandemic: International Analysis of Social Separation and Activity Restriction".*
March 3, 2021 - Dr. Jamie E. Padgett, Professor, Rice University. "*Resilience of Intermodal Transportation Infrastructure Under Multiple Hazards".*
March 17, 2021 - Dr. Priyanka Alluri, Associate Professor, Florida International University. *"Role of TSM&O in Improving Freeway Operations".*
March 30, 2021 - Dr. Laetitia Dablanc, Professor, University Gustave Eiffel. "*Gig Workers for Delivery Platforms".*
April 12, 2021 - Josette Severyn, Senior Mobility Planner, Broward County. "*Multimodal Transportation Planning".*
April 28, 2021 – Dr. Sabya Mishra (University of Memphis) and Dr. Miguel Figliozzi (Portland State University). *"FMRI Research on Home Deliveries Equity and New Technologies under the COVID-19 Pandemic".*

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.

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. Back in November 4th, 2020, the center conducted the "Regional UTC Student Spotlight – Virtual Conference for the Southeastern Region". The conference consisted of 35+ students who shared with a virtual audience of 180 participants about their research and innovations. The sessions for the virtual conference consisted of: Transportation Resilience, Transportation Operations and Simulation, Smart Infrastructure and Operations, Freight and Logistics, and Connected and Automated Vehicles. With prestigious guest speakers such as the Deputy Assistant Secretary for Research and Technology, US Department of Transportation, Diana Furchtgott-Roth and the participation from consortium member universities, the conference was a success. The conference also incentivized students by promoting awards for the best three presentations.

In regards to other main events, the FMRI center is working on organizing the "Seventh Annual Regional UTC Conference" for Fall 2021 in Boca Raton, Florida or in a hybrid setting. 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 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:

The FMRI center conducted a virtual workshop entitled "**"Freight Planning & Operational Logistics for the New Normal"** during the virtual Transportation Research Board Annual Meeting that took place in January, 2021. This workshop discerned 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. Workshop break-out sessions also engaged participants and facilitate research-oriented discussions.

For upcoming events, the center is putting together a virtual workshop entitled **"Last Mile Delivery and 50 feet Logistics Challenges on the "New Normal"**. The workshop will take place at the 24th IEEE International Conference on Intelligent Transportation – ITSC 2021, Sunday, September 18, 2021. This workshop will address the "last-mile" during the "New Normal" by discussing critical issues affecting freight industry participants, planners, and policy makers. Also, it will identify innovative strategies and technologies which are being employed/developed to

facilitate 'last-mile'/'last 50 feet' delivery challenges from around the world. Additionally, it will analyze the adoption of various newly emerged initiatives in the pandemic era. Examples of initiatives are sustainable logistics, methods for last mile deliveries, logistics terminals location, and operations.

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 year four research cycle is in progress and the FMRI five-year Research RFP projects will be awarded in Summer 2021

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 conducted quarterly conference call 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 also discuss the fifth-year problem statements in the quarterly call that took 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 virtual 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- and four year projects, --More K-12 involvement
    a. An additional virtual workshop for K-12 teachers;
    b. Virtual workshops on preventing supply chain disruption during pandemic crisis;
    c. Virtual Essay Competitions;
    d. Virtual Transportation & Logistics Science Fair;
    e. Virtual Logistics & Summer Camps & Invite guest speakers from the Industry;
    f. Virtual High School Presentations and Volunteer Participation as Judges in STEM competition;
    g. Internship for minority students with local stakeholders;
    h. 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

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 four- and fifth year.

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. Figliozzi, 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. 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, 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, PI: Dr. M. Figliozzi, Portland State University, 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)

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.

Kaisar needs to provide info
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".

Ask the consortium members about. However we have info for UMN
Regarding cost share projects, Florida Atlantic University is working with the Florida Department of Transportation on the following project:

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?

Outputs

Outputs	Target	Progress
# of proposals/projects with collaborative efforts	6 collaborative proposals/projects	4 Projects in Year 4 2 Projects in Year 5
# 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	13 workshops/webinars/seminars	1 research workshop 1 educational workshops/seminars 11 ITE/WTS lecture series events
# of features articles of FMRI research	5 featured articles	11 articles accepted 4 under review
# of organizations participating in consortium activities	4 organizations	7 research-related organizations 5 educational organizations
# of attendees to seminar/webinar/outreach activities	304 attendees	259 research-based attendees 45 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, presented a virtual workshop on freight

planning and operational logistics for the "new normal". The workshop analyzed 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	14 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.

Waiting for quarterly reports

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:

Waiting for quarterly reports

"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. In person activities and hybrid events will start to take place in Fall 2021.

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