FAU FREIGHT MOBILITY RESEARCH INSTITUTE FLORIDA ATLANTIC UNIVERSITY

Semi-Annual Progress Report

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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 bring lasting and equitable economic benefits to the U.S. and its citizens. The Center 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 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 research and development that ***improves freight mobility through information technology, freight network modeling and operations, intermodal logistics, as well as freight and supply chain sustainability*** to promote smart cities, improve multimodal connections, system integration, and security, data modeling and analytical tools to optimize freight movements and improve efficiency. Also, to advance regional planning and setting of transportation priorities that deliver higher practice and economic growth and enhance productivity.

Major center activities are as following:

Advanced & Applied Research Improving Freight Mobility: Our research activities are multimodal/intermodal and multidisciplinary in scope, with the aims of addressing nationally and regionally significant transportation issues pertinent to economic competitiveness and providing practice-ready solutions. We have assembled top expertise on supply chain and logistics freight transportation, network modeling, sustainability, and ITS, representing leading universities across the nation with deep connections to local, state, and regional communities. Each of these 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 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 US DOT strategic goal of economic competitiveness. In consultation with our respective state DOTs and metropolitan planning organizations, as well as US DOT 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 student participation in transportation education.
- Workforce development and increased minorities participation in transportation field.
- Educated K-12 teacher as well as students in logistics and supply chain management.

What was accomplished under these goals?

In the first and second year, the center developed guidelines and procedures for inviting proposals. The submitted proposals conducted external reviews and the final projects selected for funding. FMRI research program aims to generate a body of knowledge that makes a significant contribution to solving freight transportation problems. Year 1 endeavors were a set of pre-selected launch projects from proposals submitted and reviewed during the proposal preparation process, which has allowed us to begin the research during Fall 2017. As the first year research projects completed, results from the data have been recorded and has been tested and/or deployed by the engaged stakeholders. Please find listed below a brief description of the first year project reports' research findings. The first year projects have been completed and are currently located on the FMRI website. Please explore the FMRI website for in-depth project results.

FMRI Y1R1-17 Modeling the Sustainability of Small Unmanned Aerial Vehicles Technologies (PI: Figliozzi, PSU)
This research presented novel data and models for deliveries utilizing small UAVs. Small UAVs were defined as aircrafts with a tare of up to 15 kg and a potential payload of up to 15 kg. The survey data shows that UAV payload, size, energy consumption, and cost are positively correlated and tend to increase together. Unfortunately, potential safety, noise, and last-yard constraints also increase as drone capabilities and size increase.
Breakthroughs in UAV technologies may affect the typical range of UAVs' energy consumption (assumed to be 10 to 32 wh/km in this research). For example, small fixed-wing UAVs with VTOL (vertical takeoff and landing) capabilities may become suitable one day for urban deliveries. Fixed-wing UAVs are considerably more energy efficient than multicopters in terms of energy consumption per unit distance flown. The methodology developed in this research will still be applicable even if there are major improvements in terms of UAV design, battery energy storage, range, and carrying capacity.
The future of UAV deliveries will also depend on other factors such as UAV noise levels, safety concerns, and last-yard delivery configurations. Future research efforts should study the logistical impacts of these factors.

FMRI Y1R2-17: Eco-Driving Study on Trucks along Signalized Arterial with Significant Freight Traffic (PI: Zhang, TAMU)
The experiment introduced an eco-driving strategy to optimize the driving behaviors of heavy-duty vehicles (trucks) at a signalized corridor. The results show that the model reduces emissions while slightly sacrifices travel time but the saving of emissions or time is not necessarily decreasing with the increase of the weighting factor w. This is due to that the two-level optimization model has considered the final time as a variable and a part of the objective function at the same time. The weighting factor can vary to help to find the optimal results. The activity behavior of individual vehicles shows that heavy-duty vehicles require a longer distance to take actions ahead of the intersection.

FMRI Y1R3-17: Enhancement of Transportation Network Analysis Tools for Truck-Related Planning and Operations – Part B (PI: Washburn, UF)
This project extends the HCM freeway TTR analysis methodology to the network level by integrating it with the UE traffic assignment methodology. As most network analysis uses simple link performance functions to represent the travel time and flow rate relationship, this project applies the HCM freeway facility core methodology, which can better represent freeway facility traffic conditions. Furthermore, the use of HCM freeway facility core methodology makes the proposed methodology more sensitive to the impacts of tracks through multivariate influences on PCE and more flexibility with lane configurations (e.g., managed lanes).
In addition, as the freeway network TTR analysis methodology is data and computationally intensive, this project developed a software tool, based on the modification and integration of two existing software programs: XXE (Washburn and Mannering, 2007) and HCM-CALC (Washburn, 2015), that can be used to apply the Facility TTR analysis methodology. This project also demonstrated an example implementation of the freeway network TTR analysis through the software tool. The software tool provides a convenient and efficient approach for transportation planners and researchers to conduct the freeway network TTR analysis methodology, which helps to bridge the gap between research and practice.

FMRI Y1R4-17: Identifying Potential Causes of Truck Bottlenecks on Freeways and Develop Mitigation Strategies (PI: Liao, UMN)

The research team worked with stakeholders to prioritize a list of key truck corridors in the Twin Cities Metro Area (TCMA). Monthly NPMRDS data were processed to measure travel time reliability and estimate truck delay at the corridor level and then to identify system impediments during peak hours. Performance measures, including truck mobility ratio, travel time reliability, and delay, were defined and computed using 24 months of NPMRDS data.

A reliability measure was processed and analyzed to evaluate the truck travel time reliability. The results indicate that the truck travel time in the PM peak period is less reliable than the travel time in the AM peak period. Similar to the TTR measure, roadways with signalized or un-signalized intersections are generally less reliable than freeways. At the corridor level, the TTTR95 measure is much higher than the RI95 measure. The variability of TTTR95 is also higher than the RI95 measure. This is mostly caused by the long-tail distribution of truck travel time from the NPMRDS data.

We identified six truck bottlenecks in the TCMA during the PM peak period to further investigate the potential causes of the congestion. Among the six bottlenecks, I-94 WB at I-35W in Minneapolis has the highest truck delay per mile in the PM peak on an average weekday. Average truck delay in the PM peak in this segment is 570 hours per mile or 775 hours in total. We found insufficient capacity, increasing demand, roadway geometry, and density of weaving points in a roadway segment are the key causes of traffic congestion among the identified bottlenecks.

We recommend painting solid white lines on the main roadway to discourage drivers from changing lane near the bottlenecks as a less expensive solution. Traffic signs and real-time traveler information could also be placed at locations prior to approaching the bottlenecks. Ongoing performance monitoring using NPMRDS or other sources of traffic data is needed to support transportation planning and operation.

FMRI Y1R5-17: Game Theory Applications for Seaport Cooperation, Competition, and Co-Opetition (PI: Gkolias, UM)

The project was successful in developing the conceptual and mathematical framework for port and liner shipping cooperation and competition, as well as developing in improved approach of modeling container terminal cooperation.

From the reviewed studies, one of the most suggested points for future research is to include uncertain or stochastic demand, only two authors (Do et al., 2015, Ishii et al., 2013) have used this assumption in their studies. Data unavailability is another major issue noted in the reviewed literature, which restricts researchers to completer and more realistic model development. Studies that do have empirical analysis more times than not do not have full information and have to make some assumptions and approximations (Asgari et al., 2013; Nguyen et al., 2015; Ignatius et al., 2018; Saeed and Larsen, 2010a; Park and Suh, 2015; Anderson et al., 2008; Do et al., 2015; Tuljak-Suban, 2017).

FMRI Y1R6-17: Modeling Adoption of Autonomous Vehicle Technologies by Freight Organizations (PI: Mishra, UM; Co-PI: Kaisar, FAU)

Based on the estimated parameter values, the predicted market penetration of CAVs for freight transportation is much slower than most other innovations. This is justified because of the revolutionary nature of autonomous vehicles; such a drastic change from traditional transportation methods promotes caution in an industry that already adopts innovations at a slow pace. It may take up to 70 or more years for CAVs to fully integrate into the freight transportation industry. A sensitivity analysis is also conducted to understand how the Bass model parameter values impact the results of the model. Changing the CoN value has a greater impact on the model output because the changes in adoption rate are felt immediately, whereas a change in the CoM value only produces noticeable variation after critical mass is achieved.

The approach is generic so it may be applied to any city in the world. The project was successful in developing an organizational CAV adoption approach to determine CAV freight demand for a particular city.

FMRI Y1R7-17: Truck Parking study: Unveiling the Parking Space Density and Truck Volume Relationship – Phase I (PI: Wang, TAMU)

The most critical finding in this report is that the number of trucks in a rest area, after a long time of simulation time, will converge to a specific value. In general, longer rest will result in a more substantial number of truck staying in a rest area, which meets the ordinary senses. Surprisingly, the choice of breakpoint has an unneglectable influence on the number of trucks parking rest area. Under the assumption of taking only one short rest within a day, averaging of their driving time before taking interval rest will result in an enormous impact to the nearest rest area in the downstream and following rest area for a significantly long time. The phenomenon provides new ideas to ease parking shortage from scheduling sides. Logistic companies are encouraged to maximize the first part of the driving time of their drivers.

The proposed simulation system would help measure the productivity of the truckers on the highway by the average travel speed over the driving and rest time. It will also assist policy makers or planners to quantify the impact of publicly provided infrastructure on the private operations.

The proposed simulation system would help people to consider trucking parking problem from different prospect rather than conducting the survey, which is more cost efficient. The simulation outcomes are beneficial for future rest area facility management and highway management. Future work includes setting up highway network framework other than a linear system, testing more real cases and proposing mathematical models of various factors.

Second Year Research Projects:

During last year's period (April 2018 - September 2018), the center has developed their Year 2 Request For Proposals (RFP) for research projects through discussion with the advisory board and the stakeholders under the center thematic areas. These projects have undergone full external peer reviews, with each project having three to four reviewers. Each project has been revised to reflect the comments from each peer reviewer. Once revised by the PI, these projects have been viewed by the Advisory Board and changed accordingly, as needed. The Year 2 approved research projects have been listed below. These projects have been started late 2018 and early 2019 depending when the project amendment has been signed. You may find the overview of these projects listed on the FMRI website, as well as the previous Program Project Progress Report.

FMRI Y2R1-18: Interactive web-based Platform for Analyzing Freight Data – Phase I (PI: Kaisar, Florida Atlantic University, Subcontractors: Edara, University of Missouri)

FMRI Y2R2-18: Sustainable Urban Freight Mobility through Optimization of Logistics Facility Locations (PI: Kaisar, Florida Atlantic University; Co-Investigator: Lili Du, PhD, University of Florida)

FMRI Y2R3-18: Disaggregation of Freight Flows for Tennessee (PI: Gkolias, University of Memphis)

FMRI Y2R4-18: Truck Parking Study: Unveiling the Parking Space Density and Truck Volume Relationship: Phase II (PI: Wang, TAMU)

FMRI Y2R5-18: Optimization of Winter Maintenance Stations for Safe and Efficient Freight Transportation (PI: Khani, University of Minnesota)

FMRI Y2R6-18: Modeling the Impacts of Regulations and Safety Constraints on UAVs Costs and Emissions - Phase II (PI: Figliozzi, Portland State University)

FMRI Y2R7-18: Next Generation of Freight Planning and Operation Models To Incorporate Emerging Innovative Technologies (PI: Figliozzi, PhD, Portland State University, Kaisar, PhD, Florida Atlantic University; Miguel; Mihalis Gkolias, PhD, University of Memphis; Sabyasachee Mishra, PhD, University of Memphis)

FMRI Y2R8-18: Dynamic Trajectory Control and Signal Coordination for a Signalized Arterial with Significant Freight Traffic (PI: Zhang, TAMU)

FMRI Y2R9-18: Truck Parking Needs in Tennessee (PI: Gkolias, University of Memphis, Subcontractors/Co-PIs: Dan Murray, American Transportation Research Institute; Airton Kohls, University of Tennessee, Knoxville; Chris Cherry, University of Tennessee, Knoxville)

FMRI Y2R10-18: Two-lane Highway Analysis Methodology Enhancements Considering Commercial Trucks (PI: Washburn, University of Florida)

Third Year Research Projects:

The center's third year research project proposals are currently under external peer review. Evaluations will be submitted to the center on or before May 15th, 2019. These project will follow the same protocol as previous RFPs, creating collaborative discussions through the Advisory Board and stakeholders. Please find below the listed potential third year projects:

FMRI Y3R1-19: Analysis of Freight Movement Within Regional Evacuations (PI: Kaisar, FAU; Co-PI: Dhanak, FAU; Subcontractor: Parr, ERAU)

FMRI Y3R2-19: Identification of Evaluation of Critical Urban Freight Corridors (PI: Kaisar, FAU; Co-PI: Teegavarapu, FAU)

FMRI Y3R3-19: Integrate Autonomous Delivery Vehicle into Sustainable Urban Logistics Planning and Optimization (PI: Kaisar, FAU; Co-PI: Liu, FAU)

FMRI Y3R4-19: Managing the Growth of Last-Mile Deliveries and Curb Space Demand (PI: Figliozzi, PSU; Khani, UMN)

FMRI Y3R5-19: Fathoming the Maximum Potential for Freight Sensitive Intersection Control (PI: Wang, TAMU; Co-PI: Zhang, TAMU)

FMRI Y3R6-19: Optimal and Robust Control of Vehicle Platooning on Signalized Arterial with Significant Freight Traffic (PI: Zhang, TAMU; Co-PI: Wang, TAMU)

FMRI Y3R7-19: Identifying Critical and Vulnerable Freight Routes in Roadway Networks: A Game Theory Framework and Application in the State of Florida (PI: Gkolias, UM; Co-PIs: Mishra, UM, Kaisar, FAU, Hourdos, UMN, Pujats, UM)

FMRI Y3R8-19: Incorporating Freight in Regional Land Use Planning Models (PI: Mishra, UM; Co-PI: Gkolias, UM)

Education and Workforce Development:

FMRI's education goal is to foster education and training to contribute to the development of the transportation workforce. Our approach is multi-disciplinary, multimodal, under this grant we are developing a series of education activities, from K-12 to graduate level. These programs build on the education and training programs available at the consortium universities.

For our second year educational projects, the center has developed two projects listed below by Hampton University, University of Florida, and Florida Atlantic University.

Curriculum Development for Highway Freight Transportation (PI: Washburn, University of Florida; Co-PIs: Du, University of Florida; Kaisar, Florida Atlantic University)

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: 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 Year connections, the K-12 programs will be expanded.

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

Major Activities:

1. Lecture Series from University.
2. Student Internships
3. K-12 Teachers Workshop
4. K-12 Student Transportation Essay Competition
5. K-12 Transportation and Logistics field trips
6. K-12 Transportation Science Fair

Specific Objectives

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

Significant results

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

The development and implementation of graduate courses continues, as TTE 6507 Maritime Freight Operations has played a key role in education and workforce development for the Fall 2018 semester at Florida Atlantic University. Dr. Evangelos Kaisar, Director of the FMRI, and his students visited the Port of Everglades to discuss port operations and logistics as part of the class curriculum. The port authorities gave a tour to the students on all the different sections of the port. The students were provided with information on logistics operations and management of the port. He also invited a guest speaker from the shipping industry, Mr. Pantelis Peter G. Los, director of the CTT

Shipping company, who gave a lecture on marine transportation. Mr. Los explained in detail the necessary procedures for the shipping operations, the strategies and the risks that are related to maritime freight operations.

The Department of Information Technology and Operations Management (ITOM) in the College of Business and the Department of Civil, Environmental and Geomatics Engineering (CEGE) in the College of Engineering and Computer Science at Florida Atlantic University is offering a new certificate program regarding Transportation, Logistics and Supply Chain Management. This 12-credit certificate permits graduate students to expand their knowledge on technical skills of transportation engineering and the analytical business decisions-making skills of supply chain management.

ITE Student Chapter Lecture Series at Florida Atlantic University

The FMRI aims to contribute to the life-long learning of transportation engineering. Along with classroom experience, 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 ITE Student Chapters from participating universities closely collaborate with the FMRI to organize educational lectures. Below are the listed lectures from this reporting period.

Mar. 13, 2019 - Victor Walker, M.S., Research Engineer, Idaho National Laboratory, and Amy Moore, Ph.D., Transportation Planning Engineer, Oak Ridge National Laboratory. “The Next Delivery to Your Door: Looking at the Future Energy Impacts of Innovative Freight Delivery Technologies”

Feb. 27, 2019 - Hady Salloum, Ph.D. - Stevens Institute of Technology. “Research Challenges in Maritime Security”

Feb. 15, 2019 - Ali Haghani, Ph.D. - University of Maryland. “Optimization of School Bus Operations”

Dec. 12, 2018 - Yorgos Stephanedes, Ph.D., P.E - University of Patra, Greece. “C-ITS, Last-Mile Delivery and Risk Management in Smart Cities”

Nov. 16, 2018 - Pitu Mirchandani, Ph.D. - Arizona State University. “Locating Platforms and Scheduling a Fleet of Drones for Emergency Delivery of Perishable Items”

Oct. 17, 2018 - Priyanka Alluri, Ph.D., P.E., FIU. “Drafting, Designing, and Deploying Wrong-Way Driving Initiative in Florida”

Sept. 13, 2018 – Anastasios Charisis, FAU. “Containership Routing-Scheduling”

How have the results been disseminated?

Project reports are published to the FMRI website and presented at FMRI lecture series, which are open to the public. Preliminary results are often presented at peer review conferences. All research projects are expected to result in refereed journal publications. In addition, dissemination is via new graduate courses and developed certificate programs, internship assistance, employment opportunities, professional development seminars and distinguish lecture series, and our website.

The FMRI research seminars serves as a forum for faculty, industry, and graduate students to present their research and work. Seminars and lecture series take place fall and spring semesters, open to public, and are well-attended.

The FMRI has recently established a social media effort, which includes Facebook and Twitter. Facebook and Twitter has 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 center has also recently purchased a subscription to an email distribution platform, Constant Contact. This will help further disseminate information, such as our annual reports, newsletters, and marketing content. The FMRI plans to establish quarterly newsletters sent through the email distribution platform to update stakeholders and other interested parties on the progress of the center.

Through conferences, the center has held workshop sponsorship throughout this period, which includes the following:

Smart Freight Mobility, Current Applications, and Guidelines for Future Development workshop at the 21st IEEE ITS Conference in Maui, Hawaii – November 2018. The presentations covered the use of drones, last-mile solutions, marine operations, and freight congestion.

Smart Initiatives and Intelligent Transportation Systems Applications for Efficient and Sustainable Freight Mobility workshop at the TRB 98th Annual Meeting – January 2019. The workshop explored emerging logistics and supply chain initiatives, methods for last-mile deliveries, multimodal freight mobility, port resiliency and logistics terminals operations. This event has produced a successful turnout with many participants attending and gained positive news coverage in Transportation Topics News.

The FMRI held a Supply Chain Sustainability and Transportation Resilience Workshop on Friday, March 29th at SeaTech, Florida Atlantic University in Dania Beach. This event brought together academia, government, and industry to discuss local research-based sustainability and resiliency in the South Florida region. The agenda gave attendees a chance to learn about updated local government activities and research information in panel sessions, presentations, and working group discussions.

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

FMRI Year 2 projects are fully initiated, as all projects started late 2018 and early 2019. Research findings will be disseminated as needed. Tasks and deliverables will be requested and inputted for the next Semi-Annual Report update.

FMRI Year 3 Research RFP projects have been established and are currently under review from external peer reviewers who specialize in these subject matters. The reviewers have until May 15th, 2019 to submit their evaluations, seeking guidance on maximizing their uniqueness, value, and applicability. Once revisions are made, the center's Advisory Board will be the last to approve these projects and make necessary changes. Our consortium research selection goal is to develop a comprehensive program that focuses on solving high-priority freight mobility problems. In subsequent years, the center will establish an annual request for proposals focusing on the stated theme as well as high priority needs expressed by our public and private sector partners.

The center will continue their relationship with their stakeholders and State DOTs on cost-share projects and other collaborative efforts in order for the FMRI to successfully deploy their technology transfer to the community. The center will also explore collaborative opportunities with local private and public sector entities in order to develop freight related research needs.

The FMRI will also develop local community educational and technology transfer efforts to advance the knowledge on transportation supply chain, management, logistics, and operations.

For the educational initiative, FMRI plans are to:

1. Implement the approved Year 2 projects, --More K-12 involvement
    a. Another workshop for K-12 teachers;
    b. Essay Competitions;

c. Transportation Science Fair;
d. Transportation Summer Camps;
e. High School Presentations;
f. Internships with local stakeholders.

2. Begin the Year 3 RFP educational projects, to build on the continuing educational project;
3. Continue dissemination of research results via our website, professional presentations, and our seminar series.

Participants & Collaborating Organizations

What organizations have been involved as partners?

The FMRI works with multiple partners on main projects, as well as cost-share projects to help further economic development. The center has developed multiple research collaborations for the Year 2 and Year 3 initiatives. The Year 3 research projects are currently under peer review. Please find below the collaborative projects for Year 2 and Year 3:

FMRI Y2R1-18: Interactive web-based Platform for Analyzing Freight Data – Phase I (PI: Kaisar, Florida Atlantic University, Subcontractors: Edara, University of Missouri)

FMRI Y2R2-18: Sustainable Urban Freight Mobility through Optimization of Logistics Facility Locations (PI: Kaisar, Florida Atlantic University; Co-Investigator: Lili Du, PhD, University of Florida)

FMRI Y2R7-18: Next Generation of Freight Planning and Operation Models To Incorporate Emerging Innovative Technologies (PI: Figliozzi, PhD, Portland State University, Kaisar, PhD, Florida Atlantic University; Miguel; Mihalis Gkolias, PhD, University of Memphis; Sabyasachee Mishra, PhD, University of Memphis)

FMRI Y2R9-18: Truck Parking Needs in Tennessee (PI: Gkolias, University of Memphis, Subcontractors/Co-PIs: Dan Murray, American Transportation Research Institute; Airton Kohls, University of Tennessee, Knoxville; Chris Cherry, University of Tennessee, Knoxville)

FMRI Y3R1-19: Analysis of Freight Movement Within Regional Evacuations (PI: Kaisar, FAU; Co-PI: Dhanak, FAU; Subcontractor: Parr, ERAU)

FMRI Y3R3-19: Integrate Autonomous Delivery Vehicle into Sustainable Urban Logistics Planning and Optimization (PI: Kaisar, FAU; Co-PI: Liu, FAU)

FMRI Y3R4-19: Managing the Growth of Last-Mile Deliveries and Curb Space Demand (PI: Figliozzi, PSU; 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: Gkolias, UM; Co-PIs: Mishra, UM, Kaisar, FAU, Hourdos, UMN, Pujats, UM)

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 workshops, lecture series, internships, and field trips. These partners include Newport News School District (K-12 logistics education), Hampton School District (K-12 logistics education, Hampton School District Logistics Academy member), Hampton University (workshops, lecture series, internships, and administration), Canon, Inc. (field trips and internships), Norfolk Southern Corp. (internships), Hampton Roads Transits (internships), Virginia Department of Transportation (field

trips and internships), Virginia Port Authority (field trips and internships), Unilever (internships), and Massimo Zanetti Beverage USA (internships).

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, 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 towards research collaboration, collaborative research, discussion of research gaps and contributions to the new Portland Freight Master Plan.

University of Florida is working in conjunction with the University of South Florida on a Florida Department of Transportation project, providing matching funds through the project "Commercial Heavy Vehicle Impacts on Signalized Arterial Corridor Performance." Project #: BDV25 TWO 977-50.

Florida Atlantic University is working with the Florida Department of Transportation on the following projects:

Florida Department of Transportation. "Evaluation of Freight and Transit Signal Priority Strategies in Multi-modal Corridor for Improving Transit Service Reliability and Efficiency" Subcontractor FIU. Monthly meetings take place for discussion on progress.

Florida Department of Transportation. "Evaluation of Truck Tonnage Estimation Methodologies."

University of Memphis currently is 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?

Nothing to Report

Outputs

Outputs	Target	Progress
# of proposals/projects with collaborative efforts	5 collaborative proposals/projects	4 projects in Year 2 3 Projects in Year 3
# of website page views	2,500 page views	1,897 pages views
# of conference presentations	10 conference presentations	21 conference presentations
# of peer-reviewed papers	6 peer-reviewed papers	4 peer-reviewed journal papers 3 under review, 5 in preparation

Publications, conference papers, and presentations

Journal publications

Chauhan, D., Unnikrishnan, A., & Figliozzi, M. (2019). Maximum coverage capacitated facility location problem with range constrained drones. Transportation Research Part C: Emerging Technologies, 99, 1-18.

Du, L., Spana, S. Locating and Scheduling Inner-City Hubs for Last-Mile Deliveries (Under review)

Miao*, Q., Y. Li, X. Wang. 2018. A Generalized Decomposition Algorithm for Real-time Truck Routing Problems. Pesquisa Operacional, Brazilian Operations Research Society. Accepted.

Mishra S., Talebian A., Simpson J., Golias M.M. An Estimation of the Future Adoption Rate of Autonomous Trucks by Freight Organizations. Research in Transportation Economics (Under review)

Simpson*, J., Mishra, S., Talebian, A., Golias, M.M. Disaggregated prediction of autonomous trucks adoption by freight organizations. Transportmetrica-A: Transport Science (Under review)

Wang, X., Y. Li, L. Quadrifoglio and K. Yin*. 2018. Distribution Product Packaging to Maximize the Net Revenue. Computers & Industrial Engineering. Accepted.

Wang, X., K. Yin* and H.X. Liu. 2018. Vehicle Actuated Signal Performance under General Traffic at an Isolated Intersection. Transportation Research Part C: Emerging Technologies. 95 582-598.

Books or other non-periodical, one-time publications

Figliozzi, M., Tucker C., and Polikakhina P., (2018), Drone Deliveries Safety, Logistics, and Sustainability Trade-offs (July 2018, ILS conference proceedings)

Figliozzi, M. (2018). Modeling the Sustainability of Small Unmanned Aerial Vehicles Technologies, Freight Mobility Research Institute.

Jennings, D., Figliozzi, M. (2019), A Study of Sidewalk Autonomous Delivery Robots and Their Potential Impacts on Freight Efficiency and Travel, Proceedings 98th Annual Meeting of the Transportation Research Board, Washington DC, January 2019.

Identify for each one-time publication

Hampton University

"The Impact of Negative Twitter Feed on Washington Metropolitan Area Transit Authority Ridership"

Abstract

Few studies have focused on the effects of Twitter data on public transportation. Of the studies, none examined the relationship between Twitter and public transportation ridership. Using data from Washington Metropolitan Area Transit Authority (WMATA) and @unsuckdcmetro, the most influential consumer-run Twitter handle dedicated to WMATA, this study examined whether negative Twitter sentiment (average daily negative sentiment [ADNS]) and volume-related variables (i.e., tweets, retweets, and likes) affect the change in ridership after negative sentiment days. Tweets from @unsuckdcmetro were collected for approximately one year and analyzed using linguistic inquiry and word count (LIWC) to determined days in which sentiment about WMATA was predominately negative. A total of 64 negative days were found. Ridership data were used to determine the percentage change in ridership (PCR) of Day +1, Day +2, Day +3, and Day +4 after negative sentiment day, which were used as the dependent variables.

Both analysis of variance (ANOVA) and post-hoc tests were used to explore the relationships between the different levels of each independent variable (i.e., ADNS, the daily number of tweets, the daily number of retweets, and daily number of likes) and each of the dependent variables. The results showed that all variables, except the number of tweets, were statistically significant to the PCR, as the volume of each variable increased. Additional analysis was performed using linear regression models to determine if any of the independent variables could be used as a predictor of PCR. There was statistically significant regression in the PCR using ADNS values over 2.00 on Day +3. There were no significant predictions in PCR using any of the other independent variables.

Other publications, conference papers and presentations

Charisis, A. Containership Routing and Scheduling with Multiple Time Windows. Fifth Biennial Marine Transportation System Research and Development Conference. Washington, DC, June 2018.

Chauhan, D., Unnikrishnan, A., Figliozzi, M. Maximum Coverage Facility Location problem with Drones. EURO OR Conference, Bologna Italy, Jun. 2018.

Kaisar, E. Short Sea Shipping vs. Trucking: A Cost-Benefit Analysis Using Mathematical Modeling. Fifth Biennial Marine Transportation System Research and Development Conference. Washington, DC, June 2018.

Al-Ghandour M., and Kaisar E. Big Data for STIP Management. ASCE International Conference on Transportation & Developments, Pittsburgh, PA, July 15-18, July 2018.

Figliozzi, M., Tucker C., and Polikakhina P. Drone Deliveries Logistics, Efficiency, Safety and Last Mile Trade-offs. International Conference on Information Systems, Logistics and Supply Chain, Lyon, France, July 2018.

Simpson*, J., Mishra, S., Talebian, A., Golias, M.M. Disaggregated Prediction of Adoption Rate of Autonomous Trucks by Freight Organizations. Poster presentation at 2018 AUVSI symposium, San Francisco, July 2018.

Charisis, A. Multi-objective Optimization Model for Establishing Logistics Facilities in Urban Congested Areas. FAU Research Showcase. Boca Raton, Fl, September 21, 2018.

MD Sultan A., and Kaisar E. Bus Priority Treatment Guidelines for Identifying Corridor Conditions that Deploying Transit Signal Priority. 25th ITS World Congress, Copenhagen, Denmark, September 2018.

Charisis, A. Multi-objective Optimization Model for Locating Logistics Delivery Facilities in Urban Areas. 6th Annual UTC Conference for the Southeastern Region. Clemson, South Carolina, Oct. 2018.

Charisis, A. Vessel Scheduling Considering Multiple Time Windows and Berth Constrained Split Deliveries. 6th Annual UTC Conference for the Southeastern Region. Clemson, South Carolina, Oct. 2018.

Manta, S. An Optimization Model for Evaluating the Economic Competitiveness of Short Sea Shipping. 6th Annual UTC Conference for the Southeastern Region. Clemson, South Carolina, Oct. 2018.

Manta, S. Implementation of Freight Signal Priority Strategies for Improving Freight Operations. 6th Annual UTC Conference for the Southeastern Region. Clemson, South Carolina, Oct. 2018.

Charisis A., Mitrovic N., and Kaisar E. Container Shipping Route and Schedule Design with Port Time Windows and Coordinated Arrivals. 21st Annual IEEE ITCS conference, Maui, Hawaii, November 2018.

Manta, S. Implementation of Freight Signal Priority Strategies for Improving Freight Operations. 21st IEEE ITS Conference. Maui, HI, Nov. 2018.

Stephanides Y., Golias M.M., Dedes G., Douligeris C., Mishra S. Challenges, Risks and Opportunities for Connected Vehicle Services in Smart Cities and Communities. In proceedings of the 2nd IFAC Conference on Cyber-Physical and Human Systems. Miami, FL, Dec. 2018.

Charisis A., and Kaisar E. Multi-Objective Capacitated Location-Allocation Model for Urban Logistics Delivery Facilities. 98th Transportation Research Board Annual Meeting, Washington, D.C., January 2019.

Jennings, D., Figliozzi, M. (2018), A Study of Autonomous Delivery Robots and Their Potential Impacts on Freight Efficiency and Travel. 98th Annual Meeting of the Transportation Research Board, Washington DC, January 2019.

Manta S., Kaisar E., and Hadi M. The Impact of Signal Priority Strategies on Multimodal Corridors. 98th Transportation Research Board Annual Meeting, Washington, D.C., January 2019.

Simpson J., Mishra S., Talebian A., Golias M.M., Disaggregated Prediction of Adoption Rate of Autonomous Trucks by Freight Organizations. 98th Annual Meeting of the TRB. Washington, DC, January 2019.

Talebian A., Mishra S., Golias M.M., Khan J.A., Santo C., Wang L., Jacobs E., Astorne-Figari C., Simpson J. A holistic index for readiness to accommodate connected autonomous vehicles. 98th Annual Meeting of the TRB. Washington, DC, January 2019.

Jennings, D., Figliozzi, M. (2018). A Study of Autonomous Delivery Robots and Their Potential Impacts on Freight Efficiency and Travel. Portland State University, Portland OR (post-TRB event), February 2019.

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:

Discussion of 98th Annual Meeting of the Transportation Research Board presentation on Transport Topics website https://www.ttnews.com/articles/robotic-vehicles-loading-zone-updates-seen-tools-final-mile-delivery

Mishra, Sabya, "Scenarios for Adoption of Autonomous Vehicle Technologies in Freight" (2018). TREC Friday Seminar Series. 160.
https://pdxscholar.library.pdx.edu/trec_seminar/160

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

Under Hampton University, the workshop material for K-12 teacher (special High School) teacher was renewed.

A 60-minute lecture was created and presented for High School Students for Logistics, called "Transportation Logistics, and Marketing."

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 will be shared in a published paper.

The software product developed through the Enhancement of Transportation Network Analysis Tools for Truck-Related Planning and Operations – Part B Year 1 project will help transportation agencies perform travel time reliability at a network level, which is also sensitive to the vehicle performance of commercial trucks. 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

Inventions, patent applications, and/or licenses

Nothing to Report

Outcomes

Outcomes	Target	Progress
# of workshops/seminars/webinars developed	8 workshops/webinars/seminars	3 research workshops 4 educational workshops/seminars 7 ITE lecture series events
# of features articles of FMRI research	5 featured articles	4 articles accepted 3 under review
# of organizations participating in consortium activities	4 organizations	4 research-related organizations 7 educational organizations
# of attendees to seminar/webinar/outreach activities	120 attendees	158 research-based attendees 46 education-based attendees 233 ITE attendees

What outcomes has the program produced?

Under the research component, there is an increased understanding of adoption of new automobile technologies and their implications on transportation planning and movement of people and goods, as well as cooperation between marine container terminals, the limitations of current approaches used and proposed a new approach that overcomes these limitations.

The center studied truck parking by developing a simulation and examining analytical models, which has not been explored in literature. Successful carryout of this project will facilitate adequate policy development to improve trucking efficiency and safety along the freight corridors. In addition, the center also conducted traffic control involving freight traffic, which is fundamental in accommodating freight operations especially in urban areas. Also, a new cooperative control algorithm has been developed to control multiple vehicles (trucks) to pass multiple signalized intersections.

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

- Lecture and visit to West Boca High School and Forest Hill High School, Fall 2018.
- Two industry lectures presented to two high schools of logistics, Bethel High School and Heritage High School in December 2018.
- 8 female and minority students placed in industry as interns at Canon, Inc., Norfolk Southern Corp.,

Hampton Roads Transit, VA Dept of Transportation, VA Port Authority, Unilever, and MZB-USA.

- K-12 workshop conducted for high school teachers (7 teachers participated). A logistics/transportation lecture plan was shared with high school teachers to be delivered.
- An essay competition among high school student has been organized for two high schools. Submissions are awaited.
- K-12 Transportation Science Fair has been planned for Fall of 2019. Participation flyer has been distributed to two high schools.

The FMRI held and sponsored workshops, conferences, and other events during this period. The FMRI, with the assistance of Dr. Manhar Dhanak of FAU, held a Supply Chain Sustainability and Transportation Resilience Workshop on Friday, March 29th at the SeaTech, Florida Atlantic University in Dania Beach. This event brought together academia, government, and industry to discuss local research-based sustainability and resiliency in the South Florida region. The agenda gave attendees a chance to learn about updated local government activities and research information in panel sessions, presentations, and working group discussions.

The center hosted the Smart Freight Mobility, Current Applications, and Guidelines for Future Development workshop at the 21st IEEE ITS Conference in Maui, Hawaii – November 2018. The presentations covered the use of drones, last-mile solutions, marine operations, and freight congestion.

The center also hosted the TRB 98th Annual Meeting Workshop 1090, "Smart Initiatives and Intelligent Transportation Systems Applications for Efficient and Sustainable Freight Mobility." The workshop explored emerging logistics and supply chain initiatives, methods for last-mile deliveries, multimodal freight mobility, port resiliency and logistics terminals operations. This event has produced a successful turnout with many participants in attendance and gained positive news coverage in Transportation Topics News. More about this coverage may be viewed under the Website(s) and Other Internet Site(s) section.

The center has co-sponsored events during this period as well, including the 6th Annual UTC Conference for the Southeastern Region on October 24-25, 2018 in Clemson, South Carolina. This conference gathered students, faculty, staff, practitioners, and public figures throughout the Southeast to connect the academic, public- and private-sectors to foster collaborative relationships.

The center also participated in and co-sponsored the Florida Supply Chain Summit on February, 6-7, 2019 in Orlando, Florida. This event brought businesses and universities together to discuss the needs of innovation and personnel in supply chain efforts for the Florida industry.

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. Examples below show the first initiatives the center is taking with the Year 1 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, truck platooning, etc. in Texas.

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	8 partnerships
# of adopted methodologies, models, and tools	2 adopted models	2 adopted models

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

Under the education effort, K-12 students' exposures to various transportation fields through lecture series, field trips, essay competition, Transportation Science Fair, and Teacher's workshop will help move students to a career in transportation engineering and logistics.

Under the research effort, the center, for the project Truck Parking Study: Unveiling the Parking Space Density and Truck Volume Relationship, studied truck parking by developing a simulation and examining analytical models, which has not been explored in literature. Successful carryout of this project will facilitate adequate policy development to improve trucking efficiency and safety along the freight corridors. In addition, the center also conducted traffic control involving freight traffic, which is fundamental in accommodating freight operations especially in urban areas.

Since the algorithm will influence the trajectories of both trucks and conventional vehicles under the Dynamic Trajectory Control and Signal Coordination for a Signalized Arterial with Significant Freight Traffic project, the heterogeneous traffic is regulated thus the throughput at one intersection and at the whole corridor is improved. The travel time is saved for all vehicles.

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 project Y1R5-17 Game Theory Applications for Seaport Cooperation, Competition, and Co-Opetition can assist marine container terminal operators and port authorities in identifying optimal contractual agreements (for sharing capacity for serving liner shipping companies) and identify optimal operational plans that support implementation of such contractual agreements. The impact of organizational adoption research is that, until today in transportation literature, we have not seen any organizational adoption research as the technological evolution has not been significantly different in the past. But with more innovations being introduced to the market, this research will provide a new body of knowledge to understand adoption and future demand of new technologies. Other disciplines who will benefit from this research are: business administration, industrial engineering, behavioral economics, city and regional planning.

In the Dynamic Trajectory Control and Signal Coordination for a Signalized Arterial with Significant Freight Traffic project, the developed models and algorithms will have the potential to be implemented in onboard devices for driver assistantship systems, or as a part of the infrastructure (signal) control system prototypes.

The Truck Parking Study: Unveiling the Parking Space Density and Truck Volume Relationship project would allow private sectors to associate truck parking problems along the interstate highways with the supply of parking capacities so that they may proposal projects to add parking capacities for truckers. The signal optimization project will allow consulting firms on signal to improve their control algorithms to improve practices.

What is the impact on the body of scientific knowledge?

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

New understanding of the emissions tradeoffs associated to the utilization of drones or UAVs under Modeling the Sustainability of Small Unmanned Aerial Vehicles Technologies project.

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

The work produced under project Game Theory Applications for Seaport Cooperation, Competition, and Co-Opetition is likely to make an impact of the base of knowledge and research in maritime transportation. The research developed a framework to address the collaboration between marine container terminals and liner shipping companies. The research project also offered new avenues of research on competing welfare maximizing port authorities and competing profit maximizing terminal operators, introduction of uncertainty, and development of solution algorithms for the mathematical models that were developed as part of this project.

The Enhancement of Transportation Network Analysis Tools for Truck-Related Planning and Operations project created a new capability to analyze network-level travel time reliability at a macroscopic level. This methodology and tool now gives the practice an analysis capability, within reasonable time constraints, that was not previously available. This will ultimately allow agencies to make more information highway network investment decisions.

What is the impact on transportation workforce development?

The impact on the local transportation workforce development has been greatly influenced by the efforts under the FMRI. Multiple endeavors, including post-doctoral researchers, graduate research assistants, and student assistants have worked under the center projects, providing opportunities for research, teaching, and training in transportation. Currently, there are 15 graduate and undergraduate students who are actively involved in these projects. K-12 initiatives have also exposed many non-engineering college majors to the transportation field. Classes will be developed based on research information, as well.

These programs have provided opportunities for research and teaching in transportation to graduate and undergraduate students, including the applications of CAV (connected and automated vehicle) technology with multiple intersections. The research conducted will provide new information for classroom learning, such as sustainability issues related to freight new technologies, and new mathematic models and sound scientific research process on the area of microscopic traffic modeling, dynamic vehicle control, and systems design.

In order to give students a real-world experience, tours have been given to FAU students at the Port of Palm Beach, as well as Port Everglades. Students were able to tour the Lehigh Cement Facility at Port Everglades and have a discussion with Mr. Jorge Armenteros, Vice President of Cement Sales Florida, about logistics, safety, job prospects, market share, and the growing Florida industry. Students also had a chance to tour the Port of Palm Beach, exploring Tropical Shipping, Florida Sugar & Molasses Exchange, and cruise ship docking area, by Mr. Carl Baker, Director of Planning and Development.

Transportation Camps and Workshops have been held at multiple universities throughout this period. FAU held a two-week long Transportation Camp during June and July 2018. The graduate research assistants were heavily involved in teaching the students about ArcGIS based spatial analysis, VISSIM based intersection simulations, basics

of transportation engineering, freight operations, logistics, connected and automated vehicles, and traffic count observations. The campers also took part in debates, quizzes, and fun transportation-related cards games.

University of Minnesota's Minnesota Traffic Observatory (MTO) hosted two groups of 9th grade students from the College of Science of Engineering's summer Eureka! Program on Thursday, July 19th. Gordon Parikh, MTO Engineer, introduced the students to general surface transportation and freight safety, while Dr. John Hourdos, Director of Research and consortium partner, introduced the students to microscopic traffic simulation. Eureka! Program is a five-year summer and school year program for girls focused on Science, Technology, Engineering, and Mathematics (STEM), building sisterhood with girls from all over the Twin Cities, exploring career interests and dreams while supporting them through high school graduation and preparing them for the next step in their post-secondary education.

University of Florida's Dr. Scoot Washburn, held a 2-hour afternoon workshop for interested high-school students on computing applications in transportation engineering for the University of Florida's Gator Computing Camp on June 12, 2018.

Changes/Problems

Changes in approach and reasons for change

In addition to the individual vehicles, the behaviors of a truck platoon passing consecutive signalized intersections are investigated under the Dynamic Trajectory Control and Signal Coordination for a Signalized Arterial with Significant Freight Traffic project. Robustness will not be completely investigated during the next reporting period since it will be specifically explored in the proposed third-year project.

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