

Request for Research Funding for FY 2021-2022

Requesting Office	PTO CO	Priority	1 of 2
Proposed Title	Evaluating and Validating Technology Options for Estimating Transit Vehicle Occupancy in Real Time		
Justification	<p>Significance of Transit Vehicle Occupancy Estimation</p> <p>Estimating transit vehicle occupancy is essential for transit system planners and operators to optimize the delivery of transit services, measure the relative efficiency of transit operations, and assess the in-vehicle travel experience of transit riders. For public transit riders, the information on transit vehicle occupancy is desirable because such information is important for transit riders to make informed travel choices (such as take transit or not, board the incoming bus or wait for the next one), similar to the real-time vehicle arrival information that is already widely provided by transit agencies throughout the U.S. The real-time occupancy information is also necessary for transit riders to use public transit with confidence during the ongoing COVID-19 pandemic and the post-COVID era, because proximity to other passengers inside a transit vehicle is now widely viewed as a potential health risk or safety concern. Providing the occupancy information in real time is clearly helpful for current and future riders to ride transit more safely and confidently.</p> <p>Challenges in Estimating Transit Vehicle Occupancy in Real Time</p> <p>Conventional methods for estimating transit vehicle occupancy are usually based on manual surveys, automatic passenger counter (APC) data, or automated fare collection (AFC) data. Each approach may have various disadvantages. For instance, manual surveys are very labor-intensive and thus expensive, which cannot be conducted frequently. In most cases, the manual surveys can only collect a sample dataset for the calculation of vehicle occupancy. In addition, manual surveys may not be accurate due to human error, especially at locations with considerable boarding and alighting. While APC data could provide relatively accurate counts of boarding and alighting passengers, APCs may not be available in all transit systems or all routes of a system. In a fully controlled rail transit system (ticket validations required at the entry and exit), train loads can be inferred by jointly considering a passenger’s entry and exit times (obtained from AFC data) and train schedules. Nonetheless, very few transit systems are equipped with the AFC system recording both entry and exit transactions. Therefore, estimating transit vehicle occupancy, especially in a real-time and cost-effective manner, remains challenging.</p> <p>Emerging information and communication technologies (such as mobile ticketing, Wi-Fi, temperature sensing, radio-frequency identification, and crowdsourcing) may have the potential to advance the practice of estimating transit vehicle occupancy in real time. As no research has been done to evaluate and validate such occupancy estimation technologies, the overall objective of this proposed project is thus to evaluate and validate all potential information and communication technologies that can be employed to estimate transit vehicle occupancy in real time. As Florida transit agencies differ significantly in sizes, service regions, classes of customers, types of services (bus and rail), and information technology infrastructure support, the project will consider the high diversity of transit systems in Florida in conducting the technology evaluation, because a technology that works the best for one transit agency may not be preferred by another. Therefore, this proposed project is timely and very relevant to Florida, thus justifying this funding request.</p> <p>Proposed Research Activities</p> <p>The following research tasks are proposed:</p> <ol style="list-style-type: none"> 1) Identify a list of potential technology alternatives for transit vehicle occupancy estimation by scanning the academic literature, news, and technical reports, as well as interviewing transit practitioners. 2) Evaluate all potential technologies from a technical point of perspective (such as measurement accuracy, latency, reliability, level of automation, ease of implementation and use, and maintenance needs), involving both hardware and software. 3) Evaluate all potential technologies considering non-technical factors (such as cost efficiency, privacy impact, and user acceptance). 		

	<p>4) Develop detailed documentation of promising technologies, covering technical capabilities, privacy, barriers to implementation, risks, cost, and possible vendors.</p> <p>5) Conduct pilot studies and validate selected technologies at three representative transit operators in Florida.</p> <p>6) Complete a technical report on selecting and implementing a vehicle occupancy estimation technology.</p> <p>7) A free webinar will be delivered to disseminate the project findings.</p> <p>In Task 5), pilot studies are proposed to examine whether a candidate technology can achieve the expected level of performance (e.g., estimation accuracy). Considering the diversity of transit systems, the following three transit systems in various regions of Florida are proposed for the pilot study:</p> <ul style="list-style-type: none"> o StarMetro in Tallahassee: medium-sized bus transit system in north Florida (District 3). o LYNX in Orlando: large bus transit system in central Florida (District 5). o Miami-Dade Transit in Miami: large multi-modal (bus + rail + people movers) transit system in south Florida (District 6), or Broward County Transit in District 4. <p>To represent all possible scenarios, one transit route/line in each system can be selected. A suburban bus route will be selected in Tallahassee; a bus route serving the urban core will be selected in Orlando; a Metrorail line in Miami or a different route in Broward County may be selected. The route/line selection will be finalized based on feedback from representatives from the involved transit operators.</p> <p>StarMetro in Tallahassee has tentatively agreed to participate in the pilot study. Andrea Rosser and Ronnie Shelly will be involved. Coordination with transit operators in other districts are pending.</p>
<p>Impact</p>	<p>This proposed research, once completed, can advance the current practice of collecting, validating, and disseminating real-time transit vehicle occupancy information. The obtained vehicle occupancy information can help system operators better understand how transit capacity is utilized by location, route, direction of travel, and time period. The project report can also help other transit agencies that are not involved in the pilot study of this project select their preferred vehicle occupancy data collection technology.</p> <p>Once the real-time vehicle occupancy information is available, transit agencies can integrate such information into their mobile apps or signage at transit stops so that passengers can easily access such information. Therefore, this project will help identify promising technical solutions for supplying real-time vehicle occupancy information for transit riders to make informed travel choices. The extra travel information in addition to the real-time vehicle arrival provides a more complete view of the transit service, thus potentially attracting more travelers to transit.</p>  <p>If this project is not conducted, transit agencies in Florida may not know clearly how to select and deploy the right technology to collect their vehicle occupancy information. This further creates difficulty in generating performance data related to in-vehicle overcrowding and meeting government directives on social distancing. Passengers will not have necessary information for them to use public transit safely and confidently, which will hurt the transit ridership.</p>
<p>Affected Offices</p>	<p>The Public Transit Office will be affected.</p> <p>Gabrielle Matthews, Planning Administrator at the Public Transit Office, will be involved in the scoping of this proposed project.</p>
<p>Existing Work</p>	<p>After searching in both databases with keywords listed in the next item, it is found that the research on the evaluation of transit vehicle occupancy estimation technologies in real time has not been done yet. First, the existing vehicle occupancy estimation studies are primarily for auto travels not for public transit. In addition, the occupancy estimation is usually at a high level, such as regional or state, not at a vehicle level. More</p>

	importantly, none of the existing vehicle occupancy estimations are developed for real-time applications, because they are primarily for ex-post evaluations.		
Keywords Used In Existing Work Search (Cannot leave blank)	Public transit + one of (vehicle occupancy, vehicle load, overcrowding, in-vehicle congestion) + one of (real-time estimation, dynamic estimation)		
Related Contracts (Give contract numbers)	<p>After searching the following databases/websites, no contracts related to public transit vehicle occupancy estimation in real time have been found:</p> <p>https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/research/program_information/contract.development/fy/fy21-dec.pdf</p> <p>https://www.fdot.gov/research/documents.shtm</p> <p>https://trid.trb.org/</p> <p>One project titled “Vehicle Occupancy Data Collection Methods” and numbered BD-015-9 was done by the Transportation Statistics Office of FDOT. This report is primary for passenger cars, not for transit vehicles. In addition, the report is not about real-time estimation.</p>		
Funding Request	\$200K	Anticipated Duration	18 months
Project Manager	Gabrielle Matthews	Contracting Method	Direct contract with university
Urgency	1 (highest, most immediate need)	The sooner the proposed research is completed, the better public transit operators throughout Florida will understand how to systemically evaluate and choose a technical solution for estimating transit vehicle occupancy, especially in real time. The sooner the real-time occupancy information is made available to riders, the more confidence transit riders will have in their transit travels with Florida transit agencies. Thus, this request for funding should be considered with high priority.	
Implementability	1 (greatest likelihood of and proximity to implementing results)	The first stage of this project is to identify, evaluate, and document a list of potential technology alternatives, which will be ready to be used by transit planners and operators upon the completion of Task 4. Since Task 5 involves real-world validations of certain occupancy estimation technologies, coordination is needed with selected transit operators as proposed earlier. StarMetro in Tallahassee has tentatively agreed to participate in the pilot study. If all proposed pilot studies are successfully completed, the project findings and suggestions can be directly implemented by all interested public transit operators in Florida.	
Project Benefits (Succinct, complete explanation)			
Upon the completion of this project, transit planners and operators in Florida can better understand how to select a technology for estimating transit vehicle occupancy according to their agency-specific needs. Such vehicle occupancy information can help transit operators better understand how transit capacity is utilized by location and time. On the passenger side, the real-time vehicle occupancy information will empower existing and new passengers to make informed travel decisions and use public transit safely and confidently. The benefits of such information for passengers are immediate during the ongoing pandemic. The benefits will be sustained beyond the pandemic because in-vehicle crowding and seat availability has been a major factor in making transit travel plans, regardless of a public health crisis or not.			
Project Benefits (Select all that apply and explain)	Quantifiable Benefits (units, dollars, etc...if applicable)	Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits	
<input type="checkbox"/> Materials Enhancement		NA	
<input type="checkbox"/> Materials Savings	Saved investments in technologies	This project will incorporate both technical and non-technical factors in the evaluation of various technologies for transit vehicle occupancy estimation. As those technologies differ significantly in their infrastructure/equipment and	

		operating costs, a carefully selected technology after a systematic evaluation will save both initial investments and long-term operating and maintenance costs.
○ Time Savings	Reduced labor costs	Transit operators may use the project findings to find new ways for estimating the transit occupancy, thus reducing or eliminating labor-extensive and expensive manual surveys.
○ Lives Saved/Injuries Prevented	Improved public health	The transit occupancy information can help travelers make informed choices and reduce the risk of disease transmission during a pandemic.
○ Other (Explain)	Improved rider satisfaction, travel experience and ridership	The real-time vehicle occupancy information in addition to the real-time vehicle arrival information can improve the image of public transit services. As the travel experience and rider satisfaction improve, transit ridership will likely to be boosted as a result.

*Comments should explain and support urgency, financial benefit, and implementability scores