

Final Report

Technology Transfer and the Implementation of FDOT Research Results

FDOT Contract No. BDV30-977-24

July 2020

Prepared for Florida Department of Transportation



Prepared by:

Patricia (Born) Schriefer, Ph.D.
(Principal Investigator)



COLLEGE OF BUSINESS
*Dr. William T. Hold/The National Alliance
Program for Risk Management & Insurance*

Jason Bittner, PMP
Kevin Elliott
(Subcontractors)



DISCLAIMER

“The opinions, findings and conclusions expressed in the publication are those of the authors and not necessary those of the State of Florida Department of Transportation.”

METRIC CONVERSION TABLE

Approximate Conversions to SI Units				
Symbol	Known	Conversion Factor	Find	Symbol
Length				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
Area				
in ²	square inches	645.2	Square millimeters	mm ²
ft ²	square feet	0.093	Square meters	m ²
yd ²	square yard	0.836	Square meters	m ²
Volume				
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic meters	m ³
Mass				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
Temperature (exact Degrees)				
°F	Fahrenheit	5(F-32)/9 or (F-32)/1.8	Celsius	°C
Force and Pressure or Stress				
lbf	poundforce	4.45	newtons	N
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa
Approximate Conversions from SI Units				
Symbol	Known	Conversion Factor	Find	Symbol
Length				
mm	millimeters	0.039	inch	in
m	meters	3.28	feet	ft
Area				
mm ²	Square millimeters	0.0016	square inches	in ²
m ²	Square meters	10.764	square feet	ft ²
m ²	Square meters	1.195	square yard	yd ²
Volume				
m ³	cubic meters	35.314	cubic feet	ft ³
m ³	cubic meters	1.307	cubic yards	yd ³
Mass				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Temperature (exact Degrees)				
°C	Celsius	1.8C+32	Fahrenheit	°F
Force and Pressure or Stress				
N	newtons	2.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in ²

TECHNICAL REPORT DOCUMENTATION

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Technology Transfer and the Implementation of FDOT Research Results		5. Report Date May 29, 2020	
		6. Performing Organization Code	
7. Author(s) Patricia Born		8. Performing Organization Report No.	
9. Performing Organization Name and Address Florida State University – College of Business William T. Hold/The National Alliance Program in RMI Department of Risk Management/Ins., Real Estate & Legal Studies 821 Academic Way, Tallahassee, FL 32306-1110		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. BDV30 977-24	
12. Sponsoring Agency Name and Address Florida Department of Transportation 605 Suwannee Street, MS 30 Tallahassee, FL 32399		13. Type of Report and Period Covered Final Report 1/1/2018 to 5/31/2020	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract Demonstrating that a project is beneficial requires coordination and collaboration by the researchers to ensure that appropriate information is collected at the appropriate stages of the research. The Financial Achievability Model (FAM) facilitates the process of prioritizing projects that can demonstrate the benefits of research, but the application of FAM involves coordination and staffing that often is difficult for the functional area to leverage. The lack of documented results of the research creates further complications in articulating the results to those who have the ability to implement them. To justify the expenditures included in research, a more formalized approach is needed to capture anticipated benefits of the research and, consequently, realized benefits of the implemented research results, including both qualitative and quantitative assessments. During the research, appropriate measures for quantifying the research outcome should be identified; these measures are important inputs for a subsequent tracking of the results of implementation. A formalized process will lead to increased implementation and greater realization of the benefits of research. The purpose of this project was to formalize an implementation process that effectively captures data that can be used in the FAM and other information respective of the implementation effort and value gain, while maximizing technology transfer of research results.			
17. Key Words Financial Achievability; Implementation Tracking		18. Distribution Statement No restrictions	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 174	22. Price

ACKNOWLEDGMENTS

The funding of this study was provided by the Florida Department of Transportation. The project was managed by Dr. Patricia Born at Florida State University with the assistance of Jason Bittner and Kevin Elliot, both from Applied Research Associates, Inc. (ARA).

EXECUTIVE SUMMARY

The purpose of this project was to formalize an implementation process that effectively captures data that can be used in the Financial Achievability Model (FAM) and other information respective of the implementation effort and value gain, while maximizing technology transfer of research results. The project objectives included a variety of activities that emphasized improving processes for information gathering and improving the transfer and dissemination of research results to implementation.

Throughout the project, the research team communicated with, and provided feedback to, the Research Center staff, Project Managers (PMs), and Principal Investigators (PIs) to identify where efforts at improving the research and implementation processes should be focused. In particular, the research team suggested a process for identifying implementability and a system for tracking implementation, both of which can begin as soon as implementable research results are obtained. The research team worked with the Research Center staff to develop a template for collecting implementation plans.

The research team assisted in selecting projects for implementation. This was done through a comprehensive review of completed research projects beginning in 2014 and involved discussions with the project managers in all functional areas. Research projects with implementable results were added to the Research Center's Implementation Tracking System. Discussions with the functional areas included emphasis on data collection to enable quantification of the net benefits of the research, which would, consequently, allow for application of the FAM. The researchers encouraged the dissemination of implementable results across functional areas as soon as possible, especially when the research yields favorable qualitative and quantitative net benefits. To this end, the researchers recommended several modifications to reports collected during the research phase to encourage early identification of qualitative benefits, quantitative benefits, and potential for implementability.

The employment of revised reporting forms at various stages of the research project was complete midway through this project. To ensure the proper use of the forms and interpretation of the

information solicited, the research team recorded a webinar. The webinar covers all reporting requirements from the initial proposal through the implementation survey.

The FDOT participates in many pooled fund research projects. The research team considered whether and how pooled fund research projects should be evaluated. While some projects may fit into the FAM methodology, the research team suggests that a Balanced Scorecard approach may also be useful for retrospective analysis of the net benefit of FDOT contributions to these projects.

In conjunction with Research Center staff, the researchers evaluated ongoing or recently-completed projects with high tech transfer potential. The research team created fifteen articles for use by the Research Center staff. These articles have been posted on the Research Center's Research Showcase site. Finally, the research team prepared an annual report, providing a showcase of all Research Center activities for 2018.

Table of Contents

DISCLAIMER	ii
METRIC CONVERSION TABLE.....	iii
TECHNICAL REPORT DOCUMENTATION	iv
ACKNOWLEDGMENTS	v
EXECUTIVE SUMMARY	vi
LIST OF FIGURES	x
LIST OF TABLES.....	x
CHAPTER 1 – INTRODUCTION	1
1.1 Objectives and Tasks.....	2
CHAPTER 2 – REVIEW OF PROJECTS.....	4
CHAPTER 3 – TEMPLATES AND DOCUMENTS.....	7
3.2 Forms Used Throughout the Research Process.....	8
3.3 Implementation and Dissemination Report.....	9
3.4 Annual Report	9
CHAPTER 4 – TRAINING WEBINARS	10
CHAPTER 5 – TECHNOLOGY TRANSFER MATERIALS.....	11
CHAPTER 6 – ASSESSMENT OF POOLED FUND PROJECTS.....	13
6.1 Balanced Scorecard Framework.....	14
6.2 Applying the Balanced Scorecard Approach to Assess Individual Pooled Fund Projects..	15
6.3 Process for Selecting Criteria and Reporting Pooled Fund Projects.....	15
6.4 Balanced Scorecard for FDOT Projects	17
CHAPTER 7 – CONCLUSIONS AND RECOMMENDATIONS	20
Appendix A. Review of Projects Completed, 2014-2017.....	22
Appendix B. Notes on Projects in the Implementation Tracking System	40
Appendix C. Review of Projects Completed in 2019	55
Appendix D. Screening Tool	79
Appendix E. Close-out Survey Questionnaire with Suggested Edits	83
Appendix F. Research Process Forms: Kickoff Survey.....	85
Appendix G. Research Process Forms: Midpoint Survey	90
Appendix H. Research Process Forms: Closeout Survey	93
Appendix I. Research Process Forms: Deployment Plan	97
Appendix J. Dissemination and Implementation Plan.....	103

Appendix K. Webinar Slides	112
Appendix L. Technology Transfer Content	124

LIST OF FIGURES

Figure 1. Lifecycle Framework..... 7
Figure 2. Balanced Scorecard Diagram 16

LIST OF TABLES

Table 1. Articles for FDOT Research Center May 2018 – June 2019..... 11
Table 2. Key Success Factors – Balanced Scorecard Causal Analysis..... 18
Table 3. Sample Success Factor and Weights 19

CHAPTER 1 – INTRODUCTION

State department of transportation research centers, including Florida's, throughout the country are focused on conducting research with practical, implementable benefits. This objective poses a variety of challenges, including the identification and quantification of expected benefits; the coordination, monitoring, and measuring of implementation; the formal reporting of implementation; and the extent to which the research results are transferred to those who plan to apply them.

In a prior research project, BDV30-977-12, the research team developed a model for evaluating the net benefits of research for the FDOT. The “Financial Achievability Model” has subsequently been applied to a range of projects to determine the applicability of the framework to projects with differing characteristics. This research suggests that one of the biggest barriers to assessing the project benefits is the lack of an organized data collection effort. Demonstrating that a project is beneficial requires coordination and collaboration – between Project Managers (PMs) and Principal Investigators (PIs) – to ensure that appropriate information is collected at the appropriate stages of the research. Seeking projects in which to demonstrate the benefits of research involves coordination and staffing that often is difficult for the researchers to leverage.

The lack of documented results of the research creates further complications in articulating the results to those who have the ability to implement them. Implementation definitions vary considerably across transportation research programs. For the purposes of this effort, implementation efforts will be defined as the “systematic incorporation of research results into accepted and sustained organizational business practice.” By adopting this definition, the project efforts will focus on technology transfer that provides for the dissemination of research results to those most affected by research scenarios.

In order to justify the expenditures included in research, a more formalized approach is needed in order to capture anticipated benefits of the research and, consequently, realized benefits of the implemented research results, including both qualitative and quantitative assessments. During the research, appropriate measures for quantifying the research outcome should be identified; these

measures are important inputs for a subsequent tracking of the results of implementation. A formalized process will lead to increased implementation and greater realization of the benefits of research.

FDOT allocates over \$2 million per year on cooperative research projects through the National Cooperative Highway Research Program (NCHRP) and Transportation Pooled Fund (TPF). Measuring the costs and benefits associated with these projects poses unique challenges, e.g., how to obtain the required data, communicate the research results, etc. Processes developed for valuing research, tracking implementation, and communicating benefits will need to be adapted to capture the unique features of these cooperative projects.

1.1 Objectives and Tasks

The purpose of this project is to formalize an implementation process that effectively captures data and information respective of the implementation effort and value gain, while maximizing technology transfer of research results. Specifically, the project objectives include:

- 1) Conducting meetings with PMs, PIs, and other relevant parties to determine the desired impact of the research result through implementation.
- 2) Identifying opportunities for coordination and collaboration across desired locations and functional areas.
- 3) Assisting in selecting projects for implementation and establishing demonstrations (e.g., field tests) of research results through peer review and assessment.
- 4) Reporting the quantification of research benefits demonstrated through implementation.
- 5) Communicating results of implementation to encourage broader use, e.g., to statewide or area-specific implementation.
- 6) Assisting with the appropriate technology transfer of the research result through an end-of-project webinar, initial development of training materials, relevant articles, blog posts, and formal reports.
- 7) Updating and maintaining the research center's implementation tracking mechanism.
- 8) Establishing the formalized process for preparing an annual report.
- 9) Instituting and formalizing the reporting processes of implementation and technology transfer through annual and project-specific reporting.
- 10) Valuing the totality of the Research Center projects (by fiscal year started) with the emphasis on implementable projects identified by the research team.

This project had its official kick-off in January 2018. This report is a synthesis of all work performed by the research team between January 2018 and May 2019 to put implementable research results into action and further the application of the FAM. The completed tasks include:

- Task 1. Review All Active and Recently Completed Projects
- Task 2. Develop Implementation and Dissemination Template
- Task 3. Assist in Implementation Plan Development, Conduct, and Attend Kickoff Meetings
- Task 4. Conduct webinar
- Task 5. Create content for technology transfer
- Task 6. Develop Evaluation Approach for FDOT's Cooperative Research Projects
- Task 7. Draft Final and Closeout Teleconference
- Task 8. Final Report

CHAPTER 2 – REVIEW OF PROJECTS

This chapter is divided into two parts. First, we discuss our review of the projects completed since 2014 to determine which projects have implementable results. Then, we discuss our review of all projects completed in 2019 to assess the progress in tracking the financial achievability and implementability of research results.

2.1 Review of Projects Completed, 2014-2017

While our objective was to review projects that may have implementable findings and to develop a process for this identification, the main goal of this task was to identify and prioritize research projects completed since 2014 that could be moved into the Implementation Tracking System.

Appendix A presents all research projects that were completed between 2014 and 2017, listed by functional area. We reviewed the proposals and, where available, the final reports for all of these projects and noted those with results that may potentially be implemented. Our comments on all projects were provided in an Excel file to the Research Center staff. We developed separate lists, one for each functional area, which are shown in separate tabs in the worksheet. These were shared with the project managers (PMs) in each area for review. Each functional area (except for Planning) provided feedback to clarify or explain the status of the research results. Based on this feedback, we highlighted in red the projects that we recommended should be moved to the Implementation Tracking System. The PMs, in conjunction with Research Center staff, made final decisions on which additional projects could be implemented/tracked. This effort included identifying a champion to lead each project moved into the system. Our comments are included in Appendix A.

Beginning on June 4, 2018, we participated in a series of meetings with each functional area to discuss projects that had already been moved into the Implementation Tracking System. Meetings took place on June 4 (Materials), June 11 (Planning, Transit, Transportation Data & Analytics; FLP Transit, June 20 (Traffic Engineering & Operations). In these meetings, we had an opportunity to learn more about how the PMs and PIs were applying the research findings. In most cases, the

PMs and/or PIs made reference to data that they were already collecting for the purpose of tracking the benefits of implementation.

In general, we felt that the PMs responsible for tracking implementation were aware of the need to collect information. We reminded the PMs that baseline data would be needed so that an assessment of the net benefits could be assessed using the Financial Achievability Model (FAM). In some cases, we asked about the type of data that would be needed. The notes from these meetings are provided in Appendix B.

2.2 Review of Projects Completed in 2019

In April and May 2020, the research team reviewed all 49 projects that were completed in 2019. The purpose of this review was to assess whether there has been an improvement since the prior review of projects in (1) discussion and identification of research benefits, (2) discussion of potential for implementing research results, and (3) discussion of the data needed to conduct a FAM analysis. Appendix C contains our comments on these projects.

Overall, there has been a significant improvement in the Research Center's process for soliciting research benefits. However, our review indicates that there is still misunderstanding among PIs and PMs regarding statements of project benefits. We anticipated that qualitative and quantitative benefits that are noted in the kick-off presentation will be vaguer and more uncertain than those proposed in the close-out presentation. In fact, this is an expectation built into the FAM, which anticipates that information gained during the research process will help reduce the uncertainty regarding potential benefits and potential for implementation. We did note that many projects still provide an uncertain description of qualitative and/or quantitative benefits even at the close-out, or in the final report, suggesting there is still room for improvement.

The assessment of whether the research project contains results that can be implemented is now routine. PMs are reporting, and the Research Center is able to track, whether the research results can be implemented immediately or if (1) further research, (2) field testing, or (3) a pilot study might be required before full implementation is possible. However, there is still little information provided in final reports or close-out presentations that would describe how implementation could be tracked to determine the financial benefits of the research results.

The research team suggests further efforts to train PMs in the process of identifying benefits and to help them to better articulate how benefits could be measured (i.e., describe the data that must be collected to apply the FAM). We note that the wide range of research subjects complicates the ability of the Research Center staff to provide any more than a conceptual overview of the requirements for identifying research benefits. Thus, we propose a series of workshops aimed at specific types of projects that would focus on more specific applications of the FAM (e.g., to all PMs in only the Materials group).

CHAPTER 3 – TEMPLATES AND DOCUMENTS

This chapter describes the various templates and documents prepared by the research team to assist in (1) screening projects for implementation and (2) developing an implementation plan. It also provides a discussion of the annual report prepared for the Research Center.

3.1 Development of Screening Tool

Implementation is the process of integrating evidence-based research or entirely new practices within an existing business function for the agency. This implementation process is reliant on intentional and procedural stages coincident with the research life cycle (spanning from project initiation to reporting and closeout). The research team proposed development of a prescriptive process for implementation project activity

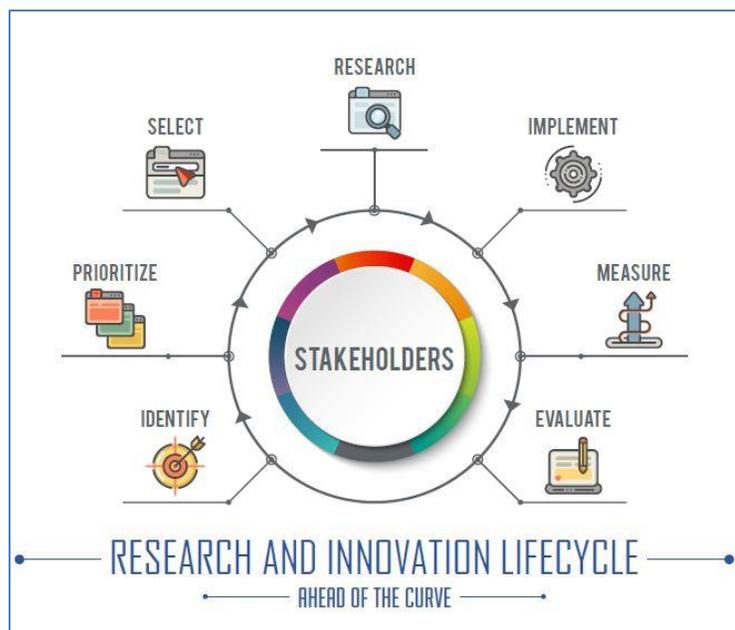


Figure 1. Lifecycle Framework

spanning several stages: Planning, Engaging,

Executing, and Evaluating. Successful implementation relies on iterative, interacting activities related to these four stages during the research life cycle (see Figure 1). While this prescriptive framework provides guidance for agency management, it remains one tool of many in the research implementation and dissemination toolset. As this framework was developed, we prepared a screening tool - *An Instrument for Screening Transportation Research Endeavors for Implementation Potential* – that will help identify institutions and individuals that will take leadership in dissemination and application of the research results (i.e., an implementation team) as well as provide assessments of the impediment and drivers for implementation activities. This screening tool was developed by the research team, based on efforts of Dr. Judy Smith-Davis during the 1980s and has been updated since then. It is derived from the classic R&D literature

on the dissemination, diffusion, adoption, and implementation of innovations in education and related disciplines. The screening tool is provided in Appendix D.

3.2 Forms Used Throughout the Research Process

We identified several opportunities to initiate implementation discussions earlier in the research initiation and selection processes. Initially, we focused on incorporating the information in the screening tool with the information that is currently collected for project close-out meetings. We made some suggestions for changes to the close-out survey questions, shown in Appendix E, which is now routinely used for all research projects.

While not a major focus of this project, the research team monitored the use of all forms to ensure that every possible opportunity for collecting information about (1) net benefits of the research, and (2) potential implementation of the research results. This information can be collected from the initial proposal, kick-off surveys, progress reports, final reports, close-out presentations, and the implementation survey. Our review of the projects completed in 2019 (see Chapter 2) was especially focused on these forms. Forms with fillable data fields were created for each of these, and are provided in Appendices F-I as follows:

- Appendix F: Kickoff Survey
- Appendix G: Midpoint Survey
- Appendix H: Closeout Survey
- Appendix I: Deployment Plan

The research team does not see a need to modify the forms any further at this time. Rather, it is important that adequate training be provided to ensure the form-driven data collection process produces relevant information.

The research team concludes that it is especially important to consider the timing of collecting implementation information in concert with the collection of information for the financial achievability model (FAM). The notes collected in our meetings with functional areas (see Appendix B) were posted in the Implementation Tracking System, but follow-up on these projects was limited due to staff turnover in the Research Center. We encourage the Research Center staff to continue moving toward a system in which the PMs, PIs, Research Center staff, and consultants can provide sharable updates on a regular basis. It was clear in our review of projects that the

Research Center needs to provide more education and support to the PMs to ensure that the FAM and Implementation Tracking processes are not onerous, and continue to build a culture of satisfaction in showing the value of the research and the value of implementing the research results

3.3 Implementation and Dissemination Report

Task 2 of the project was devoted to the development of a tool that would be used to plan the dissemination and implementation of research results. Specific objectives for the tool include:

- Identification of institutions and individuals that will take leadership in dissemination and application of the research results (i.e., an implementation team)
- Description of the audience or "market" for the research results, and value proposition for application of the research results by each principal audience segment
- Realistic assessment of impediments and drivers (i.e., Competency, Organization, and Leadership Drivers) to successful application of the research results
- Targeted technology transfer activities to achieve this project's objective, considering items (i) through (iii) (e.g., demonstration or pilot projects in host agencies, regional workshops, and peer exchange meetings; creation of a "community of interest"; development of promotional materials; etc.).

The Dissemination and Implementation Plan is provided in Appendix J. By using this approach, consistent with other national efforts, the project research team and Research Center staff will be able to identify clear approaches and paths to implementing research results.

3.4 Annual Report

After data collection and discussions with the Research Center Staff, a draft annual report was submitted to the Research Center in June 2019 (see attached, "FDOT 2018 Annual Report Edit2_June 2019.pdf").

CHAPTER 4 – TRAINING WEBINARS

Task 4 of the research project involved conducting a webinar outlining the process and facilitating technology transfer practices. The research team created a webinar presentation in consultation with the Research Center staff.

On Tuesday, December 4, 2018, the research team gave a “dry run” presentation on the Financial Achievability Model (FAM) to the Research Center Staff at the FDOT offices. A revised presentation was shared in mid-January with the Research Center after responding to comments.

On January 24, 2019, the research team gave a revised presentation to Research Center Staff and a small group of Project Managers at the FDOT offices. During and following the presentation, questions and comments were collected from the participants.

On February 5, the PI recorded a final webinar presentation. The slides for the final webinar are provided in Appendix K.

The webinar provides an introduction to the FAM which includes a discussion of the development of the model and an overview of the process for conducting analysis of project costs and benefits. The research team recommends that the Research Center staff consider arranging some smaller, focused seminars for PMs, preferably functional area, soon after funding decisions are made, to ensure that the process for collecting data for application of the FAM is in place before the research commences.

CHAPTER 5 – TECHNOLOGY TRANSFER MATERIALS

Task 5 of this project involved the preparation of content for technology transfer. Each month during the first year of the project, the research team, in collaboration with the research performance coordinator, identified research projects with high tech transfer potential. These included projects being implemented, recently completed projects that were close to implementation, and ongoing research yielding interesting results. Upon direction from Department staff, the research team created fifteen blog posts, articles, and other forms of technology transfer media. The content included background subject research and interviews with stakeholders.

Table 1 contains a list of the twelve articles created by the research team between May 2018 and October 2019, including the date submitted and the date posted (where applicable) on the FDOT Research Center’s “Research Showcase” website. Appendix L includes copies of all content submitted to the Research Center.

Table 1. Articles for FDOT Research Center May 2018 – June 2019

Topic	Project	Due	Delivered	Posted
Sinkhole Detection with 3-D Full Elastic Seismic Waveform Tomography	BDV31 977-82	5/1/18	5/1/18	5/11/18
UFTI I-Street Overview	BDV31-977-74	6/1/18	6/1/18	7/16/18
A Data-Driven Approach to Implementing Wrong-Way Driving Countermeasures	BDV29-977-36	7/2/18	7/2/18	7/31/18
A Pilot Study for Preventing Incorrect Turns at High-Rail Grade Crossings	BDV25 977-11	8/1/18	8/1/18	9/10/18
Optimal Design of Stormwater Basins with Bio-Sorption Activated Media (BAM) in Karst Environments – Phase II Field Testing of BMPS	BDV24-977-20	9/1/18	8/28/18	9/24/18
FDOT Project Makes AASHTO's Sweet 16	BDV25-977-30	10/1/18	9/18/18	10/29/18
Analysis of Freight Transport Strategies and Methodologies	BE277	11/1/18	11/2/18	12/3/18
Commercial Truck Parking Detection Technology Evaluation for Columbia and Marion County Rest Areas	BDV31 977-56	12/1/18	12/1/18	1/7/2019

Table 1. Articles for FDOT Research Center May 2018 – June 2019 (continued)

FDOT Access Management Benchmarking Study	BDV25 977-41	1/1/19	1/2/19	4/8/2019
Development of Statewide Guidelines for Implementing Leading Pedestrian Intervals in Florida	BDV25 977-22	2/1/19	2/1/19	
TR News "Research Pays Off" Article	BDV25-977-30	4/1/19	4/1/2019	
Improving Access to Transit through Crowdsourced Information	BDV26 977-05	4/1/19	4/1/19	6/17/2019
Dynamic Flashing Yellow Arrow (FYA) - A Study on Variable Left Turn Mode Operational and Safety Impacts - Phase III	BDV24-977-21	5/1/19	5/1/19	
Co-mingling Offsite Flows	BDV24 977-16	6/1/19	6/4/19	7/15/2019
Thermal Integrity Profiling for Augered Cast-In-Place Piles	BDV25 977-34	8/19	8/19	

One additional product of this research study was an animated video detailing the FDOT Research Center’s project solicitation and selection process. This video was designed to help promote the submission of research ideas and project suggestions.

CHAPTER 6 – ASSESSMENT OF POOLED FUND PROJECTS

Transportation research provides solutions. Results today lead to improvements to health, safety, environmental conditions, economy, mobility, good stewardship, and improved social interactions. Effective transportation research is not only about the research deliverables but understanding the outcome from implementation (in financial, process, societal, environmental, and other perspectives). In an era of limited resources and accountability pressures, evidence-based displays of the impacts of research become crucial.

One of the limitations on a data-intensive model such as the FAM is evident in the Research Center's contributions to pooled funds. In most of these cases, the Research Center does not have regular access to the financial records associated with the research activities. A host state or program generally holds these records. The intent of this task was to provide a repeatable framework to address the qualitative and quantitative elements to harmonize the process of evaluating these projects with other FDOT-funded research projects. The Financial Achievability Model (FAM) allows the Research Center to assess the net benefits of research projects in a framework that captures the costs and benefits of research activities from the initial kick-off of the research through implementation of the research results. The FAM framework is flexible and can be adapted for application at various stages of the research. In the earlier stages of research, the model allows for the inclusion of expected costs, i.e., it allows for uncertainty in the research outcome, implementability, potential scope of implementation, etc. It can be applied to research proposals, in-progress work, completed projects, pilot programs and, ultimately, full implementation of research results when data on the actual costs and benefits can be collected. As with any economics-based decision framework, the successful application of this framework requires the accurate identification, capture, and valuation of the relevant cost and benefit data.

At its core, the FAM requires the accurate identification, capture, and valuation of the relevant cost and benefit data associated with research activities. Pooled funds do not provide the same level of detail that Research Center-led projects can provide, but this does not mean the FAM cannot be leveraged to assess the value of these projects. Costs are generally relatively easy to identify and are composed of the costs of participating in the research project, project manager (PM) time, and, the expected costs of implementing the research findings. Benefits of the research

may also be straightforward, though uncertain at the outset. Implementing the FAM requires an appropriate allocation of the costs incurred to the benefits that are derived from that spending. It may be especially difficult to apply the FAM approach to NCHRP pooled fund projects because the costs are shared by many and the benefits – if they can be quantified – may not accrue equally among the participants of the research. The flexibility of the FAM allows it to be applied to one user of the research product – i.e., FDOT – by identifying only the costs incurred by FDOT and the savings achieved by FDOT following implementation. To the extent that information about the costs of benefits of these projects to FDOT, specifically, may be limited, we propose the use of the Balanced Scorecard Approach to evaluate these projects. This approach is more limited, but accessible to participating researchers and follows the spirit of the FAM in providing a structured evaluation of research activities.

6.1 Balanced Scorecard Framework

The use of a Balanced Scorecard (BSC) framework allows for a weighted score to be developed in cases where the data collection process cannot provide the high level of detail the FAM would be able to ingest. The creators of the BSC model liken it to the dashboard of an airplane. In any complex process (like transportation research), one set of measures will not give a complete picture of the value of the research. To calculate return on the research investment and track implementation across a diverse program of research activities, several measures may be used in a more holistic fashion across multiple perspectives. That said, the process cannot be too complicated and overwhelming to allow for research center staff to apply such a framework.

The BSC approach provides a way to assess the results of past actions (in this case, ongoing and completed pooled fund research projects and implementation activities) as well as items that will affect future activities (overall contributions of the pooled fund activities). This will give FDOT a complete, “balanced” view at any time of pooled fund activities describing 1) where the program has been and 2) where it is going. For a variety of reasons centered on capturing data and information, we do not suggest using a one-size fits-all ROI calculator for the Pooled Fund program (although we will propose limited applications of benefit/costs analysis and financial efficiencies). ROI calculations can be useful in telling a part of the story but leave much to be assumed and projected. They are ultimately difficult to defend for certain pooled fund projects.

The BSC approach combines rigorous scoring with anecdotal and storytelling principles designed to make the value of pooled fund research relevant and accessible across the enterprise.

6.2 Applying the Balanced Scorecard Approach to Assess Individual Pooled Fund Projects

Figure 2 below details the basic framework for a BSC approach. The balanced scorecard involves measuring four main perspectives: learning and growth, business processes, customers, and finance. Using the BSC allows the Agency to:

- Create a tangible road-map of existing pooled fund research from the 'current state' to a more successful 'future state'.
- Identify major areas where there may be disproportionate research endeavors on particular topics.
- Articulate the goals of the pooled fund program and how they help meet FDOT's mission and vision.
- Prioritize future pooled fund investments and activities in a particular order

To use this framework, scores need to be placed on each individual objective. The criteria and process are described in the next section. Criteria and measures can be adjusted but should be applied across all of the individual pooled fund opportunities to maintain consistency and integrity of the ultimate BSC findings.

6.3 Process for Selecting Criteria and Reporting Pooled Fund Projects

To apply a BSC framework, the consultant team identified primary set of potential perspectives of importance to the Research Center based on literature and practice in other disciplines. These are highly adaptable and can be customized to address particular management or leadership goals.

The Research Center's application of the BSC approach for Pooled Fund Research Projects focuses on four primary perspectives: Financial, Research Customer, FDOT Internal, and Learning & Growth/Reputation. These perspectives each include a number of primary objectives stemming from the FDOT Mission and Vision Statements (available on the FDOT website). For the financial perspective, we have identified three primary objectives: cost efficiency, cost savings, and development of new specifications or procurement opportunities.

The FDOT internal perspective focuses closely on the FDOT objectives and goal areas: Safety,

Infrastructure Condition, Reliability, Freight and Economic Vitality, and Project Delivery. These goal areas expressed in the FDOT mission posted at <https://www.fdot.gov/info/moredot/mvv.shtm>. Measures for environmental objectives can (and should) be identified in future developments associated with the use of the BSC.

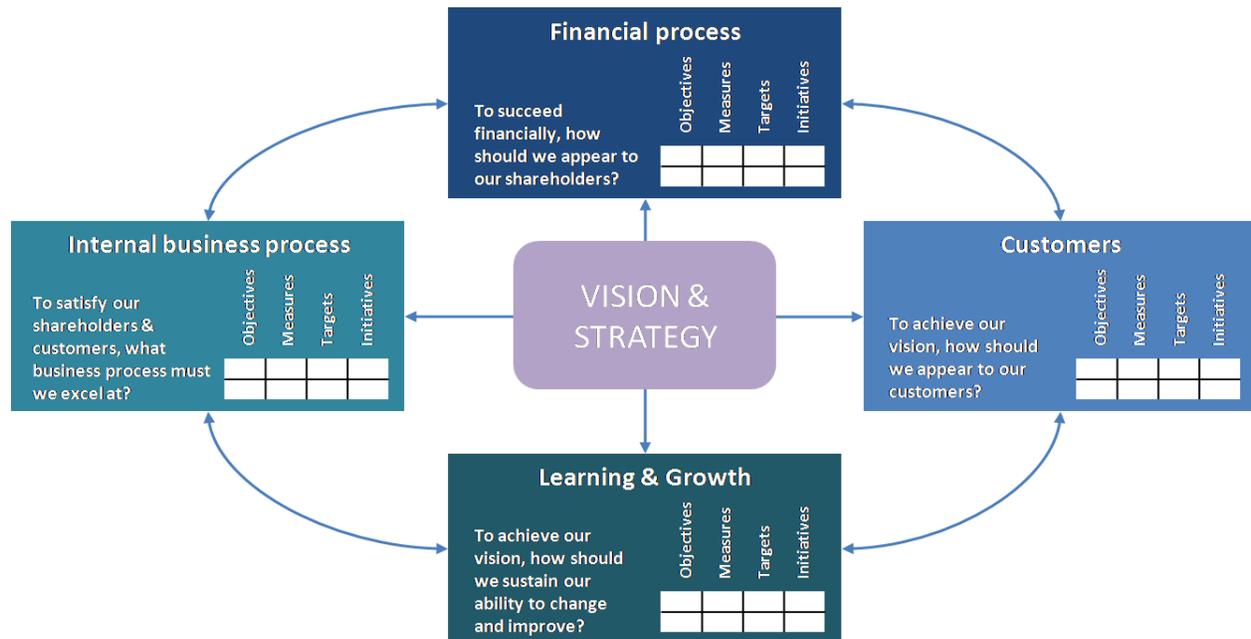


Figure 2. Balanced Scorecard Diagram

The Research Customer perspective brings in a Research Center-internal goal of increasing the number of offices engaged in FDOT research center projects and an overall objective of reducing total user costs in the system.

The final perspective looks at the Learning & Growth/National Reputation objectives for the Agency. In this perspective, the primary scored objectives are Automated Connected and Electrified vehicle leadership, succession planning to advance leadership objectives in the Department, overall leadership development, and a score for national leadership enhancing the reputation of the department.

The research team recommends that the Research Center considers hosting workshops with key research stakeholders, either online or in person, to develop an approach that works for FDOT. Each of these objectives receives scores based on the criteria shown in Table 2. Weights become

most important factor in assessing participation in each of the Pooled Funds. Once each key success factor is scored, a composite can be made for each particular pooled fund initiative. In addition, the entire portfolio of pooled fund projects can be weighed against each of the key success factors. Averages or targets can be set to build out a measurable dashboard for pooled fund participation even without the detailed information to apply the FAM. A sample table is shown below applying the scoring methodology.

For the weighting process, the research team assigned weights that favored financial perspectives and return on investment. The “weight” can be established as to the importance of each success factor, based on the perspectives and criteria described above. If these weights are changed, the expectation should be that all scoring would be revisited based on the new weights. Weights should be consistent across all programs while the impact scores range.

After performing the above work (assigning values and weights), it will be possible to define a “value” of intended research, based on the estimated magnitude and weight (importance) of success factors that are presented in the intended research (See Table 3). Specifically, estimates of the strengths of the “success factors” will essentially be a projection of the extent to which each success factor will come into play. Researchers can build these tables to show how these estimates roll up into a value estimate for the research at the programmatic level. These tables show each success factor input and the “Impact Value” that is estimated for the pooled fund project. Hence the table will automatically calculate the weighted and unweighted scores (or overall value) of the pooled fund project.

6.4 Balanced Scorecard for FDOT Projects

Appendix M presents the output of a BSC approach to evaluating 29 FDOT pooled fund research projects. The contributions to these projects by the FDOT ranged from \$10,000 to \$2,970,000.

Table 2. Key Success Factors – Balanced Scorecard Causal Analysis

Key Success Factors BSC Causal Analysis)	1	2	3	4	5
Cost Efficiency	<20%	>20%<40%	>40%<60%	>60%<80%	>80%
Cost Savings (Total-Cost)	negative	none	\$10,000 - \$100,000	\$100,000 - \$500,000	>\$500,000
New Specification	no change to practice	change to practice ad hoc	Change to Practice Implemented	Moderate Change to Process	Substantial Change
Engages new offices	No	X	X	X	Yes
Reduces User Costs	Increases User Cost	No Change	Slight Improvement	Moderate Improvement	Major Improvement
Safety	Decreases Safety	No Change	Slight Improvement	Moderate Improvement	Major Improvement
Infrastructure Condition	Substantially Decreases Condition	Decreases Condition	No Change/Mild Improvement	Moderate Improvement	Major Improvement
Reliability	Substantially Increases Congestion	Decreases Reliability	No Change/Mild Improvement	Moderate Improvement	Major Improvement
Freight/Economic Vitality	Substantially Impedes Freight	Impedes Freight	No Impact to Freight	Improves Freight Efficiency	Substantially Improves
Project Delivery	Decreases Delivery Times	No Change	Some improvement	Moderate Improvement	Major Improvement
Environmental	tbd				
AV/CV Leadership	No	X	Some	X	Yes
Succession Planning	No	X	Some	X	Yes
Leadership Development	No	X	Some	X	Yes
National Leadership	No	X	Some	X	Yes

Table 3. Sample Success Factor and Weights

Key Success Factors	Impact Value (1-5)	Weight (1-5)	Weighted Value
Cost Efficiency	4	5	20
Cost Savings	2	5	10
New Specification	3	4	12
Engages new offices	5	3	15
Reduces User Costs	4	4	16
Safety	5	5	25
Infrastructure Condition	3	4	12
Reliability	4	2	8
Freight/Economic Vitality	3	3	9
Project Delivery	3	3	9
Environmental	0	2	0
AV/CV Leadership	1	1	1
Succession Planning	1	2	2
Leadership Development	3	1	3
National Leadership	3	1	3
Total Score	N/A	N/A	145

CHAPTER 7 – CONCLUSIONS AND RECOMMENDATIONS

In summary, this project formalizes an implementation process and provides suggestions for effectively capturing information throughout the research process to ensure that promising research results are identified for implementation and an assessment of the net benefits of the research can be calculated. The research team noted substantial improvements over the course of the project in the efforts to identify qualitative and quantitative benefits of research results. The Research Center should continue to emphasize the importance of the data collection processes to enhance the growing culture of emphasizing research benefits and implementation. Further training of PMs and PIs—with a focus on specific data elements needed to evaluate certain types of projects—will improve the chances that adequate data will be collected. Training will also ensure that the FAM, developed in previous research projects (BDK83-977-24, BDV30-977-12), can be applied to most, if not all, research projects going forward.

The project also provided training webinars and resources that might be available to expand the use and application of the FAM in future projects. These emphasized the importance of a systematic approach to data collection on project activities. We recommend additional training to help institutionalize these processes and use of the form-based approach.

In addition to the FAM framework, this project provided a number of support activities to promote research implementation activities and detail the research process for internal and external stakeholders.

Support of the Research Showcase blog, coupled with the advances in the FAM framework and implementation tracking process, provide additional material for and exposure of research stories to audiences that may not know them otherwise. The FDOT and university researchers enthusiastically participated in the articles, providing interviews, reports, and other valuable information to help make the articles substantive and accessible. They also promoted the articles in their own channels. This is just one step toward better communicating the work of the Research Center and researchers statewide. We recommend FDOT not only continue this work but look at it as a first step toward broader communication of research projects and results. Florida is on the

cutting edge of many transportation research fields, and it is in the interest of the Center and Florida citizens to proactively tell those stories.

Promoting a systematic approach to assess the value of research projects also provides FDOT an important tool to communicate across a spectrum of projects. Showcasing research in a reader-friendly format that is accessible to a broad audience ensures that a variety of projects receive promotion through the Research Center.

This project demonstrated the effectiveness and use of objective tools and directed technology transfer efforts. Future work under this subject could include converting and automating the forms used as well as additional production of annual report information in a user-friendly format. The facilitation of guided research implementation efforts can benefit FDOT by allowing the investigating researchers to focus on their project outcomes and the FDOT personnel to better understand how their work could be enhanced or improved by research products. A crucial advantage of the guided facilitation approach is the efficiency gained by having a formalized and systematic process to evaluate, prepare, and execute research implementation.

Appendix A. Review of Projects Completed, 2014-2017

MATERIALS				
Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2014	BDK75-977-39	Development of Laboratory Test Method to Replace the Simulated High-Temperature Fluidity Test	Is a new test method being used?	
2014	BDK75-977-62	Slab Replacement Maturity Guidelines	was new process implemented? Is it more efficient?	This was added to the 353 spec as the method to determine when the concrete has achieved a compressive strength of 1,600 psi in order to open the pavement to traffic. There has been no follow up to establish effectiveness and efficiency.
2014	BDK80-977-27	Use of Fiber Reinforced Concrete for Pavement Slab Replacement	Are these findings related to increased use of fiber-reinforced concrete? Has this resulted in savings?	
2014	BDK84-977-22	Corrosion Characteristics of Unprotected Post-Tensioning Strands Under Stress	Did these findings lead to a new process for corrosion control?	Findings resulted in a specification change to allow grouting of tendons to be extended to 14 days after placement of steel cables
2014	BDK84-977-23	Quantification of the Physical Properties Required of Raised Pavement Markers and Accelerated Laboratory Testing	did this research lead to greater use of RPMs?	

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2014	BDK84-977-26	Comparative Testing of Radiographic Testing, Ultrasonic Testing and Phase Array Advance Ultrasonic Testing Non Destructive Testing Techniques in Accordance with the AWS D1.5 Bridge Welding Code	Was implemented. Can we evaluate extent of use?	Findings indicated that Phased Array Ultrasonic testing was suitable for inspection of welds in structural steel. Section 11.3 was added to the FDOT Materials Manual in 2015 to allow ultrasonic inspections for welds in 2015. Steve Duke has led additional testing where we compared Phased Array vs. Radiography at actual bridge shops, using the AWS Bridge Welding Code criteria. We concluded that the Phased Array could replace Radiography. He is working on language for its implementation into the materials manual.
2014	BDS15-977-01	Evaluate the Contribution of the Mixture Components on the Longevity and Performance of FC-5	did findings lead to a change in use of FC-5 mixture? Cost savings provided - what was extent of use?	Findings were implemented immediately. The net effect was increased binder contents in FC-5 mixtures, approximately 0.5 - 0.8% on average. An increase in FC-5 lifespan is expected, but it will take several years to quantify the cost savings due to increased life. At this point, the amount of increased life would be a guess at best.
2015	BDV25-977-01	Long-Life Slab Replacement Concrete	High placement temperatures and concrete placement during the day increased concrete cracking potential. Field additions of accelerator in excess of the approved mixture design were also found to increase the cracking potential	A second project, BDV25 977-23 Performance Improvement of HES Concrete Replacement Slabs, is ongoing and will finish this year. An implementation follow-up should include findings from both projects.
2015	BDV25-977-03	Distribution of Chloride, pH, Resistivity, and Sulfate Levels in Backfill for Mechanically-Stabilized Earth Walls and Implications for Corrosion Testing	model results suggested that a soil's buffering capacity might be important consideration when metal is used as reinforcement in MSE wall backfill; also suggested recommendations for changes to QA plans	

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2015	BDV25-977-12	Durability Performance of Submerged Concrete Structures, Phase 2	technical feasibility and cost/benefit aspects of incorporating protective anodes in new pilings	Results indicated the probability of corrosion in the form of steel dissolution in the submerged portion of reinforced concrete structures. However, the slow rate of corrosion identified in these areas is insignificant when compared to the tidal and splash zones. This research re-affirmed the assumptions that only the areas above water control the degradation of service life, therefore, no implementation is needed at this time.
2015	BDV25-977-14	Soil Mixing Design Methods and Construction Techniques for Use in High Organic Soils, Phase 2	designing soil mixing applications in organic soils was developed	Designing soil mixing applications in organic soils was developed. Due to the high cement contents needed to modify high organic soils, other means of improving their properties are being explored. Also, as a result, other ground modification techniques are commonly used to stabilize high organic content soils as such rigid inclusions (column supported embankments).
2015	BDV29-977-01	Long-Term Aging of Recycled Binders	solid findings associated with preferred testing approaches; new applications on recycled applications can result in better performance	This project has potential implementation in the future, especially if there is a push to use more RAP and/or rejuvenators in hot mix.
2015	BDV30-977-08	Ground Tire Rubber (GTR) as a Component Material in Concrete Mixtures for Paving Concrete, Phase 2	summary prepared; however, no definitive conclusions on thermal expansion	This project did not produce any implementable changes to procedures or specifications.
2016	BDR74-977-05	Alternative Aggregates and Materials for High Friction Surface Treatments	actively implemented - benefits to public/FDOT?? - extent of use?	Already in implemented, safety benefits are documented, and active projects statewide

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2016	BDV25-977-08	Field Device to Measure Viscosity, Density, and Other Slurry Properties in Drilled Shafts	reduction in time for testing could be assessed.	Reduction in time for testing could be assessed. I would consider an implementation project for the project "Field Device to Measure Viscosity, Density, and Other Slurry Properties in Drilled Shafts". If you remember previous discussions, the prototype device developed in the project was going to be further evaluated by Dr. Mullins. Talking with him recently, he feels that a final version is ready for distribution to the districts for full-scale field testing. In fact, he is presenting a paper on it at an upcoming conference (2018 ASTM conference in San Diego this summer). The purpose of the device to the obtain slurry properties directly from lowering the device down the drilled shaft excavation prior to concrete placement, without the need for sampling & performing the tests at the surface (which is currently being done). The device will also allow for a near-continuous profile of slurry properties versus testing at a select few depths. The main benefit is time savings of measuring properties directly from lowering the device down the hole versus sampling & testing. Other benefits are quality based since it will obtain a near-continuous profile of slurry properties and the results will potentially be more accurate because they will be less user dependent (based on the technician performing the testing).
2016	BDV31-977-32	Feasibility of Atomic and Molecular Laser Induced Breakdown Spectroscopy (LIBS) to In-Situ Determination of Chlorine in Concrete	requires spec changes/change in process	It was determined not to make changes to the specification. The new process measured total chloride instead of acid soluble, and it was not able to detect low enough levels of chloride.
2017	BDV31-977-06	Evaluation of Alternative Pozzolanic Materials for Partial Replacement of Portland Cement in Concrete	consider spec changes on 3 primary concrete specs (regarding replacement of Class F fly ash)	Not at the implementation stage yet. Two follow-up projects are evaluating plastic and hardened properties and determining relative long-term durabilities of selected alternative pozzolanic materials (BDV25 977-38 Development of Calcined Clay SCMs; and BDV31-977-76 Evaluation of Silica-Based Materials for Use in PCC)_PM-DeFord
2017	BDV31-977-30	Improved Analysis Tool for Concrete Pavement	3D models performed better in the field; move to wider adoption/use	Research recommended strain gauges for use on US-301 test road. Also developed concrete pavement response model that will be used for research purposes.

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2017	BDV34-977-03	Optimized Mobile Retroreflectivity Unit (MRU) Data Processing Algorithms	more testing necessary to confirm if the information is appropriate across all regions and light types	Lessons learned were documented and currently not implemented due to changing technology. However, future needs will be required to advance new technology to expand not only retroreflectivity, but to add raised pavement marker capability.
2017	BDX86	Method to Predict Seasonal High Ground Water Table (SHGWT)		Recommended guidelines were provided to engineers in developing more accurate assessments of the SHGWT. Being a design tool, this report will be referenced in the Soils and Foundations Handbook as an aid in estimating the SHGWT.
TRANSIT				
2014	BDK85-977-50	Evaluation of Rear-End Bus Collisions and Identification of Possible Solutions	did the research lead to process change that can be associated with a decrease in incidents? May be difficult to evaluate benefits	We assisted with the changing of the Florida Statutes to allow improved lighting on the rear of fixed route coaches. We also improved the lighting on paratransit equipment by installing LED lighting. Early reports from the transit agencies indicate a reduction of rear collisions.
2014	BDK85-977-46	Impacts of Dialysis Transportation on Florida's Coordinated Public Transportation Programs	multiple; are any new transportation services being used as a result?	Showed that for most agencies interviewed, there was no requirements or practice of tracking Demand -Response (DR) dialysis trips as a sub-category of medical trips. No one appeared to be seriously tracking trends. The thought was that this data could help in DR cost-savings by grouping trips through better coordination with dialysis centers. A follow up study would be helpful, as DR need and costs are rising.
2014	BDV26-977-01	Investigation, Quantification and Recommendations - Performance of Alternatively Fueled Buses	did the findings result in change in use of public transportation vehicles? Difficult to quantify benefits	Agencies now have a resource when considering Alternative fuels and propulsion. Through this project they can obtain operating cost, implementation issues, training requirements for staff, return on investment, and infrastructure cost
2014	BDV29-977-06	Guidelines for Bus Transit Stops in Highway Construction Work Zones	planning tool; hard to evaluate benefits from better coordination	Not implemented and not shared with stakeholders. PM is no longer with FDOT. Seems like findings may be appropriate to share with the Temporary Traffic Control folks from the Design Office. Guidance may be obsolete due to age. May need revisiting based on FDOT Complete Streets guidelines. I would think a study that incorporated transit, bike and ped instead of just one mode would be useful.

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2016	BDV26-977-03	Methodology for Linking Greenways and Trails with Public Transportation in Florida	actively implemented - benefits to public/FDOT??	This project created a methodology for analyzing and establishing connections between transit stops and routes to trail systems. This methodology is available to researchers and agencies to plan for better route connections and destinations for the transit using public, who can use public trails. It is not actively implemented but can provide benefits to FDOT by providing multi-modal transportation options.
TRAFFIC				
Year Completed	Project ID	Title	Comments	Comments on moving towards implementation
2014	BDK79-977-05	Demand Based Signal Retiming	benefits of moving traffic more efficiently; other benefits?	We developed multiple implementable outcomes in this project but probably the most significant one is a method to identify type of incident based on variations in traffic data. We identified traffic-data signatures of various traffic events (event traffic, incident, rail preemption, left-turn spillover, saturation, oversaturation, and (nearby) freeway incident). We simulated these events and recorded field-like traffic metrics (speed, occupancy, volume and travel time). It turns out each of these events has a quite unique signature in traffic data. This process could be reversed to predict/identify traffic events based on measured field metrics. The benefit of this approach was not demonstrated in the real world. We wanted to test this as part of the phase 2 research project. District 4 has a new TMC operations contract that is putting an emphasis on incorporating better data analysis methods into our standard operating guidelines. This project and the other projects D4 have been involved in are going to be prioritized and implemented as resources become available.
2014	BDV24-962-01	Real Time Monitoring and Prediction of Reduced Visibility Events on Florida's Highways	crash prevention - benefits	The project migrated to a next phase. This was mainly a preparatory project for future implementation.

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2014	BDV30-977-04	Aging Road User Studies of Intersection Safety: Lab and Simulator-based Studies of Crosswalk Markings and Flashing Yellow Arrow Comprehension -- Phase 2	did this research lead to changes in crosswalk markings? Lives saved?	It supported the use of high emphasis crosswalks to improve pedestrian safety and also led to further research to develop flashing yellow arrow tip cards.
2014	BDV30-977-05	Development of Automated Testing Tools for Traffic Control Signals and Devices (NTCIP and Security), Phase 2	are new testing tools being used? Have they saved time or reduced errors?	
2015	BDV30-977-03	Evaluation of Fog Predictions and Detections	researchers found that the ability to detect fog using satellite data was limited by the resolution of current satellite imaging -- many false positives right now	
2015	BDV26-977-06	Technology Application among Florida Community Transportation Coordinators	Follow-up study -- longitudinal study might be appropriate	Not a TEO research project
2016	BDR74-977-06	Development of Delineator Material/Impact Testing Specific to Managed Lane Use for Optimization of Service Life	product standards/compliance	

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2016	BDV24-977-10	Dynamic Flashing Yellow Arrow (FYA) - A Study on Variable Left Turn Mode Operational and Safety Impacts - Phase II - Model Expansion and Testing	actively implemented	
2016	BDV27-977-01	Demand Based Signal Retiming Phase 2 - Real-World Implementation	implementation - passive?	<p>For this project we developed multiple tools/methods that can be implemented in practice. There was a method to estimate signal's LOS (for major through phases) based on intersection-to-intersection travel times. This method requires travel times between signalized intersections which are not available for all corridors. Thus, this method was implemented in the City of Boca Raton in the past. Another method which was developed and delivered to FDOT TMC was a tool to estimate traffic conditions based on colors of Google maps or similar maps. Considering potential issues with Google IPs we abandoned this method for further development, but these efforts lead to development of new tool which is now being done under our MET project. The third implementable outcome of this project was a tool which could read SunGuide-like incidents, written in tabular form, from Palm Beach County and show them on a map. This tool was also installed in PBC traffic management center. District 4 has a new TMC operations contract that is putting an emphasis on incorporating better data analysis methods into our standard operating guidelines. This project and the other projects D4 have been involved in are going to be prioritized and implemented as resources become available.</p>

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2016	BDV29-977-09	Decision Support Systems for Transportation System Management and Operations (TSM&O)	implementation - passive?	ITSDCAP was initially used by FDOT District 4 consultant to support arterial dashboard production. This utilization is expected to resume in the near future. FDOT District 6 has utilized ITSDCAP to produce decision maker level, technical staff segment level, and technical staff intersection level dashboards to monitor the performance before and after the installation of two adaptive signal control systems. The first system installed on SW 8th Street and the second on NW 119th Street. The dashboards have been refined considerably as part of the adaptive signal evaluation contracts with FDOT District 6 and now includes both traffic and transit dashboards. The next steps that will be introduced as part of this effort is the production of freight performance measures and the production of dashboards based on high resolution controller data. The City of Miami Beach has been extremely interested in using ITSDCAP to produce a transit dashboard and then a traffic dashboard. Miami-Dade County has also expressed interested and is currently working with their consultant to identify the dashboard specifications. ITSDCAP is currently considered to be integrated with a new version of the FITSEVAL tool, also developed by FIU to support investment decisions.
2016	BDV30-977-09	Damage to ITS, Traffic Control and Roadway Lighting Equipment from Transient Surge and Lightning Strikes	implementation - passive ***	
2016	BDV31-977-62	Integrated Solar Lighting for Pedestrian Crosswalk Visibility	implemented later following additional research/demonstration project at TERL - is research ongoing?	
2017	BDV25-977-29	Comparing Countermeasures for Mitigating Wrong-way Entries onto Limited Access Facilities	Use of red rectangular rapid flashing beacons at more locations would be warranted; other countermeasures would be valuable.	This project helped understand the need for a WWD Countermeasures Implementation Plan. The project helped compare the countermeasures and evaluate which ones are more effective than others.

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2017	BDV25-977-30	Application of Demographic Analysis to Pedestrian Safety	some correlation between specific measures based on demographics	The District 4 office is systematically implementing the methodology and recommendations included in this research.
2017	BDV25-977-32	Impact of Transit Stop Location on Pedestrian Safety	can be used to evaluate bus stop locations; predictions of pedestrian crashes	An important finding of the research was that only a very small percentage of the pedestrian crashes near bus stops actually involved bus patrons (3% to 5%). What this means is that when analyzing pedestrian crashes, the problem is not the bus stop itself but some other factor(s). The most recurring behavior that was found in the data analysis and was observed during the field reviews of the bus stops was pedestrians crossing at mid-block or somewhere outside the designated crosswalk. Because of this research, FDOT District 4 has a systematic process that can be used to review bus stops on a regular ongoing basis.
2017	BDV27-977-05	Manual on Performance of Traffic Signal Systems: Assessment of Operations and Maintenance	useful dashboards for keeping traffic signal information and condition	This project had two major components: 1. Framework for annual evaluation of the operations and maintenance of traffic signals, and 2. Dashboards to monitor performance of traffic signals based on cyclical medium-resolution data. The first component is ready for implementation, but it would have to be done at C/O as the matter of traffic signal maintenance is not administered at local districts. The second component was delivered and implemented at the D4 TMC as part of this project. District 4 has a new TMC operations contract that is putting an emphasis on incorporating better data analysis methods into our standard operating guidelines. This project and the other projects D4 have been involved in are going to be prioritized and implemented as resources become available.
2017	BDV30-977-14	Evaluation of Fog Predictions and Detection, Phase 2	improved fog detection using radar can be deployed across early warning systems	
2017	BDV30-977-15	Human Factors Guidelines to Develop Educational Tip Cards for Aging Road Users	tip cards might be the best next step to advance this study	Tip cards were developed for flashing yellow arrow, right turn on red, and roundabouts. A checklist was also developed and is being used to design future educational materials.

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2017	BDV31-977-52	Warrants, Design, and Safety of Road Ranger Service Patrols	effectively route the safety service patrols	
2017	BDV31-977-56	Commercial Truck Parking Detection Technology Evaluation for Columbia and Marion County Rest Areas	accuracy was confirmed - probably a next step would be to advance a purchasing decision if desired	Technology tested is currently being deployed in seven design/build projects throughout the state.
MAINTENANCE				
Year Completed	Project ID	Title	Comments	Comment on moving towards implementation
2014	BDK78-977-09	Maintenance Practices for Stormwater Runoff	have new maintenance practices implemented?	Implemented
2014	BDK80-977-17	Managing Florida's Fracture Critical Bridges	is this new procedure in use? How often/extent?	The work in this contract is being extended in contract BDV29 TWO 977-40
2014	BDK83-977-16	Axle Equivalent Transverse Loading on Segmental Bridge Decks	are new methods in use? Have they saved time/money?	<p>Are new methods in use? No. It is my understanding that Rodenberry sponsored a graduate student to develop an Excel spreadsheet that would accelerate calculations for transverse deck analysis on segmental type bridge decks. Although the resulting spreadsheet, now at \\dotscomaint01\Public_external\Structures\LoadRating\CO\CALC_Segmental\Transverse_Tool_for_JDv4.xlsm, was forwarded to segmental specialist Corven for consideration, the spreadsheet is not in general use because it was insufficiently documented, too slow, and not verified/honed by practical use. That is, no real-world transverse load rating analyses were performed, summarized, and sealed (put to use). The spreadsheet only reached the "alpha" phase.</p> <p>Have they saved time/money? No.</p>

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2015	BDV24-977-02	Maintenance Practices for Stormwater Runoff - Phase 2	best management practices were assessed across 7 ponds; handbook on Maintenance Practices for Stormwater Runoff would be worth promulgating; handbook is effective Implementation	Implemented
	BDV28-977-02	Proof of Concept for Using Unmanned Aerial Vehicles for High Mast Pole and Bridge Inspections	continued application for cost savings and personnel time savings	The work in this contract was continued in contract BDV31 977-55 which has just been completed. We will be modifying our procedure to allow the use of sUAVs in inspection.
2016	BDV30-977-07	Implementation of the 2013 AASHTO Manual for Bridge Element Inspection	partially implemented	With the implementation of AASHTOware BrM, this is now fully implemented.
STRUCTURES				
Year Completed	Project ID	Title	Comments	Comment on moving towards implementation
2014	BDK75-977-31	Validation and Implementation of Bridge Design Specifications for Barge Impact Loading	Are new design specifications being used?	Structures Design Bulletin 17-01 was released to implement rounded piers/footings. Further implementation continues to be evaluated by SDO in the form of design guidelines.
2014	BDK78-977-08	Repair of Impact Damaged Utility Poles with FRP	how many poles have been repaired? Is this less costly?	There has only been 1 known application. Depending on the complexity and MOT required this could be less costly. The current plan is to provide repair guidance to the Maintenance Office.
2014	BDK80-977-20	Steel Plate Girder Diaphragm and Cross Bracing Loads	is this new procedure in use? How often/extent?	Some of the findings of this report coupled with the findings of BDK80 977-21 were used to revise the FDOT Structures Design Guidelines Section 5.1.A and 5.1.B.

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2014	BDK80-977-28	Phase and Widening Construction of Steel Bridges	did the findings lead to change in how cross frames are configured?	The parametric study showed that cross-frames could not be eliminated between phases. Although the proposed alternative cross-frame configuration has merit, it was not moved toward implementation as it was not deemed to be equal to or better than the current configuration shown in the Structures Manual.
2014	BDK83-977-10	Design and Fabrication of Curved Precast U-Beam Bridges	is new method of fabrication being used? How often/extent?	The method of fabrication for pretensioning is not being used due to the complexities involved. This research was cut short due to these findings.
2014	BDK83-977-17	Investigation of Carbon Fiber Composite Cables (CFCC) Prestressed Concrete Piles	have CFCCs been substituted for conventional steel? How often/extent?	This research has been implemented within the Structures Design Guidelines and Standard Plans. A project is under construction utilizing CFCC for the piling and sheet piles.
2014	BDK84-977-07	Design and Construction of Precast Piles with Stainless Reinforcing Steel	is new method of fabrication being used? How often/extent?	This research was implemented at the same time as the above project with CFCC. There are potential projects in the future that could use either SS or CFCC.
2014	C9289	Solid Deck Retrofit	was solution implemented? Extent.	We are continuing to wait until a test panel is installed on a bridge in District 4. Testing performed by FDOT showed promise for this technology. The implementation of this technology is limited due the limited number of movable bridges.
2015	BDU79	Investigation and Development of an Effective, Economical, and Efficient Prestressed Concrete Pile Splice	Prestressed spliceable piling; demonstration project was completed; more wide-scale approaches? Concept splice design can effectively restore full capacity	The plan was to contact pile driving contractors to evaluate the constructability aspect in more detail. That assessment is required before further use can be explored.

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2015	BDV24-977-04	Repair of Impact Damaged Utility Poles with Fiber Reinforced Polymers (FRP), Phase II	quick repair process; summary already produced: link http://www.fdot.gov/structures/structuresresearchcenter/Project%20Summaries/2015/FDOT-BDV24-977-04-sum.pdf	Same project as above BDK78 977-08
2015	BDV29-977-10	Use of Fiber Reinforced Polymer Composite Cable for Post-Tensioning Applications, Phase 2	continued monitoring of the tendons would be useful. This was a 5 month period only.	Post-tensioning anchorage shortcomings were found within this project. The overall concept is viable but the constructability due to the anchorages makes this concept limiting. Industry is working to improve this area, but until then the concept is on hold.
2017	BDV29-977-05	Non-Destructive Testing (NDT) of a Segmental Concrete Bridge Scheduled for Demolition, with a Focus on Condition Assessment and Corrosion Detection of Internal Tendons	more promotion is probably necessary -- might not be the best timing wise	The comments are correct. More development is required to gain confidence in the methods for inspection.
2017	BDV30-977-16	Rheology Limits for Grout Materials used for Precast Bent Cap Pile Pockets in Hot Weather	procedure changes to decrease allowable gap size (to 4") as well as better understanding of the temperature concerns	Right now, there is not a lot of demand to use grouts for connections between precast bent caps and piles. Design-build projects using precast bent caps are typically using self-consolidating concrete instead of grout. So, the design standards for precast bent caps have been put on hold and the specifications that were developed for US-90 haven't been modified. While there is still a plan to implement this project, it is not a high priority. Implementation will require design standards for precast bent caps and development specifications for grout which, based on the research, can have relaxed limits compared to specifications written for the US-90 project (manufacturer allowable limits instead of recommended limits).

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2017	BDV31-977-01	Durability Evaluation of Florida's Fiber-Reinforced Polymer (FRP) Composite Reinforcement for Concrete Structures	high potential for increased life cycle savings	The findings provided favorable information on the durability of FRP repairs. These repairs can provide benefit to the structures for 15+ years and likely much longer. The increased life cycle improves the long term value of the repairs.
2017	BDV31-977-05	Evaluation of Static Resistance of Deep Foundation	changes to the FB-DEEP software to better enhance the usability of said	The results of the effort performed by UF researchers (new correlations between SPT blow count and pile capacity) were implemented into FBDEEP software by the Bridge Software Institute (BSI). A new version of the software has been released and is currently in use by geotechnical engineers across the State. The software is typically used for estimating Test Pile and production pile length as well as required drilled shaft embedment.
2017	BDV31-977-46	Distribution Factors for Construction Loads and Girder Capacity Equations	changes to the girder designs as suggested; Distribution factors can also be updated	This project has been implemented. The revised girder capacity equations have been incorporated into the FDOT girder stability program and the FDOT Structures Design Guidelines, which all designers are required to use.
ROADWAY DESIGN				
Year Completed	Project ID	Title	Comments	Comment on moving towards implementation
2014	BDK78-977-18	Evaluation of Pollution Levels Due to the Use of Consumer Fertilizers under Florida Conditions: Examination of Lower Slopes and Rainfall Intensities Taking into Account Overland Flow	did the results lead to a change in fertilizer use?	Fully implemented in NPDES program to get nutrient credits for the cessation of fertilizer use. Quantification of credits is a money maker throughout the State. Invited by TRB to present the "win" at 2015 TRB Conference.
2014	BDK78-977-19	Demonstration Bio Media for Ultra-urban Stormwater Treatment	has permitting process become more efficient (quicker?) as a result?	Implemented on D5 Wekiva Parkway to reduce pond size. Regulatory agencies used research as "proof of concept" to issue permits.

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2014	BDK80-977-36	Closed Flume Inlet Efficiency	are new hydraulic performance curves used? How often/extent?	New curves implemented in Appendix I of the Drainage Design Guide. Curves used in closed flume inlet design, which are used frequently in gentle sloped areas.
2015	BDV24-977-12	Optimal Design of Stormwater Basins with Bio-sorption Activated Media (BAM) in Karst Environments-Phase I: Site Screening and Selection	Very specific to filtration -- Phase II is the test and deployment effort	Project is complete and sites implemented in the Phase II study .
2017	BDV31-977-49	Survey of Key Monarch Habitat Areas Along Roadways in Central and North Florida	updated mowing plans for butterfly preservation	Landscape is working with OEM and USFWS to protect the milkweed, Monarchs, and the Department. The process is moving in a favorable direction.
PLANNING				
Year Completed	Project ID	Title	Comments	Comment on moving towards implementation
2014	BDK77-977-22	Roundabouts and Access Management	were guidance documents changed? Has this affected # roundabouts?	n/A
2014	BDK84-977-20	Using Truck Fleet Data in Combination with Other Data Sources for Freight Modeling and Planning	as a result, is ATRI data used in any FDOT practices? To what extent?	
2014	BDV32-977-01	Deployment Strategies of Managed Lanes on Arterials	traffic flow benefits? Or other?	
2014	BDV32-977-02	Comparison of Methods for Measuring Travel Time at Florida Freeways and Arterials	traffic flow benefits? Or other?	

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2014	BDV32-977-03	Estimation of Capacities on Florida Freeways	traffic flow benefits? Or other?	
2015	BDV29-977-12	Investigating the Value of Time and Value of Reliability for Managed Lanes	using these updated figures for calculations of VOT/VOR will help forecasting	
2015	BDV30-977-01	Twenty-Four Hour Peaking Relationship to Level of Service and Other Measures of Effectiveness	not sure that the investment warrants the updated analysis	
2016	BDV25-977-04	Evaluation of Logistics Led Economic Development	passive implementation?	
2016	BDV25-977-17	GPS Data for Truck-Route Choice Analysis of Port Everglades Petroleum Commodity Flow	actively implemented - benefits to public/FDOT??	
2016	BDV27-977-07	Unmanned Surface Vessel (USV) Systems for Bridge Inspection	change in process for on-water bridge inspections	
2016	BDV29-977-14	Updating and Improving Methodology for Prioritizing Highway Project Locations on the Strategic Intermodal System (SIS)	actively implemented	
2016	BDV30-977-11	Enhanced Mobility for Aging Population Using Automated Vehicles	implementation - passive - benefits to public/FDOT??	

Year Completed	Project ID	Title	Comments	Comments on Moving towards Implementation
2017	BDV29-977-15	Examining the Value of Travel Time Reliability for Freight Transportation to Support Freight Planning and Decision-Making	survey results to help establish further work - no further action at this time	
2017	BDV29-977-19	Framework for Multi-Resolution Analyses of Advanced Traffic Management Strategies	combining software to provide more detailed information to planners -- bring this into practice	

Appendix B. Notes on Projects in the Implementation Tracking System

Materials				
Status	Year	Contract	Project Title	Notes
Active	2017	BDV25-977-34	Thermal Integrity Profiling for Augered Cast-In-Place Piles Implementation Plan	[6/4/18] Application in smaller diameter elements; need viable and cost-effective detection for quality control - robust spacer detection; unknown consequence of pile variability - i.e., don't know what it really means without measures. Need to know what is done now (how much cost/time?); is additional training needed? What change in outcomes is anticipated? McVay noted the design process is affected as well - consider how to add this to the worksheets
Active	2018	BDV25-977-52	Field Demonstration of Tendon Imaging Methods	[6/4/18] This is a "gadget" oriented project; sensor can be used during regular inspections or even right after grouting. Field trial to begin July 2018; prototype made using 3D printer. Some discussion of who will get trained and who will pay for the device. Cost savings must consider cost of a tendon failure. Est. savings \$100,000 to replace one cable - this doesn't include cost of bridge closure. Quantitative benefits can be captured using a range, depends on the type of bridge; there are estimates of cost of traffic delays. There have been some issues with tendon gutting.
Active	2018	BDV31-977-88	Field Implementation of the Vertical In situ Permeameter (VIP)	[6/4/18] Another type of probe for more robust VIP testing. Rolling out to statewide implementation; 3 other projects led to this one (see IT system); Cost \$2000/probe. Increase database of measurements; Discussion included how to capture estimated costs, time/speed should be greatly improved, but also the data will be higher quality -how will that be measured? This project is being installed at eight locations - one in each district and one on the turnpike
Active	2018	BDV31-977-91	Implementation of Measuring While Drilling Shafts in Florida (FLMWDS)	[6/4/18] validating methods and identifying sources of variability; goal is better quality data and a reduction in cost per shaft; currently mostly identified visually on the auger. Using commercial equipment; collecting data for future work - building repository; can incorporate strength assessment; can tap into existing sensors, so no cost to set up.

Status	Year	Contract	Project Title	Notes
Active	2018	BDZ36	Automated Identification and Quantification of Flexible and Rigid Pavement Distresses - ACES	[not on call 6/4/18]
Transit				
Status	Year	Contract	Project Title	Notes
Active	2018	BDV31-977-79	University of Florida Testbed Initiative - Transit Components	Presentation made for June 2018 implementation update indicated that the project was going to include installation on buses in the summer of 2018. 9 buses were installed at the time of the meeting with 11 more planned during the coming months. Data would be collected through the end of December. The team is exploring additional spin off applications based on the technology.
Active	2018	BDV25-977-54	Pilot Implementation for Preventing Incorrect Turns at Highway-Rail Grade Crossings	Presentation made for June 2018 implementation meeting demonstrated a series of signs used to prevent turns onto tracks. The pilot locations were chosen, and signage installed.
	2014	BDK85-977-50	Evaluation of Rear-End Bus Collisions and Identification of Possible Solutions	We assisted with the changing of the Florida Statutes to allow improved lighting on the rear of fixed route coaches. We also improved the lighting on paratransit equipment by installing LED lighting. Early reports from the transit agencies indicate a reduction of rear collisions.
Traffic				
Status	Year	Contract	Project Title	Notes
Active	2018	BDV25-977-44	Integration of a Robust Automated Pedestrian Detection System for Signalized Intersections - ACES	[July 2018] Pedestrian detection system is being combined into the ACES corridor. Project is to research and develop an accurate and reliable automated pedestrian detection system at signalized intersections and mid-block crosswalks with high intensity activated crosswalks (HAWKs), rectangular rapid-flashing beacons (RRFBs) and full pedestrian signals through integration of pedestrian detection technologies or improved available pedestrian detection systems on the market.

Status	Year	Contract	Project Title	Notes
Completed	2018	BDV29-977-21	Utilization of Connected Vehicle Data to Support Traffic Management Decisions - ACES	[July 2018] Implemented in D5 TMC and on road ranger vehicles (6/7 vehicles). The effort sends data via cellular service to communicate a range of information. Part of the SunGuide effort. Nine SunGuide functions that make use of field data and can possibly be supported by connected vehicle data were reviewed, and discussions are provided on how connected vehicle data can be used to support these SunGuide modules. CV data were collected, transferred in real-time to a central server, processed, and used in an analysis of mobility measures of a roadway section along the I-4 in Central Florida. a field test was conducted by installing cell-based CV technologies.
Active	2018	BDV30-977-23	Evaluation of Connected Vehicle Applications on Mahan Corridor, Phase II - ACES	[July 2018] this project extended the Tallahassee SPaT challenge efforts and was the first one to implement a security management system (SCMS) -- it has been a successful application of this approach
Completed	2018	BDV31-977-45	Development and Testing of Optimized Autonomous and Connected Vehicle Trajectories at Signalized Intersections - ACES	[July 2018] This project allowed for setting up intersection controls. The setup worked and experiment was successful. Next steps would be for FDOT to contract for complete projects and working alongside UF. Parallel testing is recommended. Key issues remain interoperability between the equipment (different manufacturers and vendors). This project can be used to leverage additional funding.
Completed	2018	BDV31-977-56	Commercial Truck Parking Detection Technology Evaluation for Columbia and Marion County Rest Areas - ACES	[July 2018] A large number of vendors are promoting truck parking technologies. 3 vendors responded for this application and are being deployed in 7 design build projects in the state. Spring of 2019 is target for taking the systems live. Data responsiveness (how often do we get the data) through SunGuide. There is a 5 year warranty on the installed devices.
Active	2018	BDV32-977-05	Before-and-After Implementation Studies of Advanced Signal Control Technologies in Florida - ACES	[July 2018] Statewide deployment efforts since 2014. Long term monitoring activities. Some vendor deployments to test varying technologies. Training is being delivered through a FAU initiative. Also developing 2 more courses to broaden awareness.

Status	Year	Contract	Project Title	Notes
Active	2018	BDV34-977-07	Evaluation of Project Processes in Relation to Transportation Systems	[July 2018] Project looks at mainstreaming TSMO activities. Prior to project not a lot of discussion on TSMO in agencies. 3 strategies: discussions with one office at a time, putting TSMO into manuals, and presentations to Directors and District Staff. An extension of the project resulted in modified procurement framework --an implementation issue remains whether we can incorporate this into agile procurement practice. Did a 3 hour (1/2 day) workshop that was well received. There are other training opportunities identified, including Florida ITE. The savings can be captured in the development of TSMO leadership plans in the districts.
	2014	BDK79-977-05	Demand Based Signal Retiming	We developed multiple implementable outcomes in this project but probably the most significant one is a method to identify type of incident based on variations in traffic data. We identified traffic-data signatures of various traffic events (event traffic, incident, rail preemption, left-turn spillover, saturation, oversaturation, and (nearby) freeway incident). We simulated these events and recorded field-like traffic metrics (speed, occupancy, volume and travel time). It turns out each of these events has a quite unique signature in traffic data. This process could be reversed to predict/identify traffic events based on measured field metrics. The benefit of this approach was not demonstrated in the real world. We wanted to test this as part of the phase 2 research project. District 4 has a new TMC operations contract that is putting an emphasis on incorporating better data analysis methods into our standard operating guidelines. This project and the other projects D4 has been involved in are going to be prioritized and implemented as resources become available.
	2014	BDV24-962-01	Real Time Monitoring and Prediction of Reduced Visibility Events on Florida's Highways	The project migrated to a next phase. This was mainly a preparatory project for future implementation.
	2014	BDV30-977-04	Aging Road User Studies of Intersection Safety: Lab and Simulator-based Studies of Crosswalk Markings and Flashing Yellow Arrow Comprehension -- Phase 2	It supported the use of high emphasis crosswalks to improve pedestrian safety and also led to further research to develop flashing yellow arrow tip cards.
	2014	BDV30-977-05	Development of Automated Testing Tools for Traffic Control Signals and Devices (NTCIP and Security), Phase 2	2015 project

Status	Year	Contract	Project Title	Notes
	2015	BDV26-977-06	Technology Application among Florida Community Transportation Coordinators	Not a TEO research project
	2015	BDV30-977-03	Evaluation of Fog Predictions and Detections	Attempted to look at fog locations and creation criteria. It was found that using the difference in two frequencies in the infrared spectrum that have different water absorption characteristic, that it was possible to infer the presence of fog. However, many non-foggy days also got included. It is thought that other discriminates, such as wind speed could reduce the false alarm rate.
	2016	BDR74-977-06	Development of Delineator Material/Impact Testing Specific to Managed Lane Use for Optimization of Service Life	developed a minimum requirement specification to ensure compliance on lane delineators
	2016	BDV24-977-10	Dynamic Flashing Yellow Arrow (FYA) - A Study on Variable Left Turn Mode Operational and Safety Impacts - Phase II - Model Expansion and Testing	Project led to 2018 effort.

Status	Year	Contract	Project Title	Notes
	2016	BDV27-977-01	Demand Based Signal Retiming Phase 2 - Real-World Implementation	<p>For this project we developed multiple tools/methods that can be implemented in practice. There was a method to estimate signal's LOS (for major through phases) based on intersection-to-intersection travel times. This method requires travel times between signalized intersections which are not available for all corridors. Thus, this method was implemented in the City of Boca Raton in the past. Another method which was developed and delivered to FDOT TMC was a tool to estimate traffic conditions based on colors of Google maps or similar maps. Considering potential issues with Google IPs we abandoned this method for further development, but these efforts lead to development of new tool which is now being done under our MET project. The third implementable outcome of this project was a tool which could read SunGuide-like incidents, written in tabular form, from Palm Beach County and show them on a map. This tool was also installed in PBC traffic management center. District 4 has a new TMC operations contract that is putting an emphasis on incorporating better data analysis methods into our standard operating guidelines. This project and the other projects D4 has been involved in are going to be prioritized and implemented as resources become available.</p>

Status	Year	Contract	Project Title	Notes
	2016	BDV29-977-09	Decision Support Systems for Transportation System Management and Operations (TSM&O)	<p>ITSDCAP was initially used by FDOT District 4 consultant to support arterial dashboard production. This utilization is expected to resume in the near future.</p> <p>FDOT District 6 has utilized ITSDCAP to produce decision maker level, technical staff segment level, and technical staff intersection level dashboards to monitor the performance before and after the installation of two adaptive signal control systems. The first system installed on SW 8th Street and the second on NW 119th Street. The dashboards have been refined considerably as part of the adaptive signal evaluation contracts with FDOT District 6 and now includes both traffic and transit dashboards. The next steps that will be introduced as part of this effort is the production of freight performance measures and the production of dashboards based on high resolution controller data.</p> <p>The City of Miami Beach has been extremely interested in using ITSDCAP to produce a transit dashboard and then a traffic dashboard. Miami-Dade County has also expressed interested and is currently working with their consultant to identify the dashboard specifications.</p> <p>ITSDCAP is currently considered to be integrated with a new version of the FITSEVAL tool, also developed by FIU to support investment decisions.</p>
	2016	BDV30-977-09	Damage to ITS, Traffic Control and Roadway Lighting Equipment from Transient Surge and Lightning Strikes	
	2016	BDV31-977-62	Integrated Solar Lighting for Pedestrian Crosswalk Visibility	
Active	2017	BDV24-977-21	Dynamic Flashing Yellow Arrow (FYA) - A Study on Variable Left Turn Mode Operational and Safety Impacts - Phase III	[July 2018] using Econolite controllers to communicate with field. District 5 application. Crucial project success factor will be improving/automating decision process at the TMC (SunGuide).

Status	Year	Contract	Project Title	Notes
	2017	BDV25-977-29	Comparing Countermeasures for Mitigating Wrong-way Entries onto Limited Access Facilities	[July 2018] This project helped understand the need for a WWD Countermeasures Implementation Plan. The project helped compare the countermeasures and evaluate which ones are more effective than others. It includes a video analytics element that triggers alarms to prevent Wrong Way driving. Idea is to more quickly notify enforcement.
	2017	BDV25-977-30	Application of Demographic Analysis to Pedestrian Safety	The District 4 office is systematically implementing the methodology and recommendations included in this research
	2017	BDV25-977-32	Impact of Transit Stop Location on Pedestrian Safety	An important finding of the research was that only a very small percentage of the pedestrian crashes near bus stops actually involved bus patrons (3% to 5%). What this means is that when analyzing pedestrian crashes, the problem is not the bus stop itself but some other factor(s). The most recurring behavior that was found in the data analysis and was observed during the field reviews of the bus stops was pedestrians crossing at mid-block or somewhere outside the designated crosswalk. Because of this research, FDOT District 4 has a systematic process that can be used to review bus stops on a regular on-going basis.
Active	2017	BDV25-977-40	Testing and Evaluation of Freeway Wrong-way Driving Detection Systems	[July 2018] Technically the project is a wrong-way driver countermeasure implementation in 8 districts. New signage and identifying what is effective. What are the non-engineering elements? (i.e. demographics, age, DUI). Project included 3 statewide meetings with agencies. Realization that you cannot go high tech at every interchange (costs, design considerations, etc.).

Status	Year	Contract	Project Title	Notes
	2017	BDV27-977-05	Manual on Performance of Traffic Signal Systems: Assessment of Operations and Maintenance	This project had two major components: 1. Framework for annual evaluation of the operations and maintenance of traffic signals, and 2. Dashboards to monitor performance of traffic signals based on cyclical medium-resolution data. The first component is ready for implementation, but it would have to be done at C/O as the matter of traffic signal maintenance is not administered at local districts. The second component was delivered and implemented at the D4 TMC as part of this project. District 4 has a new TMC operations contract that is putting an emphasis on incorporating better data analysis methods into our standard operating guidelines. This project and the other projects D4 has been involved in are going to be prioritized and implemented as resources become available.
Active	2017	BDV29-977-36	A Data-Driven Approach to Implementing Wrong-Way Driving Countermeasures	
	2017	BDV30-977-14	Evaluation of Fog Predictions and Detection, Phase 2	
	2017	BDV30-977-15	Human Factors Guidelines to Develop Educational Tip Cards for Aging Road Users	Tip cards were developed for flashing yellow arrow, right turn on red, and roundabouts. A checklist was also developed and is being used to design future educational materials.
	2017	BDV31-977-52	Warrants, Design, and Safety of Road Ranger Service Patrols	
	2017	BDV31-977-56	Commercial Truck Parking Detection Technology Evaluation for Columbia and Marion County Rest Areas	Technology tested is currently being deployed in seven design/build projects throughout the state.

Maintenance				
Status	Year	Contract	Project Title	Notes
Completed	2017	BDV31-977-55	Small Unmanned Aerial Vehicles (sUAV) for Structural Inspection - ACES	2018: University of Florida sUAVs equipped with optical sensors, an assessment of available image processing software, and an assessment of current data storage. Six high mast light poles (HMLP) and eight bridges were inspected; approximately half of the inspections were performed alongside traditional inspections, and the remainder were performed with no prior knowledge of the structure to compare findings. Project team looked at cost and data storage requirements to quantify potential changes resulting from utilizing sUAV for structural inspections. Preliminary recommendations included periodically replacing the use of UBIVs on bridges in good condition. Work well for monitoring a particular deficiency.
Active	2017	BDV31-977-73	Sunshine Skyway Bridge Monitoring Phase II System Development	2018: Project is designed to provide a Skyway monitoring system capable of providing effective maintenance and safety decision support. Expected to be completed in 2020. integrate sensor and data acquisition systems and design a comprehensive web interface
	2014	BDK78-977-09	Maintenance Practices for Stormwater Runoff	have new maintenance practices implemented?
	2014	BDK80-977-17	Managing Florida's Fracture Critical Bridges	The work in this contract is being extended in contract BDV29 TWO 977-40
	2014	BDK83-977-16	Axle Equivalent Transverse Loading on Segmental Bridge Decks	are new methods in use? Have they saved time/money?
	2015	BDV24-977-02	Maintenance Practices for Stormwater Runoff - Phase 2	best management practices were assessed across 7 ponds; handbook on Maintenance Practices for Stormwater Runoff would be worth promulgating; handbook is effective Implementation
	2015	BDV28-977-02	Proof of Concept for Using Unmanned Aerial Vehicles for High Mast Pole and Bridge Inspections	continued application for cost savings and personnel time savings
	2016	BDV30-977-07	Implementation of the 2013 AASHTO Manual for Bridge Element Inspection	partially implemented

Safety				
Status	Year	Contract	Project Title	Notes
Active	2018	BDV25-977-43	Understanding Interactions between Drivers and Pedestrian Features at Signalized Intersections, Phase 3	This project helped build on SHRP2 efforts of the Naturalistic Driving Study. Evaluated no turn on red, blank, right after stop, stop here at red, and turning vehicle yield signs. Mast arm and roadside applications. The project team worked with each district to set up before and after studies. The project has about 85-90% of the data collected as of July 16 update. Phase 2 results show nearly 70% compliance when sign says right after stop.
Roadway Design				
Status	Year	Contract	Project Title	Notes
Active	2018	BDV34-977-01	Empirical Deck for Phased Construction and Widening	[7.16.18] Project could provide a strong amount of savings as this is available now for Design Build projects in the state. For projects in the pipeline, contractors could modify based on the findings. Recommended outreach through AASHTO to revise specifications -- however these is little appetite for this right now
Active	2017	BDV24-977-20	Optimal Design of Stormwater Basins with Bio-Sorption Activated Media (BAM) in Karst Environments – Phase II Field Testing of BMPS	7/10 sites have been sampled. BEP is splitting funding for Phase II efforts. Project is proceeding.
	2014	BDK78-977-18	Evaluation of Pollution Levels Due to the Use of Consumer Fertilizers under Florida Conditions: Examination of Lower Slopes and Rainfall Intensities Taking into Account Overland Flow	Fully implemented in NPDES program to get nutrient credits for the cessation of fertilizer use. Quantification of credits is a money maker throughout the State. Invited by TRB to present the “win” at 2015 TRB Conference.
	2014	BDK78-977-19	Demonstration Bio Media for Ultra-urban Stormwater Treatment	Implemented on D5 Wekiva Parkway to reduce pond size. Regulatory agencies used research as "proof of concept" to issue permits.
	2014	BDK80-977-36	Closed Flume Inlet Efficiency	New curves implemented in Appendix I of the Drainage Design Guide. Curves used in closed flume inlet design, which are used frequently in gentle sloped areas.

Status	Year	Contract	Project Title	Notes
	2015	BDV24-977-12	Optimal Design of Stormwater Basins with Bio-sorption Activated Media (BAM) in Karst Environments-Phase I: Site Screening and Selection	Project is complete and sites implemented in the Phase II study .
	2017	BDV31-977-49	Survey of Key Monarch Habitat Areas Along Roadways in Central and North Florida	Landscape is working with OEM and USFWS to protect the milkweed, Monarchs, and the Department. The process is moving in a favorable direction.
Planning				
Status	Year	Contract	Project Title	Notes
Active	2018	BDV25-977-48	Autonomous Vehicle (AV) and Alternative Fuel Vehicle (AFV) Florida Market Penetration Rate and VMT Assessment Study - ACES	2018: Project is completing a comprehensive market penetration analysis of autonomous and alternative fuel vehicles to look at VMT. The results will help address future transportation funding needs and revenue requirements as market penetration rates increase.
Completed	2017	BDV31-977-69	Florida Driver Assistive Truck Platooning Analysis - ACES	2018: Developing Driver Assistive Truck Platooning in Florida and Guidelines for implementation
Active	2018	BDV29-977-37	Estimation of System Performance and Technology Impacts to Support Future Year Planning - ACES	2018: looking at planning efforts that enhance and extend existing models in FITSEVAL to allow the assessment of system performance and the impacts of additional advanced and emerging technologies. Builds on 2010 workshop and survey. In this project, FITSEVAL tool, identified methods to estimate the impacts of 13 ITS applications. Performance measures considered.
Research Center				
Status	Year	Contract	Project Title	Notes
Completed	2018	BDV31-977-74	University of Florida Advanced Technologies Campus Testbed - ACES	July 2018: Report submitted, and next steps initiated. Article in Research Showcase. The report briefly documents FDOT's peer exchange held on April 25–27, 2017 to discuss state DOT research roadmaps in the contexts of national agenda/activity and emerging technologies, and to explore how a program can work to be aware, agile, and relevant in this environment. The final report also proposed management procedures for the testbed along with a marketing and communications plan.

Status	Year	Contract	Project Title	Notes
Active	2018	BDV31-977-77	Data Management and Analytics for UF Smart Testbed	July 2018: This project will (1) survey data sources and requirements, (2) build hardware/software infrastructure for data analytics, (3) design data warehouse architecture for local servers and clouds, (4) develop an application using historical data from the City of Gainesville, and (5) develop applications based on signal phase and timing (SPAT) data.
Structures				
Status	Year	Contract	Project Title	Notes
	2014	BDK75-977-31	Validation and Implementation of Bridge Design Specifications for Barge Impact Loading	Structures Design Bulletin 17-01 was released to implement rounded piers/footings. Further implementation continues to be evaluated by SDO in the form of design guidelines.
	2014	BDK78-977-08	Repair of Impact Damaged Utility Poles with FRP	There has only been 1 known application. Depending on the complexity and MOT required this could be less costly. The current plan is to provide repair guidance to the Maintenance Office.
	2014	BDK80-977-20	Steel Plate Girder Diaphragm and Cross Bracing Loads	Some of the findings of this report coupled with the findings of BDK80 977-21 were used to revise the FDOT Structures Design Guidelines Section 5.1.A and 5.1.B.
	2014	BDK80-977-28	Phase and Widening Construction of Steel Bridges	The parametric study showed that cross-frames could not be eliminated between phases. Although the proposed alternative cross-frame configuration has merit, it was not moved toward implementation as it was not deemed to be equal to or better than the current configuration shown in the Structures Manual.
	2014	BDK83-977-10	Design and Fabrication of Curved Precast U-Beam Bridges	The method of fabrication for pretensioning is not being used due to the complexities involved. This research was cut short due to these findings.
	2014	BDK83-977-17	Investigation of Carbon Fiber Composite Cables (CFCC) Prestressed Concrete Piles	This research has been implemented within the Structures Design Guidelines and Standard Plans. A project is under construction utilizing CFCC for the piling and sheet piles.
	2014	BDK84-977-07	Design and Construction of Precast Piles with Stainless Reinforcing Steel	This research was implemented at the same time as the above project with CFCC. There are potential projects in the future that could use either SS or CFCC.

Status	Year	Contract	Project Title	Notes
	2014	C9289	Solid Deck Retrofit	We are continuing to wait until a test panel is installed on a bridge in District 4. Testing performed by FDOT showed promise for this technology. The implementation of this technology is limited due the limited number of movable bridges.
	2015	BDU79	Investigation and Development of an Effective, Economical, and Efficient Prestressed Concrete Pile Splice	The plan was to contact pile driving contractors to evaluate the constructability aspect in more detail. That assessment is required before further use can be explored.
	2015	BDV24-977-04	Repair of Impact Damaged Utility Poles with Fiber Reinforced Polymers (FRP), Phase II	Same project as above BDK78 977-08
	2015	BDV29-977-10	Use of Fiber Reinforced Polymer Composite Cable for Post-Tensioning Applications, Phase 2	Post-tensioning anchorage shortcomings were found within this project. The overall concept is viable but the constructability due to the anchorages makes this concept limiting. Industry is working to improve this area, but until then the concept is on hold.
	2017	BDV29-977-05	Non-Destructive Testing (NDT) of a Segmental Concrete Bridge Scheduled for Demolition, with a Focus on Condition Assessment and Corrosion Detection of Internal Tendons	The comments are correct. More development is required to gain confidence in the methods for inspection.
	2017	BDV30-977-16	Rheology Limits for Grout Materials used for Precast Bent Cap Pile Pockets in Hot Weather	The findings provided favorable information on the durability of FRP repairs. These repairs can provide benefit to the structures for 15+ years and likely much longer. The increased life cycle improves the long term value of the repairs.
	2017	BDV31-977-01	Durability Evaluation of Florida's Fiber-Reinforced Polymer (FRP) Composite Reinforcement for Concrete Structures	The results of the effort performed by UF researchers (new correlations between SPT blow count and pile capacity) were implemented into FBDEEP software by the Bridge Software Institute (BSI). A new version of the software has been released and is currently in use by geotechnical engineers across the State. The software is typically used for estimating Test Pile and production pile length as well as required drilled shaft embedment.

Status	Year	Contract	Project Title	Notes
	2017	BDV31-977-05	Evaluation of Static Resistance of Deep Foundation	This project has been implemented. The revised girder capacity equations have been incorporated into the FDOT girder stability program and the FDOT Structures Design Guidelines, which all designers are required to use.
	2017	BDV31-977-46	Distribution Factors for Construction Loads and Girder Capacity Equations	2018: This report updates the previously developed capacity equations for wind load and gravity load and to develop empirical construction stage distribution factor equations at multiple levels of design conservatism

Appendix C. Review of Projects Completed in 2019

State Materials					
Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV25-977-23 (USF)	Performance Improvement of High Early Strength (HES) Concrete for Pavement Replacement Slabs	Will be implemented later	Is Being Implemented	Mitigated replacement slab cracking results in less maintenance and shorter MOT, so there would be less inconvenience to the traveling public	Cost savings from less maintenance, reduced raw material usage, and shorter MOT can only be determined if Maintenance tracks these categories and this information is not available
COMMENTS	<p>In close-out meeting, qualitative and quantitative benefits are suggested: Qualitative Benefits - Minimization or elimination of cracking would reduce MOT times, improve safety for drivers; Quantitative Benefits - Minimization or elimination of cracking would reduce overall costs involved with labor to replace cracked concrete (MOT, cutting and removing damaged concrete, base preparation, drilling of holes placing dowel bars, and placement of concrete) and cost of replacement concrete. This project would have been good for the FAM as \$ costs could have been collected to quantify potential savings under various degrees of implementation. Would need to know how many concrete slab replacement projects are undertaken per year, current costs, etc. This project is also well suited for implementation tracking and FAM may be applied retrospectively.</p>				
BDV25-977-38 (USF)	Development of Calcined Clays as Pozzolanic Additions in Portland Cement Concrete Mixtures	Will be implemented later	Will Be Implemented Later	Availability of another pozzolanic material to replace fly ash would reduce stress on contractors and local concrete suppliers	Cost savings would come from the reduced chance that a work project would be delayed due to the shortage of quality pozzolanic materials
COMMENTS	<p>In close-out meeting, benefits are simply stated: "Alternative pozzolanic material for Class F fly ash for use in concrete elements." It appears this project was mostly informative, there will be no implementation of the results of this research until after Phase II (I am assuming this is another funded project). To apply the FAM to this research, we would need to aggregate costs for all relevant phases of research. Costs of the new material and the costs of transporting it can be collected. Would need to know extent to which the particular concrete mix would replace current concrete mix in FDOT projects/year. Overall, this project is also well suited for implementation tracking, and FAM may be applied retrospectively.</p>				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV27-977-08 (FAU)	Corrosion Propagation of Carbon Steel Rebars in High Performance Concrete	Partial implementation	Implemented Passive	Informational - confirmed previously assumed parameters regarding corrosion propagation in high performance concrete.	Verified methodology used to prescribe 75-year service and related savings expected on maintenance costs
COMMENTS	<p>Research yields information to improve understanding of how corrosion propagates in high performance concretes. The findings of this project suggest that because of a slower propagation on these concretes as compared to standard concretes, a longer period to perform corrective actions after corrosion is initiated could be considered. This longer period may give the local FDOT Maintenance Offices time to secure funds for the needed repairs. To apply the FAM to this research, we would need a long period of time to accurately determine whether FDOT maintenance activities do, in fact, react to this new consideration. However, we could collect repair costs and generate a theoretical measure of savings assuming some number of repair projects that are pushed off to a future date. Implementation tracking will rely on perceptions/judgment that the research results are influencing repair activities. FAM could be applied retrospectively.</p>				
BDV27-977-09 (FAU)	Chloride Diffusivity and Resistivity of Cured and Mature Binary/Ternary Concrete	Information Only	Information Only	Gained a better understanding on the diffusivity of mature concrete and how it compares to the apparent diffusion measured on samples exposed to field-simulated conditions.	Obtained aging factor values for a variety of concrete compositions relevant to FDOT structures. It was found that the m value varies by concrete composition and is influenced by the environment as well as concrete moisture.
COMMENTS	<p>Research yields information to improve understanding of diffusivity of mature concrete. The researchers indicate that better service life predictions could allow existing structures' usage to be extended - this is a quantifiable benefit, but it is stated as a qualitative benefit. To apply the FAM to this research, we would need a long period of time to accurately determine whether FDOT maintenance of structures do, in fact, react to this new consideration. However, we could collect repair costs and generate a theoretical measure of savings assuming some number of projects that are pushed off to a future date. Implementation tracking will rely on perceptions/judgment that the research results are influencing activities. FAM could be applied retrospectively.</p>				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV27-977-10 (FAU)	Corrosion Prevention of Bridge Tendons using Flexible Filler Materials	Has been implemented (Passive)	Has been implemented (Passive)	Identified items to pay extra attention to, to help ensure adequate corrosion protection is achieved	Confirmation that flexible fillers provide suitable corrosion protection
COMMENTS	Kickoff meeting slides neglect to include benefits of the research; close out slides also do not clearly identify either qualitative or quantitative benefits, other than noting that the information will be useful. Research yields information to improve understanding of corrosion protection using flexible fillers. To apply the FAM to this research, we would need costs of the different fillers and a history of FDOT corrosion protection activities and outcomes. The results are suitable for implementation tracking and the FAM could be applied retrospectively.				
BDV29-977-26 (FIU)	Susceptibility of Bridge Steel and Concrete Components to Microbiological Influenced Corrosion (MIC) and Microbiological Influenced Deterioration (MID) in Florida	Has been implemented (Passive)	Implemented Passive	The research provided a quicker recognition and clearer understanding of MIC/MID.	Improved repair procedures and response time to MIC/MID will reduce rehabilitation costs and structure damage.
COMMENTS	Research yields information to improve understanding of microbiological influence corrosion/deterioration to bridge steel and concrete components. TWO states "Benefit to the State: The results from this research will facilitate <i>early identification</i> of civil infrastructure in the State that may be susceptible to early degradation due to MIC and MID <i>so that appropriate maintenance resources can be allocated</i>. It will also provide early means of identifying the presence of MIC. The research aims to characterize MIC and MID degradation so that appropriate means to monitor microbial induced degradation can be developed and also <i>to identify effective remediation methods</i> that can be implemented. Close-out "Project Benefit" slide does not identify benefits - it's just a summary of the findings. The PM indicates that the research provides a quicker recognition and clearer understanding of MIC/MID - this is a quantifiable benefit if FDOT changes its processes in response to this result (the three benefits italicized above could be quantified). To apply the FAM to this research, we would need to know how many processes are affected by MIC/MID. Does repair - in recognition of this information - now take place sooner and/or is the life of the bridge extended? Implementation tracking will rely on perceptions/judgment that the research results are influencing activities, i.e., faster response time, increased time before needing to repair structural damage (are rehabilitation costs reduced?). FAM could be applied retrospectively.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV28-977-04 (FIT)	Development and Testing of the Miniaturized Pavement Pressuremeter for Use in Unbound Pavement Layers	Will be implemented later	Information Only	If fully implemented, this test method would introduce stiffness/modulus to the compaction control acceptance process. This currently is done with density which indirectly relates to stiffness/modulus but doesn't directly relate to any design parameter used for pavement design. It would be a significant improvement to the overall design & construction process to measure a direct design parameter during construction to ensure the pavement foundation meets or exceeds to material properties used to design the pavement.	The current test method for field density is using a nuclear density gauge. This equipment has a radioactive source which requires expensive administrative and regulatory requirements for any user of these gauges (Department personnel, consultants, contractors, etc.). Finding a non-nuclear alternative test would eliminate the need of these requirements and costs.
COMMENTS	<p>I (Patty) attended the kickoff meeting for this project and suggested the researchers/PM collect some costs. Close-out slides indicate some thought to the amount spent currently for nuclear testing capability but does not provide costs of alternative approach (MPP). To apply the FAM to this research, we would need costs of the different fillers and a history of FDOT corrosion protection activities and outcomes. The results are suitable for implementation tracking, once a prototype is available; the FAM could be applied retrospectively but we would need historical costs of testing, average number of tests performed over a year, etc.</p>				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV29-977-34	Development of Quality Assurance and Quality Control System for Post Tensioned Segmental Bridges in Florida: Case of Ringling Bridge - Phase II	Information Only	Information Only	Provided valuable information on the capabilities and limitations of two non-destructive evaluation technologies for inspecting external post tensioning tendons.	The development and understanding of tools for inspecting post-tensioned bridges can ultimately provide for faster identification of damage and reduce cost that would have been associated with catastrophic failures.
COMMENTS	Research yields information to improve inspection methodology. If a new methodology is implemented, the cost of this research should be included in the evaluation of the benefits of implementing the research findings. It is unclear whether additional research is needed before the results can be implemented. The FAM could be applied to this project if assumptions regarding the extent and time period for implementation could be reasonably estimated.				
BDV29-977-35 (FIU)	Evaluation of the Effect of Homogeneity of the Asphalt Binder on Performance of a Recycled Mix	This project was originally created to approve rejuvenators to be used in hot-in-place recycling projects. However, subsequently that process of pavement rehabilitation was removed by upper FDOT management.	Can't Be Implemented	N/A	N/A
COMMENTS	Research yielded results that cannot be implemented for some reason. The FAM could be applied to this project if the results of the research can be weighed against potential costs of having implemented versus staying the course. Would need to know more about why the results cannot be implemented; would the new process cost more or less? what are the inherent risks? etc.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV30-977-18 (FSU)	Performance Evaluation of Glass Fiber Reinforced Polymer (GFRP) Reinforcing Bars Embedded in Concrete Under Aggressive Environments	Will be implemented later	Implemented Passive	Provided supporting information for allowing the use of GFRP bars for concrete in direct contact with water	Expanded use of GFRP bars in highly aggressive environments is expected to provide significant savings on maintenance costs normally associated with the corrosion of reinforcing steel
COMMENTS	Research yields information to improve understanding whether the use of GFRP rebars can be expanded to highly aggressive environments. Closeout slides do not clearly address quantifiable benefits; there is vague mention of durability. FAM could be applied retrospectively. To apply the FAM to this research, we would need to estimate the number of applications of GFRP rebars and would need to compare maintenance costs before and after the implementation. Implementation tracking should be initiated as soon as a decision to use GFRP rebars is made.				
BDV31-977-31 (UF)	Evaluation of Shelf Life in Post-Tensioning Grouts	Will be implemented later	Will Be Implemented Later	Reduced maintenance and shorter MOT would reduce inconvenience to the traveling public	Calculation of cost savings would require maintenance to track incidences of grout failure and compare before and after implementation of new test procedures
COMMENTS	Research yields information to improve screening of grout. Close-out document contains reference to quantifiable benefits, i.e., "An accurate estimate would require determining the percentage reduction in product failures and the average cost of such failures." The project is well-suited for the FAM if such costs can be tracked. Implementation tracking should be initiated as soon as a new evaluation method is implemented.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV31-977-86 (UF)	Reducing Portland Cement Content and improving Concrete Durability	Will be implemented later	Will Be Implemented Later	Longer service life would reduce maintenance and MOT, reducing inconvenience to the traveling public	Reducing cementitious material content 1) reduces cementitious materials usage, 2) reduces heat generation which reduces thermal cracking and the potential for delayed ettringite formation, and 3) reduces shrinkage cracking. Savings stem from reduced cementitious material usage and the increase in durability and service life, which reduces maintenance costs. Calculating the savings would require data from Maintenance which is currently unavailable.
COMMENTS	Research yields information to potentially reduce cementitious material usage. Final report indicates that "savings stem from reduced cementitious material usage and the increase in durability and service life, which reduces maintenance costs." Final report includes cost savings calculations. The project is well-suited for the FAM if the extent of implementation can be estimated. Implementation tracking should be initiated as soon as change is made to the cement content.				
BDV31-977-94 (UF)	Requirements for Use of Field-Cast, Proprietary Ultra-High-Performance Concrete in Florida Structural Applications	Currently being implemented	Implemented Active	Longer service life would reduce maintenance and MOT, reducing inconvenience to the traveling public	Any cost savings would be based on the increased service life of UHPC elements versus the increased cost of UHPC
COMMENTS	Research yields specifications for the use of UHPC. To apply the FAM, we would need to know how the specification has changed the use of UHPC and how this use has affected service life/maintenance. The close-out slides do not mention any quantifiable benefits. Implementation tracking should be initiated to begin monitoring the use of UHPC. The FAM may be applied to this project retrospectively if the extent of implementation can be estimated.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV34-977-02 (UNF)	Testing, Evaluation, and Specification for Polymeric Materials used for Transportation Infrastructures	Will be implemented later	Implemented Passive	The research provided a potential test protocol for evaluating UV resistance of structural plastics	Identifying UV resistance of structural plastics can indicate longer service life and less maintenance cost versus traditional materials
COMMENTS	Research yields specifications for the use of polymeric materials. To apply the FAM, we would need to know how the new test protocol has changed the maintenance and repair of transportation infrastructures that are affected by various forms of degradation. The kick-off and close-out slides were not available for review. The final report makes no mention of benefits. Implementation tracking should be initiated as soon as the new test protocol is implemented. The FAM may be applied to this project retrospectively if the extent of implementation can be estimated and associated costs of testing, training, etc. can be identified.				
BDV34-977-09 (UNF)	Reinforced Concrete Foundation Remote Monitoring	Can't be implemented	N/A	N/A	N/A
COMMENTS	Research evaluates possibility for remote foundation monitoring and finds that two wire transmission line approaches were not adequate. Given a decision to not implement the findings, it is not well suited for the FAM. If further research is funded to evaluate alternative remote testing approaches, the cost to conduct this research should be included in a FAM evaluation of the research. A "what if" scenario might be possible to evaluate the benefit of NOT using the 2.4 GHz or 8kHz wire transmission lines in favor of another approach.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV34-977-06 (UNF)	Application of Microbial Induced Calcite Precipitation to Stabilize Florida High-Organic Matter Soils for Roadway Construction	Can't be implemented	Can't Be Implemented	Information – showing that traditional MICP (Microbial Induced Calcite Precipitation) techniques were not effective at stabilizing organic soils. As part of the testing program, an alternative stabilization method “Surfactant-Induced Soil Strengthening” (SISS) was developed from a very preliminary basis; initial results appear promising.	If proved successfully, this method offered an environmentally friendly (natural stabilizing agents versus traditional ones – cement, lime, etc.) method to stabilize and improve the engineering properties of organic soils. This technique is totally independent of the MICP method, so a more thorough evaluation was outside of this project’s scope. Therefore, the recommendation of the researchers was that this alternative stabilization method warrants its own separate project to evaluation its potential of stabilizing organic soils.
COMMENTS	Research finds that an MICP method of stabilizing soils is not successful. Given a decision to not implement the findings, it is not well suited for the FAM. If further research is funded to evaluate methods for stabilizing soils, the cost to conduct this research should be included. A "what if" scenario might be possible to evaluate the benefit of NOT applying MICP in favor of another approach.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDZ36 (FUGRO)	Automated Identification and Quantification of Flexible and Rigid Pavement Distresses	Will be implemented later	Is being implemented	3D pavement distress data will provide more detailed information on pavement condition. Pavement performance models will be more accurate.	Better pavement forecasting models will lead to a more accurate allocation of work program funding for resurfacing.
COMMENTS	<p>Research evaluates an automated system that would have particular benefits to the FDOT Annual Pavement Condition Survey, i.e., increased safety for pavement data collection personnel, and an increase in efficiency, consistency and repeatability. Implementation tracking should be initiated as soon as a new automated system is deployed; data collection should include information about the time and training needed to use the automated system. The challenge for applying FAM will be how to establish a pre-implementation baseline cost.</p>				
BE287 (TXA&M)	Evaluation of FC-5 with PG 76-22 HP to Reduce Raveling	Is currently being implemented at a slow pace due to the very high cost of PG 76-22 HP binder; only roadways that need this premium asphalt binder are being selected for application.	Is Being Implemented	The road will last longer. Speculation is 2-3 years longer but could be more.	Life extension benefits are based on laboratory tests. The actual extended length of service of the roadways in real life is unknown.
COMMENTS	<p>Research concludes that a new HP binder can be used in OGFC mixtures to minimize raveling. The close-out slides indicate benefits that stem from increased pavement service life. As this finding is already being implemented, FDOT should begin tracking the costs and benefits. Life extension benefits will take some time to determine; any increase or reduction in costs to implement need to be tracked now. The project is well-suited for the FAM, which could use the laboratory test results to estimate benefits in the short run. We would need to know the extent of implementation (i.e., how frequently will the new binder be used, in what volume/no. of applications per year?)</p>				

Aviation					
Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV25-977-36 (USF)	Florida Aviation Activity Forecast Methodologies and Tools Development	Has been implemented (Active)	Will Be Implemented Later		
COMMENTS	<p>Research project developed new methodologies for airport aviation activity forecasting. Benefits of the research are identified in the kick-off and close-out presentations - namely, that a more advanced forecasting model would provide "better decision support for FDOT personnel making financial and resource allocation decisions." Notes here are inconsistent - i.e., Has been implemented? or "will be implemented later?" This project should be moved into the implementation tracking system as soon as a new methodology is employed. Data collection should include costs of maintaining the current FAD and the costs to implement and maintain the new system, any necessary training costs, and an accounting of the decisions that are made using the new system that have improved due to the enhanced system. With regard to the latter form of data, FDOT may collect subjective assessments; a counterfactual scenario or simulation might be possible to track these benefits. To apply the FAM to this research, we would need estimates of whether and how the new system would result in financially-beneficial personnel and resource allocation decisions.</p>				
Freight					
Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV29-977-31	Large Truck Crash Analysis for Freight Mobility and Safety Enhancement in Florida	Will be implemented later	Will Be Implemented Later	Reduction in large truck crashes	Indeterminate at this time
COMMENTS	<p>Research addresses large truck crashes and the proposed quantitative benefit is clearly defined as a reduction in large truck crashes (see close-out survey), however the results appear to be largely informative. TWO suggests that the project involved a statewide crash analysis and developed practical countermeasures to reduce crashes involving freight mobility. The implementable research results seem to be the adoption of new countermeasures identified in task 4. To the extent that the countermeasures identified in the research are implemented, the costs and benefits should be tracked in the Implementation Tracking system. If future research is funded to evaluate the viability of any of these countermeasures, the cost of this research project should be carried into the FAM for the future project. The FAM could be applied retrospectively to this project if a reasonable estimate of the adoption of countermeasures, and their likely impact, could be determined.</p>				

Geotech					
Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV24-977-19 (UCF)	Field Study of Recycled Concrete Aggregate in French Drain	Will be implemented later	Will Be Implemented Later	Use of a recycled product eliminates transportation and storage in landfills. Reduces the emission of carbon dioxide. Saves limited natural resources.	Eliminates Debris-Removal Bid Item, if RCA from FDOT project can be reused. RCA agg is less expensive than natural aggregate. Can reduce the environmental impacts by up to 70%.
COMMENTS	Research provides information about the effectiveness of using RCA in place of other aggregates in French drains and is largely informational. The PI/PM notes two main quantifiable benefits: (1) RCA is cheaper and (2) disposal costs can be reduced. Implementation tracking of the costs and benefits of the research should be prioritized as soon as a demonstration structure has been chosen. The FAM could be applied retrospectively to this project if a reasonable estimate of the proliferation of implementation (after the demonstration project) can be determined.				
BDV25-977-53 (USF)	Re-evaluation of LRFD Resistance Factors for Driven Piles	Not yet determined	Implemented Active		
COMMENTS	Research project involves a re-evaluation of the appropriate load and resistance factors for use in the evaluation of the capacity of driven piles. The close-out presentation provides a summary but no mention of quantifiable benefits (I assume there was more discussion here). The final report is also lacking in detail regarding implementation benefits. If the research findings (new factors) have been implemented (the notes above are unclear), this project should be added to the Implementation Tracking system. Necessary data for evaluating benefits includes the costs of implementing the new factors, number of applications per year, estimated costs of NOT using these factors and relying on the old measures. The FAM could be applied retrospectively to this project if reasonable estimates of the adoption of the new factors, and their likely impact, could be determined.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV31-977-26 (UF)	Effect of Proximity of Sheet Pile Walls on the Apparent Capacity of Driven Displacement Piles	Will be implemented later	Will Be Implemented Later	Allow Designers estimate additional load piles need to be driven to prevent leaving them with low capacity	Not Applicable.
COMMENTS	<p>Research involves an assessment of capacity of driven displacement piles based on proximity to sheet pile walls. Note that the notes from the kick-off meeting (slides are not available) suggest adding calculations of quantifiable benefits to the final report, but the final report does not contain such evaluation. As such, it is not clear to me what the benefits are (preventing collapse of structures?). This project should be added to Implementation Tracking as soon as the results are implemented, but I cannot comment on the data elements aside from the number of installations/piles that are affected. I believe the FAM could be applied retrospectively to this project, but I would need to know more about the implications of the proximity of the walls.</p>				
BDV31-977-51 (UF)	Strength Envelopes for Florida Rock and Intermediate Geomaterials	Will be implemented later	Will Be Implemented Later	The result of this project will provide a calibrated model for shallow foundation design in Florida limestone, which is a significant advancement in current practice because national design methods were found to be inappropriate for Florida limestone.	Use of shallow foundations is a cheaper foundation than the alternative (deep foundations; typically, driven piles). Alternative designs using both can be easily quantified on projects for South Florida where rock is near the surface making shallow foundations a viable option.
COMMENTS	<p>This research project provides a model for design of shallow foundations. Benefits are not clearly indicated in the kick-off slides. Rather, the benefits slide merely reiterates the project outputs. Unfortunately, this is also the case for the close-out slides as well as the final report. Notes above (column J) suggest that the use of shallow foundations is cheaper. If implementation (field test) will occur in Phase II of this project, then then the research should be moved into Implementation tracking and data collection should begin. Data should include cost comparisons of shallow versus deep foundations, number of designs that may be affected by the change from deep to shallow, etc. The FAM could be applied retrospectively to this first project and continue with phase II assuming these type of data are available.</p>				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV31-977-102 (UF)	Effect of Proximity of Sheet Pile Walls on the Apparent Capacity of Driven Displacement Piles, Phase 2	Will be implemented later	Will Be Implemented Later	Allow Designers estimate additional load piles need to be driven to prevent leaving them with low capacity	Not Applicable.
COMMENTS	See comments on BDV31-977-26 above.				
Maintenance					
Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV31-977-55 (UF)	Small Unmanned Aerial Vehicles (sUAV) for Structural Inspection	Has been implemented (Passive)	Implemented Passive	NA	NA
Note:	Procedure 850-010-030 - Bridge and Other Structures Inspection and Reporting was updated to allow the use of sUAVs, if requested, on a case by case at the discretion of the District Structures Maintenance Office and with approval from Central Office. However, the updated procedure is still pending approval. Also, so far, none of the Districts have requested approval for its use.				
COMMENTS	This project compared tradition practice for light pole inspection and maintenance with a drone based approach. Six high mast light poles (HMLP) and eight bridges were inspected as part of this project; approximately half of the inspections were performed alongside traditional inspections, and the remainder were performed with no prior knowledge of the structure to compare findings with the results of recently performed inspections. They also compared costs. The FAM structure and approach would be valuable for applying to this project. The biggest issue is convincing the districts to use it. A training session or similar activity is probably the next step to make this something that they request. The cost savings is substantial.				

Public Transportation

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV25-977-45 (USF)	Understanding Ridership Trends in Transit	Will be implemented later	Information Only	<p>Understanding the contributing factors to declines in ridership is very important to ensure that new initiatives are appropriately targeted, and expectations of various initiatives are understood. Economic, technological and demographic conditions have provided additional choices for travelers making it is more difficult for transit to compete. Policy makers should understand that as they contemplate responses. The responses will require initiatives beyond the operating agencies.</p>	<p>As with many policy research initiatives, there is no direct linkage between the dissemination of new knowledge and the subsequent performance of the transportation system. The fundamental premise is that informed decisions will lead to better decisions and accordingly better system performance with respect to customer satisfaction and cost effectiveness.</p>
COMMENTS	<p>This research project was largely informational. Some of the information gained may be useful in future planning, so the costs of this research should be carried forward into further evaluations of ridership and/or efforts that affect riders. At this point, it is not a good project for the FAM or for implementation tracking.</p>				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV31-977-79 (UF)	University of Florida Testbed Initiative – Transit Components	Not yet determined	Can't Be Implemented	N/A - This TWO was not completed and cannot be implemented.	N/A - This TWO was not completed and cannot be implemented.
COMMENTS	Photos of installation were not available. Can't be implemented because it wasn't completed. Bike rack sensors were not widely installed. There is a presentation on the project available - - the research findings show some promise, but I cannot tell from the files in place why the project wasn't completed. Sensor testing got behind schedule.				

Roadway

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV24-977-14 (UCF)	Comparative Nitrogen and Pesticide Removal with Sorption Media in Linear Ditch for Groundwater and Stormwater Treatment	Currently being implemented	Implemented Active	Better for the environment.	Reduction in nutrient loading; reduced permit acquisition time.
COMMENTS	The performance of a mixed sand, clay, and tire crumb in the field is consistent during laboratory testing for continual flooding but woodchip performs completely differently in the field. The reasons involve media characteristics and environment differences. In addition, the cost benefits analysis was assessed based on both lab and field removal performance, B&G showed great potential when it was applied in the field while woodchip has negative nitrogen removal due to significant ammonia generation, plus, over 50% decomposition of woodchip was observed within one year of field operation. The large decay of the woodchip only makes it a more frequent use. Overall LCC costs favor the mixture, even though it is more expensive up front				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BE321 (UNV)	Structural Coefficient for High Polymer Modified Asphalt Mixes	Will be implemented later	Will Be Implemented Later	Adds structural value to the asphalt mix	Requires 1/4" less of structural asphalt due to higher layer coefficient.
COMMENTS	This project recommended additional mix designs. A testing plan for the Accelerated Pavement Testing was recommended to further validate the recommended structural coefficient described here in. There remain issues of understanding the rutting characteristics in the 0.54 coefficient mix. The cost savings could be reasonable so it might be worth additional work. How has this been received by the designers? What is the feel from Moseley/Davis?				

Traffic

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV24-977-15 (UCF)	Evaluating the Benefits of Multi-Modal Investments on Promoting Travel Mobility in Central Florida	Partial implementation	Information Only	Representation of multimodal demand, allowing for the representation of project outputs our stakeholders are interested in.	Benefits have not been quantitatively assessed.
COMMENTS	The project developed a model estimation effort and framework to incorporate non-auto mode choices within the traditional travel demand framework. The project looked at travel demand. Looking at several scenarios. However, based on the notes, it looks like there is a change in FDOT practice.				
BDV24-977-21 (UCF)	Dynamic Flashing Yellow Arrow (FYA) - A Study on Variable Left Turn Mode Operational and Safety Impacts - Phase III	Will be implemented later	Will Be Implemented Later	Reduced driver frustration and encourage better decision making as left turn drivers assess gaps in oncoming traffic..	Reduced delay, reduced left turn crashes, and reduced emissions.
COMMENTS	Two methods were used to calculate the minimum gap for light signals: discrete and average approach. Although the average method provides a more conservative approach, the discrete approach was more accurate. The developed platform is applicable at any four section head configuration to alter the left turn restriction. The project identified a series of possible implementation efforts and it is under consideration for funding and evaluation outside the "lab".				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV24-977-31 (UCF)	Investigation of Low Visibility Related Crashes in Florida	Not yet determined	Implemented Active	Siting low visibility detection devices at low visibility crash related hot spots	Aim to reduce low visibility crashes at frequent low visibility crash locations
COMMENTS	This project identified clusters for fog/smoke crashes in Florida and examined these. 81 locations were determined to be hot spots for recurring fog and smoke. 6 segments and 3 intersections were identified for additional labeling and mitigation. Added to RWIS is good implementation approach.				
BDV25-977-40 (USF)	Testing and Evaluation of Freeway Wrong-Way Driving Detection Systems	Will be implemented later	Partial Implementation	Reduction in WWD crashes on freeway mainline segments	Reduction in WWD crash numbers and quality of life of all road users
COMMENTS	This project evaluated video - analytic freeway WWD detection systems currently on the market from three vendors. The testing is difficult in real world settings as WWD is a rare occurrence. One system did test better than others and can be used for evaluation. Implementation is for acquisition strategies based on evaluations.				
BDV28-977-08 (FIT)	Accuracy, Consistency, and Reliability of Raw Traffic Data from Vehicle Detection Systems, Phase II	Will be implemented later	Will Be Implemented Later	Provide more reliable and accurate traffic data used to manage traffic on limited access facilities (travel time, express lanes, ramp metering, etc.)	Improved mobility and reduced maintenance costs.
COMMENTS	This project assessed microwave vehicle detection system for TOC use. They provided acceptance testing inspection and determinations of accuracy. The study found that accuracy is often an installation issue, there's no evidence of loop detector degradation, current detection equipment can meet standards for speed and volume, congestion does raise concerns but within the scope. This study provides value in that system installation is the critical finding for long term accuracy. Recommendations include creating maintenance routines among many others.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV29-977-27 (FIU)	Assessment of the Performance of Vehicular Traffic Signal Assemblies During Hurricane Force Winds	Not yet determined	Partial Implementation	Increase survivability of traffic signal assemblies during hurricane force winds.	When fully implemented, the results of this project will improve safety and mobility by reducing the number of dark signalized intersections after high wind events and reduce maintenance/replacement costs due to a decrease number of damaged signal assemblies.
COMMENTS	This project looked at spans for light signals for hurricane conditions. The findings were tested in lab settings. Flexible hangars performed best under high wind conditions. The research team was able to replicate the observed conditions from storms in the test environment. FAM might be applicable here from a maintenance perspective.				
BDV29-977-36 (FIU)	A Data-Driven Approach to Implementing Wrong-Way Driving Countermeasures	Will be implemented later	Is Being Implemented	Reduction in WWD crashes on freeway mainline segments and exit ramps statewide	Reduction in WWD crash numbers
COMMENTS	This project is being implemented as WWD countermeasures are being installed. The findings showed a combination of red rectangular rapid flashing beacons and internally illuminated raised pavement markers helped for impaired drivers. Tourists were recommended for beacons or lighted signs. Density of alcohol sales was a contributing statistic in the study. Some association around facilities that attract older drivers.				
BDV30-977-19 (FSU)	Development of Safety Performance Functions for Restricted Crossing U-Turn (RCUT) Intersections	Not yet determined	Is Being Implemented	Reduction in conflict points compared to conventional intersections. Reduction in number of crashes and mitigating the crash severities.	New Intersection Control Evaluation (ICE) Policy and Procedure. Development of SPF's and/or CMF's.
COMMENTS	Looked at RCUT intersections as a new geometry. Can be used by FDOT planners. These are J-Turns. Not sure why we need to have so many different terms on them. Project provided guidance for crash factors and design.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV31-977-67 (UF)	Geospatial Model for Identifying Transportation Service Availability Gaps for Florida's Vulnerable Populations	Will be implemented later	Implemented Passive	By providing the information about the gaps in transportation services, this research can support planning and implementation of improvement to address transportation services of vulnerable populations, which can eventually lead to improved mobility, accessibility, and safety.	<ol style="list-style-type: none"> 1. Increase the productivity and shorten the time of the FDOT and other stakeholders in taking targeted steps and planning resources to address the issues and maximize the transportation services. 2. Potentially use results to setup performance measures baselines in order to assess the service gap reduction after implementation of any improvement measures.
COMMENTS	This project developed a GIS model to use a supply demand approach for understanding transportation gaps for disabled populations. There is a Phase 2 study that will assess its implementation value. There are also some policy actions that can help - including adding webpages and updating all data available to riders. This seems to be an ongoing issue with these types of websites.				
BDV34-977-10 (UNF)	Evaluation of Incident Response Improvements for Statewide Application: Learnings from the New Regional Traffic Management Center in Jacksonville, FL	Will be implemented later	Implemented Active	This data driven enhancement will allow RTMC Operations to become more predictive on secondary crashes within the multi-modal RTMC and will allow us to dispatch Road Ranger vehicles upstream of the initial incident to prevent or respond to secondary crashes.	The goal is to see a reduction in the more severe secondary crashes with a target of 5% each year.
COMMENTS	This projects attempts a before and after analysis on the new regional TMC. It also compared risks associated with the new approach. Looked at incident durations to determine improved responses. Project also attempted to estimate delays and develop an approach to model secondary crashes. The new approach identified more secondary crashes than traditional methods for estimating impacts. All in all, the project helped provide better information for projecting incident durations and assigning resources potentially saving money.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV34-977-11 (UNF)	Exploring the Modified Procurement Framework for Expediting Florida Connected Vehicle (CV) Deployments	Currently being implemented	Implemented Active	Lowered overall costs for implementing projects with Value-Add built into the initial project scopes	Time savings for efficient procurement process; and More Efficient and procedural connected vehicle equipment procurement process.
COMMENTS	Examined the current procurement practices for CV -- project provided an overview and surveyed project managers in two districts. Identified possible ways to change procurement approaches to work for CV. Process improvements considered developing flow charts, inform local agencies, adopting statewide FCC licenses, and scheduling regular communication meetings. A companion project was also updated with new information as a result of this study. All in all, this will help the CAV implementation. This study is likely a candidate for using FAM but is mostly restricted to staff time savings.				

TransData

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV29-977-37 (FIU)	Estimation of System Performance and Technology Impacts to Support Future Year Planning	Not yet determined	Will Be Implemented Later	Improved mobility, reliability and safety.	The benefits will depend on the specific project under consideration
COMMENTS	This project identified performance measures, prediction of performance, models, and business processes for supporting planning efforts. The outcomes are highly dependent on specific projects. FAM would be a challenge to use here.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV25-977-42 (USF)	Determination of Traffic Adjustment Factors for Florida's High Tourist Activity Sites	Information Only	Is Being Implemented	The results highlighted a need to conduct 7-day short-term counts vs. standard one or two-day counts. A review of analytic methodology is indicated for determining factors on recreational roads, as well as a designation for this type of roadway utilization.	The project results showed a need to be able to 1) collect volume counts in congested, near-stationary traffic, and 2) develop and apply a congestion factor for certain hours of the day when actual counts cannot be accurately collected.
COMMENTS	This project aimed to adjust traffic factors based on seasonal tourist activity. The counts can assist in the development of projects and planning activities. Count stations under performed during high periods. With bumper to bumper traffic. Monthly traffic adjustment factors are close approximations. The project successfully validated FDOT practice. But it does need to be adjusted as the undercounting issue was noted for permanent and temporary locations.				

Contract Number	Title	Implementation Status - FY 18-19 Submitted by Project Manager	Current Implementation Status	Qualitative Benefits	Quantitative Benefits
BDV31-977-57 (UF)	LiDAR Data Collection to Support Quality Control (QC) Processes and the Florida Shared-Use Nonmotorized SUN Trail System	Has been implemented (Passive)	Implemented Passive	The researcher provided promising results on the accuracy and capabilities of utilizing a compact LiDAR sensor by performing data collection feasibility tests on FDOT roadways. The feasibility tests also tested a unique deployment method by mounting the sensor to capture data from traditional LiDAR blind spots. The feasibility tests provided results that gave the TDA office personnel perspective into future system requirements of a LiDAR sensor to support FDOT's current and future data collection methods. TDA is utilizing these results to review the Quality Control processes for data collection and focus the technology deployment needs to support and perform data collection. The Velodyne Puck system is on the lower range of quality due the FDOT business requirements that require not only geospatial data from LiDAR but also photo/video imagery to support data extraction from the LiDAR point cloud and archival and distribution of imagery of roadway assets to other FDOT business units.	The research provided the feasibility to capture RCI based on the deployment method by determining the amount of RCI features that could be collected on the roadway. There are accuracy concerns as features that are farther away from the sensor are less accurate depending on what side of the road the LiDAR is being deployed at. The data analysis results of what could be collected through this deployment method cannot be fully compared to the RCI program as further tests are needed to perform data collection on higher functional classified roads or complex roadways. The researcher calculated the estimated costs for deployment of a sensor compared to man-hour cost estimates of the RCI consultants. These costs consider the estimation of effort performed by District consultants to the costs of standing up the system. The respective man-hour estimates identified a wide range of magnitude costs that still require additional information on the FTE costs of running, maintaining, and training on the new system. Finally, the researcher identified LiDAR data vendor software that is available on the market, which gives FDOT an idea on what to invest in if the Department were to start performing data analysis or extraction of RCI data through LiDAR point clouds.

COMMENTS	This project should be considered for FAM. Using LiDAR as a new method can be compared against existing practices. The project compared collection times, costs, safety, and data consistency between traditional collection and LiDAR collection. This report is compiled in a manner that makes review difficult. there is substantial cost to moving to a new process, but these costs can be estimated and flow from FAM. Might not be a good candidate as the costs of project management might be difficult to collect.
----------	--

**Appendix D.
Screening Tool**



An Instrument for Screening Transportation Research Endeavors for Implementation Potential

Draft Developed by Jason Bittner, Applied Research Associates and Dr. Patricia Born (Schriefer), Florida State University
 This instrument is based on efforts of Dr. Judy Smith-Davis during the 1980s and has been updated since then. It is derived from the classic R&D literature on the dissemination, diffusion, adoption, and implementation of innovations in education and related disciplines.

Screening Research Outcomes for Adoption

Best practices indicates that implementation begins at project identification and selection. This checklist and screening tool, however, is designed to be completed as research projects are beginning to wind down. Major deliverables have been drafted and research practices are addressed. Each section includes the ability to rate the match between what Principal Investigators are reporting and what the Project Champion sees.

	Ask the Principal Investigator	Ask the Project Champion	Rate the Match				
Claims	What goals and objectives is the research designed to achieve?	What goals and objectives is FDOT we seeking to fulfill?	1	2	3	4	5
			No Match				Good Match
	Notes: _____ _____ _____						
Effectiveness	What evidence proves this research is achieving what it claims?	Is the evidence convincing?	1	2	3	4	5
			No Match				Good Match
	Notes: _____ _____ _____						



Advantage	Is this something that makes it better than what is already in operation here?	Would adopting this advance our program or activity?	1	2	3	4	5
			No Match		Good Match		
	Notes: _____ _____ _____						
History Of Use	Has this been tried elsewhere?	Are there unique barriers for implementing this?	1	2	3	4	5
			No Match		Good Match		
	Notes: _____ _____ _____						
Minimum Standards for Replication	Exactly what must the adopter do to achieve success?	How much are we willing and able to do in order to replicate a practice?	1	2	3	4	5
			No Match		Good Match		
			Match		Match		
	Is the practice completely proscribed --or does it permit adjustments and tailoring by the agency?	Are we seeking a flexible or proscribed program to meet this need?					
	Does anything have to be added at FDOT sites?	What are we willing and able to add to the practice we adopt?					
Can the practice be tried out on a small scale first?	Is a trial effort desirable as part of the decision- making process?						
Notes: _____ _____ _____							



Complexity and Convenience	How complicated are the procedures and sequencing necessary for implementing this practice?	What level of complexity can we accommodate in implementing a new practice?	1 2	3 4 5
			No Match	Good Match
	How much discomfort and reorganization are likely to occur in implementation?	What level of discomfort and reorganization can FDOT tolerate?		
	Notes: _____ _____ _____			
Assistance With Implementation	How is the practice conveyed to new users?	What kinds of training or assistance would we need for implementation?	1 2	3 4 5
			No Match	Good Match
	Notes: _____ _____ _____			
Costs	What is the price of adoption?	What budget has been estimated for initiating a new practice?	1 2	3 4 5
	What additional resources, personnel facilities, does the practice require?		No Match	Good Match
	Notes: _____ _____ _____			
Payoff	How rapidly does the project achieve its goals?	What is our timeline for producing change?	1 2	3 4 5
	Does the package include evaluation procedures for measuring success?	What are our criteria for judging the success of the replication of this practice?	No Match	Good Match



The _____ (project) was screened on _____ (date) by: _____ (champion).

It was judged ___ worthy of ___ unworthy of:

(a) ___ further examination, (b) ___ demonstration, (c) ___ trial use, (d) ___ adaptation; (e) ___ adoption

Because: _____

Signed:



Appendix E. Close-out Survey Questionnaire with Suggested Edits

1. Choose from the 7 options below and give a detailed explanation of the project relating to the designated option.

- a) **The project can't be implemented** (select this option if the project should be implemented, but cannot be due to fiscal, political, logistical, or other considerations)
- b) The project will be implemented later
- c) The project is currently being implemented
- d) **The project has been implemented, Passive** (select this option if the results/implementation items of the research project are available for use, but to the PMs knowledge they have NOT been used on any projects yet, but may be later)
- e) **The project has been implemented, Active** (select this option if the results/implementation items of the research project are being used on current transportation projects; whether internal or external)
- f) **The project should not be implemented** (select this option if the results/implementation items of the research project should not be implemented because they were unfavorable; example, a new material was tested and deemed to be sub-standard)
- g) **Information Only** (select this option if the project does not have any implementation items and was for informational purposes only)

2. Was the deliverable what was expected? ** this is a yes/no – it should at least include an “Explain”.

3. Were there implementation items not anticipated that were derived as a result of the research?
** We should be able to track this if they are submitting regular “progress” reports with the research **

4. List the implementation item(s) derived from the research? (Spec modification, Methodology, Process Enhancement, Field Device, Insight, Best Practice Recommendations, etc.)

5. Qualitative Benefits of research result? (Please state the benefits and supporting information)

6. Quantitative Benefits of research result? (Please state the benefits and supporting information)
** Actual data items **

7. What is the implementation plan of the research result? ** We could provide more guidance here, e.g., include some timeframes, who will “champion” the effort, etc. **

8. Who are the stakeholders needed for deployment of the research result? ** included in 7 **

9. Are they invited to the close-out meeting?

10. Was there appropriate communication from the PI throughout the project, in the form of reports, conversation, and questions to keep on task and maintain focus on FDOT objectives? **
Does the final report address the potential implementation of the findings? **

11. Are there any planned publications/presentations of the results?
12. What was your opinion on working with the PI?
13. Is follow-up work possible? Suggested? What would it be?
14. What were the reasons for extensions, rejections, etc., if any?
15. What areas of the Research Center process of developing, funding, executing these contracts and projects needs improvement?
16. Do results merit implementation? **** redundant ****
17. Were there implementation issues that came about because of the research? **** Not sure what this means –“issues?” – seems redundant ****
18. If a demonstration project or full implementation is warranted please list all stakeholders and offices who would be involved. **** Different than 8? ****
19. Timeline for implementation/future action. **** We can provide some organization here; timeline should also include estimated costs ****
20. Any related contracts?

Appendix F. Research Process Forms: Kickoff Survey



Part I – Contract Information

Research Contract No:

Research Project Title:

Originating Office and District:

Kickoff Date: Contract End Date: Ending Project Cost:

Project Manager: Principal Investigator:

Related
Projects:
(provide contract
numbers)

List the data, data sources (internal and external to FDOT) needed to conduct this research.

Internal

External

Part II – Implementation

Is this project conducive to implementation?

Yes No

If yes, how?

If no, why?

What are the projects expected implementable items? (Spec modification, Methodology, Process Enhancement, Field Device, Insight, Best Practice Recommendation, etc....).

Who is/are the Implementation Owner(s)? (The person responsible to coordinate implementation for the originating office with all affected offices and can be contacted for implementation status in the future).

List all the activities required to implement the expected outcomes and project deliverables.

Activity	Contact Name
1. 2. 3.	

List any implementation challenges and potential solutions.

Challenges	Solutions
1. 2. 3.	1. 2. 3.

List all FDOT offices that may be affected by this research implementation.

FDOT Office	Contact Name
1. 2. 3.	

Please list the stakeholders invited to the kickoff meeting.

1. 2. 3. 4. 5.

Part III – Benefits Assessment

Project Benefits (Select all that apply and explain)	Qualitative Benefits	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			
<input type="checkbox"/> Materials Savings			
<input type="checkbox"/> Time Savings			
<input type="checkbox"/> Lives Saved/ Injuries Prevented			
<input type="checkbox"/> Other (Explain)			
<input type="checkbox"/> Other (Explain)			

Part IV – Estimated PM Time Expenditures (Hours)

PM Hours Spent Previous to Kick-off of the Research Project:	
Conducting relevant background research:	
Discussing/preparing/writing research proposal (in-house):	
Discussing research proposal with Research Center staff:	
Preparing an RFP (if applicable):	
Reviewing RFP Proposals (if applicable):	
Discussing the project scope with the potential investigator(s):	

Appendix G. Research Process Forms: Midpoint Survey



Part I – Contract Information

Research Contract No:

Research Project Title:

Originating Office and District:

Today's Date: Contract End Date: Updated Project Cost:

Project Manager: Principal Investigator:

Related Projects:
(provide contract numbers)

Part II – Implementation

Implementation Owner(s)

1.

2.

3.

Have there been any contractual amendments that will affect the implementations items or time schedule of implementation?

- Yes No

Please explain.

Have there been any changes and/or additions to the stakeholders/interest groups?

- Yes No

If yes, please explain.

List all FDOT offices that may be affected by this research implementation.

<i>FDOT Office</i>	<i>Contact Name</i>
1. 2. 3.	

Has anything changed from the kickoff?

When is the intended research implementation to occur?

- Immediate – 6 months
- 7 months – 18 months
- > 18 months
- Prior to the completion of the research
- Unsure

Briefly describe the process on when and how this research will be implemented

How will the benefits of this research project be measured?

How should FDOT measure success on this project?

How can the Research Center assist in implementing this research? (Continued research/tracking, technology transfer, other assistance, etc.)

Appendix H. Research Process Forms: Closeout Survey



Part I – Contract Information

Research Contract No:

Research Project Title:

Originating Office and District:

Closeout Date: Contract End Date: Ending Project Cost:

Project Manager: Principal Investigator:

Related
Projects:
(provide contract
numbers)

Part II – Implementation

Choose from the 7 options below and give a detailed explanation of the project relating to the designated option.

- The project can't be implemented (select this option if the project should be implemented, but cannot be due to fiscal, political, logistical, or other considerations)
- The project will be implemented later
- The project is currently being implemented
- The project has been implemented, Passive (select this option if the results/implementation items of the research project are available for use, but to the PMs knowledge they have NOT been used on any projects yet, but may be later)
- The project has been implemented, Active (select this option if the results/implementation items of the research project are being used on current transportation projects; whether internal or external)
- The project should not be implemented (select this option if the results/implementation items of the research project should not be implemented because they were unfavorable; example, a new material was tested and deemed to be sub-standard)
- Information Only (select this option if the project does not have any implementation items and was for informational purposes only)

Detailed explanation from previous answer.

List the implementation item(s) derived from the research? (Spec modification, Methodology, Process Enhancement, Field Device, Insight, Best Practice Recommendations, etc.)

- 1.
- 2.
- 3.
- 4.
- 5.

Who is/are the Implementation Owners? (List all district/CO contacts)

- 1.
- 2.
- 3.
- 4.
- 5.

List all FDOT offices that may be affected by this research implementation.

<i>FDOT Office</i>	<i>Contact Name</i>
1. 2. 3.	

Please list the stakeholders engaged in the project.

1. 2. 3. 4. 5.

Has anything changed from the kickoff?

--

When is the intended research implementation to occur?

- Immediate – 6 months
- 7 months – 18 months
- > 18 months
- Prior to the completion of the research
- Unsure

Briefly describe the process on when and how this research will be implemented

How will the benefits of this research project be measured?

How should FDOT measure success on this project?

How can the Research Center assist in implementing this research? (Continued research/tracking, technology transfer, other assistance, etc.)

Qualitative Benefits of research result? (Please state the benefits and supporting information)

Quantitative Benefits of research result? (Please state the benefits and supporting information)

What areas of the Research Center process of developing, funding, executing these contracts and projects needs improvement?

Appendix I. Research Process Forms: Deployment Plan



Part I – Contract Information

Research Contract No:

Research Project Title:

Originating Office and District:

Today's Date: Contract End Date: Ending Project Cost:

Project Manager: Principal Investigator:

Related Projects:
(provide contract numbers)

Part II - Project Information

Please identify any other offices that may be affected by the outcome of this research.

- | | |
|--|---|
| <input type="checkbox"/> Aviation | <input type="checkbox"/> Public Transportation |
| <input type="checkbox"/> Civil Integrated Management | <input type="checkbox"/> Research Center |
| <input type="checkbox"/> Construction | <input type="checkbox"/> Roadway Design |
| <input type="checkbox"/> Environmental Management | <input type="checkbox"/> Safety |
| <input type="checkbox"/> Forecasting and Trends | <input type="checkbox"/> Seaports |
| <input type="checkbox"/> Freight and Multimodal Operations | <input type="checkbox"/> Structures |
| <input type="checkbox"/> Geotechnical | <input type="checkbox"/> Systems Implementation |
| <input type="checkbox"/> Maintenance | <input type="checkbox"/> Traffic Engineering and Operations |
| <input type="checkbox"/> Materials | <input type="checkbox"/> Other <input style="width: 150px;" type="text" value="Please specify..."/> |
| <input type="checkbox"/> Office of Information systems | <input type="checkbox"/> Other <input style="width: 150px;" type="text" value="Please specify..."/> |
| <input type="checkbox"/> Planning | <input type="checkbox"/> Other <input style="width: 150px;" type="text" value="Please specify..."/> |
| <input type="checkbox"/> Policy Planning | <input type="checkbox"/> Other <input style="width: 150px;" type="text" value="Please specify..."/> |

Part III - Implementation

This section of the survey asks project managers to identify any prerequisites to or requirements for implementation. It should identify potential barriers to implementation and any actions that should or will need to take place before the research can be put into practice.

Will implementation of the research results require a change to legislation?

- Yes No

If yes, please explain.

Will implementation of the research results require a change to an FDOT Rule?

- Yes No

If yes, please explain.

Will implementation of the research results require a policy change?

- Yes No

If yes, please explain.

Will implementation of the research results require a change to a procedure or the development of a new procedure or test method?

- Yes No

If yes, please explain.

Will implementation of the research results require a change to specifications or a new specification?

- Yes No

If yes, please explain.

Will a demonstration or experimental project be required?

- Yes No

If yes, please explain.

If this project will result in the development of a product(s), please identify the type(s) of product(s) to be developed.

Field Device

Other

Scientific Equipment

Other

Software

Other

If a product will be developed, please identify any of the following that may be required. If more than one product was identified in the previous question, be sure to identify the need(s) for each product in the comments box provided below

- Commercial partnership
- Pilot test deployment
- Prototype design
- Other Please specify...
- Machine shop assistance

Please provide an explanation for each of the choices selected (for each of the products).

Part IV - Performance Measures

This section of the survey requests project managers to identify performance measures that could be applied to the output and/or outcome of the research. Quantitative measures refer to quantifiable benefits that can be measured. Qualitative measures refer to non-quantifiable benefits, i.e., which are not subject to discrete analysis.

Can economic benefits be determined if the results of this research are successfully implemented?

- Yes
- No

If yes, please explain.

Are there non-economic quantifiable benefits that could be assessed if the research results are successfully implemented?

- Yes
- No

If yes, please explain.

Will successful implementation of the research result in a safety enhancement?

- Yes
- No

If yes, please explain.

Will successful implementation of the research result in system efficiencies?

- Yes No

If yes, please explain.

Will successful implementation of the research result in resource savings?

- Yes No

If yes, please explain.

Will successful implementation of the research result in environmental gains?

- Yes No

If yes, please explain.

Will successful implementation of the research result in community enrichment?

- Yes No

If yes, please explain.

Are there any other qualitative benefits that could be measured?

- Yes No

If yes, please explain.

Part V - Technology Transfer

The Research Center currently performs a variety of technology transfer activities. These activities are intended to inform practitioners of the research results. They include posting reports online; distributing final reports to national repositories and online transportation resources; using listservs to notify FDOT and non-FDOT recipients of report availability; and production of project cards. This section asks project managers to identify any additional technology transfer needs. If no additional technology transfer is needed please check that box.

Are any of the following additional technology transfer efforts needed or expected to be performed? If so, please identify who is anticipated or desired to perform the activity in the comment box below—for example, if your office has a newsletter or hosts a conference/meeting that you anticipate being used to perform technology transfer for this project. If any of the following options are selected as a need, but no provider has yet been identified, please so indicate.

- | | |
|---|--|
| <input type="checkbox"/> No additional technology transfer needed | <input type="checkbox"/> Technical Summary |
| <input type="checkbox"/> Conference | <input type="checkbox"/> Web posting |
| <input type="checkbox"/> Executive Summary | <input type="checkbox"/> Workshop |
| <input type="checkbox"/> Meeting | <input type="checkbox"/> Other |
| <input type="checkbox"/> Newsletter | |

Please specify...

Please explain the anticipated need for any of the options selected, and identify anticipated venue or provider, if known.

Part VI - Outreach

Unlike technology transfer, outreach is directed towards a larger, general audience. Current activities include general project summaries, a research showcase magazine, and development of videos. These activities are done in coordination with project managers. In this section, project managers should identify additional outreach efforts that may be warranted.

A small percentage of projects may warrant additional outreach efforts. With respect to news media options, candidate projects would likely either be highly visible to the public, in which case outreach may be conducted as part of the project, or have a substantial safety or cost-savings benefit.

- No Outreach needed
- News media (radio, TV, newspaper)
- Printed materials
- CDs/DVDs
- Other Please specify...

Please explain the anticipated need for any of the options selected, and identify anticipated venue or provider, if known.

Part VII - Training

Training may sometimes be needed to implement the results of research, and it may be delivered by a variety of means, including processes already established within the implementing office. This section asks project managers to identify any training that might be needed for the research to be implemented.

Please identify any of the following that may apply, and provide a brief explanation.

- | | |
|---|---|
| <input type="checkbox"/> No training needed | <input type="checkbox"/> Training for non-FDOT to be provided by non-FDOT source(s) |
| <input type="checkbox"/> Training for FDOT and/or non-FDOT using existing processes | <input type="checkbox"/> Training may be needed, source unidentified |

Comments:

Appendix J. Dissemination and Implementation Plan



Office of Research and Innovation

<PROJECT NAME>

DISSEMINATION AND IMPLEMENTATION PLAN

Version <1.0>

<mm/dd/yyyy>

AGENCY: _____

CONTACT: _____



[Insert appropriate Disclaimer(s)]

VERSION HISTORY

*[Provide information on how the development and distribution of the **Implementation & Dissemination Plan**, up to the final point of approval, was controlled and tracked. Use the table below to provide the version number, the author implementing the version, the date of the version, the name of the person approving the version, the date that particular version was approved, and a brief description of the reason for creating the revised version.]*

Version #	Implemented By	Revision Date	Approved By	Approval Date	Reason
1.0	<Author name>	<mm/dd/yy>	<name>	<mm/dd/yy>	<reason>

Note to the Author

[This document is a template of an **Implementation and Dissemination Plan** document for a research project that has completed a screening tool effort positively. The template includes instructions to the author, boilerplate text, and fields that should be replaced with the values specific to the project.

- Blue italicized text enclosed in square brackets ([text]) provides instructions to the document author, or describes the intent, assumptions and context for content included in this document.
- Blue italicized text enclosed in angle brackets (<text>) indicates a field that should be replaced with information specific to a particular project.
- Text and tables in black are provided as boilerplate examples of wording and formats that may be used or modified as appropriate to a specific project. These are offered only as suggestions to assist in developing project documents; they are not mandatory formats.

When using this template for a research document, it is recommended that you follow these steps:

1. Replace all text enclosed in angle brackets (i.e., <Project Name>) with the correct field values. These angle brackets appear in both the body of the document and in headers and footers. To customize fields in Microsoft Word (which display a gray background when selected):
 - a. Select File>Properties>Summary and fill in the Title field with the Document Name and the Subject field with the Project Name.
 - b. Select File>Properties>Custom and fill in the Last Modified, Status, and Version fields with the appropriate information for this document.
 - c. After you click OK to close the dialog box, update the fields throughout the document with these values by selecting Edit>Select All (or Ctrl-A) and pressing F9. Or you can update an individual field by clicking on it and pressing F9. This must be done separately for Headers and Footers.
2. Modify boilerplate text as appropriate to the specific project.
3. To add any new sections to the document, ensure that the appropriate header and body text styles are maintained. Styles used for the Section Headings are Heading 1, Heading 2 and Heading 3. Style used for boilerplate text is Body Text.
4. To update the Table of Contents, right-click and select "Update field" and choose the option- "Update entire table"
5. Before submission of the first draft of this document, delete this "Notes to the Author" page and all instructions to the author, which appear throughout the document as blue italicized text enclosed in square brackets.]

TABLE OF CONTENTS

1. IMPLEMENTATION TEAM MEMBERS	5
2. IMPLEMENTATION AUDIENCE & APPROACH	5
3. IMPLEMENTATION SCHEDULE	5
4. IMPLEMENTATION ROLES AND RESPONSIBILITIES	5
5. EXPECTED OBSTACLES AND BARRIERS	6
6. INITIAL COMMUNICATION PLAN	6
7. DATA COLLECTION PLAN	6
8. TECHNOLOGY TRANSFER PRODUCTS	6
9. ASSUMPTIONS.....	6
IMPLEMENTATION PLAN APPROVAL	7

1. IMPLEMENTATION TEAM MEMBERS

[Describe the scope of the Implementation effort and potential team members (typically the PI and Project Champion from the Screening tool). Be sure to list all potential research customers and office locations associated with this project.]

2. IMPLEMENTATION AUDIENCE & APPROACH

[Describe the recommended audience for this particular research project. Specify if the proposed approach will be one or a combination of the following:

- *Direct implementation of the proposed product*
- *Parallel operation of both the existing system and the proposed products/activities for a period of time*
- *Pilot implementation at a demonstration site of office*
- *Phased implementation of functional components*
- *Staged implementation, such as by location, division, department, agency*

If a decision is made to adopt any form of partial implementation, specify the implementation sequence of all sub-systems, noting any sub-system dependencies.

3. IMPLEMENTATION SCHEDULE

[Provide a high-level schedule that estimates the time required to complete each implementation and depicts the sequence of the implementation.]

Activity	Implementation Date
Initial Pilot	
Other Deployments	
Other	

4. IMPLEMENTATION ROLES AND RESPONSIBILITIES

[Specify who needs to be engaged in this effort]

Implementation Role	Responsibility and Name
PI	XXXX XXXX

5. EXPECTED OBSTACLES AND BARRIERS

[Specify the strategy for addressing the barriers to implementing this project outcome. Be sure to assess resources available, including financial, human, IT, or other]

6. INITIAL COMMUNICATION PLAN

[Define a communication plan for the implementation. Who will be involved in the dissemination and production of technology transfer activities]

7. DATA COLLECTION PLAN

[Define a plan and approach for collecting the data necessary for the Financial Achievability Model]

Purpose: *[The first thing that needs to be clarified before any effort is done is the purpose.]*

Type of Data: *[Describe the data that you expect to collect. Also the sub-type of data like binary, ordered pairs etc need to be mentioned and explained to the people collecting the data.]*

Frequency: *[Is there any expected frequency for data collection? What time frame?]*

8. TECHNOLOGY TRANSFER PRODUCTS

[Document any expected product (e.g., demonstration or pilot projects in host agencies, regional workshops, and peer exchange meetings; creation of a "community of interest"; development of promotional materials; etc]

9. ASSUMPTIONS

[Document any assumptions made in creation of the Implementation Strategy.]

IMPLEMENTATION PLAN APPROVAL

The undersigned acknowledge they have reviewed the <Project Name> **Implementation and Dissemination Plan** document and agree with the approach it presents. Any changes to this plan will be coordinated with and approved by the undersigned or their designated representatives.

[List the individuals whose signatures are required. Examples of such individuals are PI, Project Champion, and Project Manager. Add additional signature lines as necessary.]

Signature: _____ Date: _____
Print Name: _____
Title: _____
Role: _____

Signature: _____ Date: _____
Print Name: _____
Title: _____
Role: _____

Signature: _____ Date: _____
Print Name: _____
Title: _____
Role: _____

Appendix A: References

[Insert the name, version number, description, and physical location of any documents referenced in this document. Add rows to the table as necessary.]

The following table summarizes the documents referenced in this document.

Document Name and Version	Description	Location
<i><Document Name and Version Number></i>	<i>[Provide description of the document]</i>	<i><URL or Network path where document is located></i>

Appendix B: Key Terms

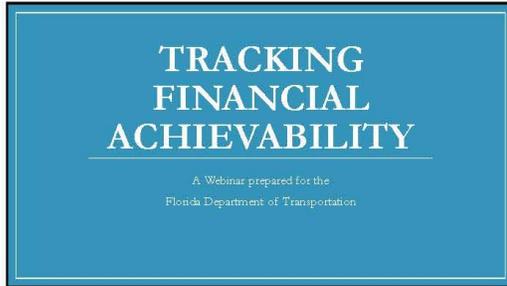
[Insert terms and definitions used in this document. Add rows to the table as necessary.]

The following table provides definitions for terms relevant to this document.

Term	Definition
<i>[Insert Term]</i>	<i>[Provide definition of the term used in this document.]</i>
<i>[Insert Term]</i>	<i>[Provide definition of the term used in this document.]</i>
<i>[Insert Term]</i>	<i>[Provide definition of the term used in this document.]</i>

Appendix K. Webinar Slides

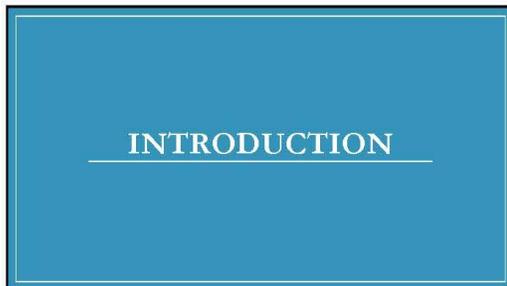
5/20/2020



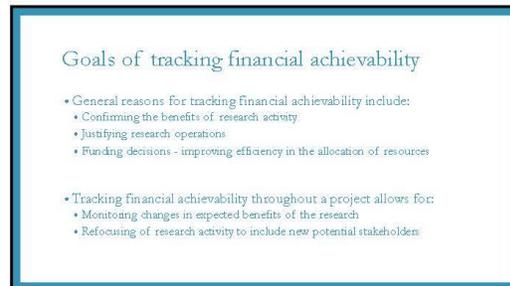
1



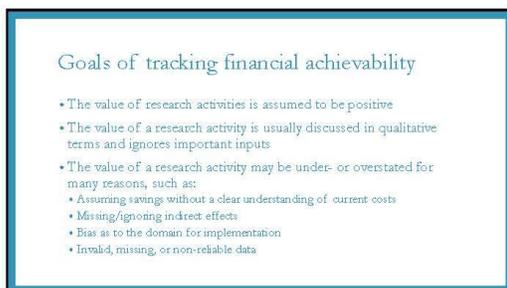
2



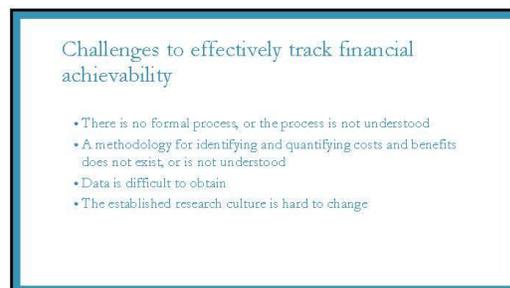
3



4



5



6

1

The FAM Model

- The Financial Achievability Model (FAM) is an assessment process designed to show the value of a research project.
- The basic goal is to calculate net benefits or a rate of return, i.e.,

$$\text{Benefits} - \text{Costs} = \text{Net Benefits}$$

or $\frac{\text{Benefits}}{\text{Costs}} = \text{Rate of return (ROI)}$

7

Background - Development of a Process

- Two completed research projects have addressed tracking financial achievability:
 - [BDK83-977-24](#) "Financial Achievability of Florida Department of Transportation Research Projects" (2014)
 - Development of FAM model and approach
 - Evaluation of model using the Mail-survey Survey Vehicle
 - [BDV30-977-12](#) "Financial Achievability of the Florida Department of Transportation Research Projects: Putting the Financial Analysis Framework into Action" (2018)
 - Further development of processes
 - Pilot collection of management costs
 - Evaluation of eight projects for suitability, discussion of unique considerations
 - Ensuring "benefits" are being identified in all stages of research projects

8

Development of a Process

- [BDV30-977-24](#) – "Technology Transfer and the Implementation of FDOT Research Results"
- Emphasis on tracking implementation benefits
- Continues focus on developing processes for tracking relevant costs and benefits throughout the research process
- Output from FAM model feeds into implementation tracking efforts

9

Vision for Tracking Financial Achievability

- Successful tracking of financial achievability requires overcoming challenges by:
 - Establishing a formal, systematic process and methodology (FAM)
 - Providing guidance to researchers (e.g., worksheets, training, data, examples)
 - Developing a culture that supports the FAM
- Early application of the FAM to a research project will facilitate the identification of implementation benefits, and will naturally feed in to a process for implementation tracking.

10

**THE FDOT RESEARCH
PROCESS**

11

The FDOT Research Process in Forms

- The research process has multiple stages that involve information and data collection:
 - Request for research funding
 - Scope submission and review
 - Kickoff presentation
 - Mid-point meetings
 - Close out

12

Scope of Service Development & Review

- Example statements with cost components identified
- Analysis methods to be used will include (i) statistical methods to evaluate the effects of the various mix parameters on the properties of the concrete, (ii) pavement analysis models to evaluate the potential performance of the concrete pavement slab given the concrete properties, and (iii) a comparison of the costs of current, trial, and production mixes that meet PDOT objectives for strength and workability.
- A detailed report will include offices' roles and responsibilities, manpower involvement, and a diagrammed process chart examining the steps involved to collect data, manage data, develop data products, and coordinate updates/maintenance.

19

Kickoff Meeting

- A kickoff meeting must be conducted within the first 30 days of a task work order
- The PI(s) are generally responsible for making a presentation
- Identified stakeholders shall be invited to attend
- RC policies and procedures are reviewed with PMs and PIs to ensure contractual requirements are met throughout the project
 - Adherence includes any required data collection activities

20

Kickoff Meeting Presentation Requirements (1 of 2)

- The presentation *must* include:
 1. Title slide/page
 - a. PM name, PI name, school, project (task work order) title, contract number
 2. Presentation outline
 3. Project Benefits (expected)
 - a. Qualitative
 - b. Quantitative
 4. Implementation items/issues anticipated (if any)
 - a. Software, physical patches/device, policy, procedure, etc.
 - b. Discussion of any additional stakeholders needed for implementation who were not previously identified?
 5. Introduction
 6. Project background: describe the problem/issue PDOT is attempting to address with this research project

21

Kickoff Meeting Presentation Requirements (1 of 2)

7. Project objectives, as identified in the scope of services
8. Task outline from the scope of services: discuss the anticipated activities that will be conducted to complete each task; the PI, PM, and RPC will discuss any needs/issues associated with each of these tasks; repeat for each task on a separate slide (e.g. below). The PI will also list and discuss the required deliverable that will be submitted for each task.
 - a. List task 1 from the scope, discuss anticipated research activities and any needs/issues to fulfill task 1, and its associated deliverable.
 - b. List task 2 from the scope, discuss anticipated research activities and any needs/issues to fulfill task 2, and its associated deliverable.
 - c. Etc...
9. Discussion of anticipated project timeline (from scope of services)
10. Closing Slide/Page

22

Kickoff Meeting Presentation – Example 1

Project Benefits

- Reduction or elimination of end region cracking that currently occurs in prestressed concrete girders.
- Improve service life of the girders, life-cycle cost savings
- Reduction or eliminate the need for repairs and repair the beam ends, which can have a significant impact on cost and schedule
- Remove some impediments to increasing span length, which can reduce overall bridge cost.

23

Kickoff Meeting Presentation – Example 2

Project Benefits

- **Qualitative:**
 - Additional local source of pozzolanic material available for use in concrete elements
 - Potential growth of the state economy and job market
- **Quantitative:**
 - Less expensive alternative for cementitious systems

24

Kickoff Meeting Presentation – Example 3

FMR (Freight Mobility Research Method)

Project Benefits

- Quantitative
 - Effects on the freight operations.
 - Effects of the freight movements on the transit operations and on the overall transportation network.
 - Overall impacts on the transportation network. ?
- Qualitative
 - Encourage the use of advanced technologies on signal control and operation to improve overall agency practices.

25

Kickoff Survey (1 of 3)

- At the time of the kickoff, additional information is collected through a survey of PMs
- The goal for this survey is to establish a process for data collection and anticipate deployment/implementation where appropriate
- The responses establish baseline expectations for the benefits of the research

26

Kickoff Survey (2 of 3)

Part III – Benefits Assessment

Project Benefits (Select all that apply and explain)	Qualitative Benefits	Quantifiable Benefits (costs, 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			
<input type="checkbox"/> Materials Savings			
<input type="checkbox"/> Time Savings			
<input type="checkbox"/> Lives Saved/Injuries Prevented			
<input type="checkbox"/> Other (Explain)			

27

Kickoff Survey (3 of 3)

Part IV – Estimated PM Time Expenditures

PM Hours Spent Previous to Kick-off of the Research Project: _____

Conducting relevant background research: _____

Discussing/preparing/writing research proposal (in-house): _____

Discussing research proposal with Research Center staff: _____

Preparing an RFP (if applicable): _____

Reviewing RFP Proposals (if applicable): _____

Discussing the project scope with the potential investigator(s): _____

28

Midpoint Survey (1 of 3)

- At the mid-point of the project, additional information is collected through a survey of PMs
- The goal of this survey is to assess progress and any changes that might affect expected benefits of the research and/or potential for implementation
- This process point is intended to be a performance management function to indicate policy and procedure adherence
- This survey is a data collection process

29

Midpoint Survey (2 of 3)

Part II – Implementation

Implementation Owner(s)

1
2
3

Have there been any contractual amendments that will affect the implementation items or time schedule of implementation?

Please Explain: _____

Have there been any changes and/or additions to the stakeholder/interest groups?

Yes: _____

No: _____

If yes, please explain: _____

30

Midpoint Survey (3 of 3)

Briefly describe the process on when and how this research will be implemented

—

How will the benefits of this research project be measured?

—

Provide an answer on the measure of success for this research project?

—

How can the Research Center assist in implementing this research? (Continued research/tracking, technology transfer, other assistance, etc.)

31

Closout Meeting

- The closout meeting should showcase the benefits of the research
- All intended stakeholders shall be invited to the closout presentation to discuss deployment/implementation and identify the implementation owner moving forward

32

Closout Meeting Presentation (1 of 2)

Presentation must include:

1. Title Slide/Page
 - a. PM Name, PI Name, School, Contract Title, Contract Number
2. Presentation Outline
3. Project Benefits
 - a. Qualitative
 - b. Quantitative
4. Implementation Items (if any)
 - a. Software, Physical Product/Device, policy, procedure, etc.
 - b. Are there any additional stakeholders needed for implementation that were not previously identified?
5. Introduction
6. Project Subject Background

33

Closout Meeting Presentation (2 of 2)

7. Project Objectives
8. List task outline from the scope of services, and then discuss the completed research activities/findings for that task, repeat for each task
 - a. List task 1 from the scope, discuss research activities conducted to fulfill task 1 (research conducted)
 - b. List task 2 from the scope, discuss research activities conducted to fulfill task 2 (research conducted)
 - c. Etc...
9. Summary of Research Conclusions
10. Recommendations
11. Further research needed (if any)
12. Closing Slide/Page

34

Closout Presentation – Example 1

Project Benefits

- A validated finite element model using the DIANA software which can be used to determine accurately the temperature development of mass concrete at early age.
- A user-friendly interface software DFG for quick thermal analysis of rectangular concrete footings and cylindrical concrete drilled shafts.
- The findings sound the alarm that segmental bridge and drilled shaft can possibly be considered as mass concrete under some typical conditions in Florida. Appropriate thermal analysis of these two types of structure will greatly reduce the risk of problems in construction and service.
- Prediction equations for estimating 28-day compressive strength ~~keep compressive at other curing time for ternary blend mixes~~

35

Closout Presentation – Example 2

Summary: Benefits of Recommended Strategies and Methods

- Better visibility into and beyond the "last-mile" in urban areas
- Improved planning / programming of projects and policies to improve local truck operations (e.g. improved transportation / land use coordination)
- Ability to influence, and maybe shape demand for freight in terms of delivery timings, vehicle types
- Scalable to other FDOT Districts and transportation agencies
- Collaborative relationships with freight system actors, strategic partners and vendors
- Increased efficiency and value capture from data sources in the overall system

CPCS

36

Closeout Survey (1 of 2)

- In addition to the closeout presentation, the PMs and PIs are required to submit responses to a closeout survey
- Once again, this survey is a data collection process
- Survey designed to *confirm, to the extent possible*, expected benefits and indicate implementability

Qualitative Benefits of research result? (Please state the benefits and supporting information)

—

Quantitative Benefits of research result? (Please state the benefits and supporting information)

—

37

Closeout Survey (2 of 2)

Part II – Implementation

1. Choose from the 7 options below and give a detailed explanation of the project relating to the designate option.

- The project can't be implemented (select this option if the project should be implemented, but cannot be due to fiscal, political, logistical or other considerations)
- The project will be implemented later
- The project is currently being implemented
- The project has been implemented. Please select this option if the results/implementation items of the research project are available for use, but to the PMs knowledge they have NOT been used on any projects yet, but may be later
- The project has been implemented. Active (select this option if the results/implementation items of the research project are being used on current transportation projects, whether internal or external)
- The project should not be implemented (select this option if the results/implementation items of the research project should not be implemented because they were unfavorable; e.g. in a test, a new material was tested and deemed to be sub standard)
- Information Only (select this option if the project does not have any implementation items and was for informational purposes only)

38

Some Thoughts on Benefits

- Many benefits of research can't be identified at the outset
 - This is why we track changes in expected benefits over the course of the research project
- Some projects are "informational"
 - It is still important to track the relevant financial costs; the information may be matched with benefits in the future (i.e., in a follow-up project)
- Many benefits can't be easily quantified
- Still, most research projects are well-suited for application of the FAM

39

THE FINANCIAL ACHIEVABILITY MODEL

40

The FAM Model

- Eligibility Criteria
- Data Collection
- Calculations

41

The FAM Model: Eligibility criteria

- Most research projects are well-suited for application of the FAM
- Projects most suitable for the FAM involve the potential for changes in:
 - Materials
 - Processes
 - Equipment
 - Any combination of the areas above
- These projects are well-suited because existing materials, processes, or equipment (or lack of) can serve as a baseline for evaluation

42

The FAM Model: Eligibility criteria

- Projects that may be difficult to assess include:
 - “Purely informational” research
 - Jointly funded or pooled fund projects
 - Projects with only qualitative benefits
 - Projects with multiple dimensions
 - Projects with multiple research phases

43

Examples

- Projects that are potentially suitable for the FAM:
 - Use of Fiber Reinforced Concrete for Pavement Slab Replacement (Materials)
 - Damage to ITS, Traffic Control and Roadway Lighting Equipment from Transient Surge and Lightning Strikes (Equipment)
 - Investigating the Value of Time and Value of Reliability for Managed Lanes (Process)

44

The FAM Model: Data Collection

- The responsibility for data collection is shared by PMs and PIs
- Data can be categorized into four key areas:
 - Research project budget (funded amount)
 - FDOT direct and indirect costs of support (value of time invested)
 - Data to illustrate baseline costs
 - Data needed to show potential cost savings

45

The FAM Model: Data Collection

- Accounting for the value of PM time requires estimates of time spent on all phases of the project
 - Preparing proposal
 - Evaluating RFPs
 - Scope development
 - Reviewing deliverables
 - Close-out survey
 - Communications with PIs

46

The FAM Model: Data Considerations

- Some of the challenges with data collection include:
 - Relevance and reliability of existing data
 - Putting a financial value on a qualitative outcome
- Further challenges for implementing the model include:
 - Selecting appropriate time frame and periods for analysis
 - Selecting appropriate units of measurement for analysis
 - Scaling amounts based on expected implementation
 - Accounting for future expected benefits

47

The FAM Model: Calculating Net Benefit

Benefits of Research – Costs of Research = Net Benefits of Research

*Old Costs – New Costs = Cost Savings = Benefits of Change
(e.g., old vs. new material)*

Benefits of Research = f(Benefits of Change, Expected Implementation)

Costs of Research = f(Project Funding, value of other FDOT Support)

48

The FAM Model: Calculating ROI

$$\frac{\text{Benefits of Research}}{\text{Costs of Research}} = \text{Rate of return on research investment}$$

49

The FAM Model: Breakeven Period

- A breakeven period (t) for the research activity can be determined by calculating the benefits of research on a yearly basis, under assumptions of implementability

50

Cost Effectiveness as an Alternative Approach

- When the desired outcome can be achieved in multiple ways, cost effectiveness analysis compares the costs of the alternative approaches
- May be useful if the outcome is difficult to quantify
- Hard to implement in practice, but may be a useful intermediate approach

51

EXAMPLES

52

Three Examples

- The following three examples illustrate various ways in which the FAM Model can be applied
 - Focus/area:
 - Materials
 - Equipment
 - Process
 - Units of analysis
 - Time frames for analysis

53

Example 1: Durability of Fiber Reinforced Concrete Pipe Exposed to Florida Aggressive Environments

- Assumptions for this example
 - New material replaces an old material
 - Use of material (relevant volume) is aggregated across all applications
 - Yearly number of applications can be estimated

54

Example 1, continued

- Data related to scope

If the new material(s) may be used in an existing application, enter the actual number of times per period the existing material is applied.	20
If the new material(s) may be used in an existing application, enter the expected number of times per period that it could be applied.	15
Or, if the new material(s) may be phased in to an existing application over time, enter the expected number of times per period that it is likely to be applied.	Y1: 10
	Y2: 15
	Y3: 15

55

Example 1, continued

- Materials-related costs

Enter the actual cost of using the existing material in one (average) application.	\$50,000
Enter the expected cost of using the new material in one (average) application.	\$40,000
Enter the actual cost of training employees to use existing material in one period, if applicable.	\$2000
Enter the estimated cost of training employees to use existing material in one period, if applicable.	\$3000

56

Example 1, continued

- FAM Assessment

- Cost of research project \$200,000
- Current cost of material (per year) = $20 * 50,000 = 1,000,000$
- Expected cost of material (per year) = $(15 * 40,000) + (5 * 50,000) = 850,000/\text{year}$
- Materials savings = $1,000,000 - 850,000 = 150,000/\text{year}$
- Increase in expected training cost, \$1000/year

$\text{Net benefit (Y1)} = 150,000 - 200,000 - 1000 = -\$51,000$
 $\text{Net benefit (Y2, Y3)} = 150,000 - 1000 = \$149,000$
 $\text{FV(Net benefit Y2)} = \$149,000 / (1 + .04) = \$143,269$
 $\text{FV(Net benefit Y3)} = \$149,000 / (1 + .04)^2 = \$137,759$
 $\text{Sum of three-year net benefits} = \$230,028$

57

Example 1, continued

- Breakeven period analysis

$\text{Investment} = \$200,000$
 $\text{Benefit (Y1, ... Yt)} = 150,000 - 1000 = \$149,000$

- Solve: $= \text{NPER}(0.04, 149000, 200000) = 1.33 \text{ years}$

58

Example 1, continued

- FAM Assessment if new material is phased in:

- Expected cost of material (Y1) = $(10 * 40,000) + (10 * 50,000) = 900,000/\text{year}$
- Expected cost of material (Y2, Y3) = $(15 * 40,000) + (5 * 50,000) = 850,000/\text{year}$
- Materials savings (Y1) = \$100,000/year
- Materials savings (Y2, Y3) = \$150,000/year
- Increase in expected training cost, \$1000/year

$\text{Net benefit (Y1)} = 100,000 - 200,000 - 1000 = -\$99,000$
 $\text{Net benefit (Y2, Y3)} = 150,000 - 1000 = \$149,000$
 $\text{FV(Net benefit Y2)} = \$149,000 / (1 + .04) = \$143,269$
 $\text{FV(Net benefit Y3)} = \$149,000 / (1 + .04)^2 = \$137,759$
 $\text{Sum of three-year net benefits} = \$182,028$

59

Example 1, continued

- Other considerations

- Relevant transportation-related events (e.g., accidents, repairs) that are expected to be impacted by use of the new material, if applicable.
 - Actual costs vs. expected costs
- Estimated values may change during the research project period
 - Number of estimated applications
 - Cost of new material
 - Training cost

60

Example 2: Damage to ITS, Traffic Control and Roadway Lightning Equipment from Transient Surge and Lightning Strikes

- Assumptions for this example:
 - New equipment, not replacing old equipment
 - Multiple sites where new equipment can be installed
 - Yearly loss experience can be estimated

61

Example 2, continued

- Data related to scope

If the new equipment may be used in an existing process, enter the actual number of times the process is currently executed per period.	
If the equipment may be used in an existing process, enter the expected number of times the process will be executed per period after installation.	
If new equipment is to be installed, enter the expected number of installations.	100

62

Example 2, continued

- Current costs (per location, per period)

Enter the current cost of location damages when loss is incurred, per location.	\$5,000
Enter likelihood of location damage, per period	20%

Expected loss/location = \$1,000

63

Example 2, continued

- New equipment-related costs

Enter the cost of acquiring and installing new equipment for one installation.	\$500
Enter the cost of maintaining new equipment for one period, if applicable	\$200
Enter the estimated cost of training employees to use existing equipment in one period, if applicable.	\$0
Enter the current cost of any relevant transportation-related events (e.g., accidents, repairs) that are expected to be impacted (reduced) by installation of the equipment, if applicable.	\$3000

64

Example 2, continued

- FAM Assessment
 - Cost of research project: 200,000 (set \$196,793)
 - Current cost of location damages (estimated) = .20 * \$5000 = \$1,000/location = \$100,000 for all locations
 - Fixed cost of acquiring/installing equipment = 100 * \$500 = \$50,000
 - Expected maintenance cost (per year) = (100 * \$200) = \$20,000/year

Net benefit (Y1) = (\$100,000+\$3,000) - (\$200,000+\$50,000) = - \$200,000
 Net benefit (Y2...Yt) = (\$100,000+\$3,000) - \$20,000 = \$83,000/year

Breakeven period = 2.58 years (at 4%)

65

Example 2, continued

- Other considerations
 - Useful life of new equipment
- Estimated values may change during the research project period
 - Cost to acquire and install
 - Maintenance cost
 - Effectiveness of equipment in preventing damage
 - Locations experiencing greatest need for equipment?

66

Example 3: Development of Sinkhole Risk Evaluation Program

- Assumptions for this example:
 - New process replacing old process
 - Multiple areas/sites where process is used
 - Yearly activity and loss experience can be estimated

This example illustrates the wide variety of costs and benefits that might be considered...

67

Example 3: Development of Sinkhole Risk Evaluation Program

- Example data elements:
 - average number of emergency sinkhole repairs on FDOT roadways per year
 - probability of correctly identifying a sinkhole problem area
 - costs of testing roadway materials to identify possible sinkhole problems
 - number of accidents associated with temporarily rerouting traffic
 - probability of having to reroute traffic following the appearance of a sinkhole
 - increase in roadway construction costs incurred to reroute roadways to avoid sinkhole prone areas
 - savings likelihood if contractor had greater certainty regarding sinkhole development
 - expected costs reduction anticipated through use of a sinkhole management system that allows for "just-in-time" repair.
 - estimated costs (money, loss of life, physical damage) related to increased accidents when roadways are rerouted

68

Example 3, continued

- Other considerations
 - Increase/decrease in employee cost (e.g., salary) resulting from either less time on the process or change in experience that may be required
- Qualitative benefits are hard to measure
 - Easier, more efficient process?

69

Qualitative Benefits

- Travel experience is improved
 - Commercial trucking
 - Private passengers
- Injuries prevented or lives saved



70

Example Resources

- HANSEN, Ings. "Determination and Evaluation of Traffic Congestion Costs." *European Journal of Transport and Infrastructure Research*, [SI], v. 1, n. 1, p. 61-72, oct. 2018. ISSN 1567-7141. Available at: <https://journals.open.tudelft.nl/index.php/etir/article/view/2627>. Date accessed: 04 dec. 2018.
- J.M. ROMEDER, J.R. MCWHINNIE. Potential Years of Life Lost Between Ages 1 and 70: An Indicator of Premature Mortality for Health Planning. *International Journal of Epidemiology*, Volume 6, Issue 2, 1 June 1977, Pages 145-151. <https://doi.org/10.1093/ije/6.2.145>

71

VISION

72

Vision for Tracking Financial Achievability at FDOT

- Objectives of FAM Research:
 - Development of a process
 - Building a culture that embraces tracking research benefits
 - Developing tools that support PMs and PIs
 - Worksheets
 - Data repositories
 - Facilitating transition from research stage to implementation.

73

QUESTIONS?

74

Appendix L. Technology Transfer Content

(1) Project BDV31 977-82

What's Really Down There?

Researchers Develop New Methods for Sinkhole Detection

According to the [U.S. Geological Survey](#), sinkhole damages over the last 15 years cost at least \$300 million per year in America, and Florida is a [leading state](#) for sinkhole susceptibility.

Sinkholes and other underground anomalies are not only a major hazard to Florida's commercial and residential property owners; they are also a serious concern for those who manage the state's roads, bridges, and other infrastructure.

Detecting and remediating sinkholes and other weaknesses *before* construction of a bridge or building has obvious benefits. However, traditional methods for finding and modeling these anomalies have clear limitations.

Recently, researchers at the University of Florida and Clarkson University, in partnership with the Florida Department of Transportation (FDOT) Research Center, developed a new, more nuanced non-destructive technique for sinkhole detection. Phases I and II of the project proved the viability and practicality of the method, as well as its limitations. Phase III is underway, with the goal of developing a 3D method for assessing sites for sinkholes and other karst features in a more comprehensive, timely, and accurate manner than ever before.

Phase I: A More Holistic View

The most common traditional methods for sinkhole detection at a construction site are invasive ground-penetrating tests, such as standard penetration tests (SPT) and cone penetration tests (CPT). However, because these methods have a very limited range, they uncover only small amounts of soil and rock (< 0.1 percent), soil/rock layering, and anomalies like sinkholes. Also, soil properties can change significantly over relatively short distances. Conventional testing can miss these changes, including sinkholes, even if the anomaly is just a few meters away.

"Invasive techniques work pretty well if your site is relatively consistent," said Dr. David Horhota, FDOT State Geotechnical Materials Engineer and Project Manager for the research project. "But in Florida they rarely are. And even then, you can't do enough boring to get a complete picture. You always have to infer the information between the borings."

Ideally, evaluation of a site would begin with a wider ranging geophysical non-destructive test (NDT) to give technicians and engineers a more detailed, holistic view of the site and an

accurate map of potential problem areas. Then, traditional invasive tests could be conducted at just those areas to obtain more detailed information.

Several NDT approaches are already in use to identify sinkholes. They range from gravity, electrical resistivity (ER), and ground penetrating radar (GPR), to electromagnetic wave methods and traditional seismic wave methods. However, these all have limitations in identifying and quantifying variability.

The goal of this research was to develop a timely, more comprehensive, higher resolution NDT to detect small sinkholes and other karst features to provide a complete underground map of a location.

This would not only be valuable for assessing the existence and limits of sinkholes. It would also allow engineers to plan borings and soundings more efficiently. This type of detailed information is needed to develop successful, cost-effective remediation programs to protect existing infrastructure long-term and address issues before new construction.

[A Bigger Picture with Full Waveform Inversion](#)

Before developing a new field test or software, the researchers knew they had to define the most accurate and useful NDT method for discovering underground anomalies. In Phase I of the project the team explored the use of Full Seismic Wave Fields and developed a technique called Full Waveform Inversion (FWI).

They chose seismic testing because it has the potential to provide a more comprehensive view of anomalies. But seismic testing also has the advantage over other geophysical methods (ground penetrating radar, electrical resistivity, etc.) because the results can be directly related to geotechnical parameters typically used by engineers, making the output most usable to practitioners.

“You get the advantages of both,” Horhota said. “You have a geophysical test that can map out a large area and the result gives you an engineering property that is directly applicable to our work.”

Traditional seismic reflection/refraction tests have significant drawbacks, however. For instance, they do not use the entire measured seismic wave field, which gives an incomplete picture and makes it difficult to accurately locate sinkholes and other soft spots.

By contrast, the FWI technique developed in Phase I uses the entire measured seismic wave field, and because later points in the wave field provide information on low-velocity zones—soft underground material—it gives a more complete picture of potential trouble spots.

“We have so much variability underground in Florida and many existing test methods can give you false readings or don’t provide the whole picture,” said Dr. Michael McVay, University of Florida researcher and Principal Investigator for the project. “The higher resolution picture provided by FWI is significant.”

Phase I testing showed that FWI was successful in identifying the location and extent of both known and unknown sinkholes at several sites in two dimensions. Analysis of simulated data sets showed that FWI accurately characterized embedded air- or water-filled voids. Results from real data sets proved that FWI did a good job of characterizing various site conditions including an embedded concrete culvert, low-velocity anomalies, open chimneys, and naturally occurring embedded voids.

“The contrast is very clear,” Horhota said. “Soft spots—including sinkholes, air- and water-filled voids, or very loose soil—appear in blue. The surrounding rock shows up in sharp red.”

To ground-truth their findings, the team did either soundings or borings over the locations where the FWI test showed anomalies.

“We showed exactly that there was next to zero-strength material in those areas,” Horhota said. “It worked.”

The more complete FWI picture presented a challenge, however. Namely, FWI was computationally expensive as it required solving elastic wave equations thousands of times. The algorithm developed to process the FWI code took two hours to analyze data from one 120-foot test line on a standard computer. It takes technicians about 30 minutes to test an average line in the field. To be efficient, the FWI data-processing time would have to be reduced to 30 minutes. This became a primary goal of Phase II research.

Phase II: Real-Time Data, Real-Time Decisions

Building on the results of Phase I, the objectives for Phase II were to develop a standalone software for 2D FWI analysis that could process data in 30 minutes or less, and to conduct a sensitivity analysis of measurements along the test array to discover any other limitations to the 2D method.

For FWI to be a practical tool, the faster software program needed a simple Graphical User Interface (GUI) for field use on a laptop computer so technicians could use that information to decide the locations of the next test lines. This ensured that as much information of layering, voids/anomalies, etc., was recovered in the field on one site visit, reducing unnecessary field testing and data processing efforts.

The software also had to automatically run on raw field data so technicians could use it without significant training.

To achieve the 30-minute threshold, the development team implemented advanced boundary conditions and solution convergence methods (e.g. gradient techniques) developed by Dr. Khiem Tran at Clarkson University, as well as variable grid dimensioning, temporal windowing, and parallel computing.

These methods overcame the limitations. At the end of Phase II, the software processed the needed data within 30 minutes. The software development team, led by Dr. Scott Wasman at

the University of Florida, had also created a user-friendly GUI to easily import data and display results.

While the time threshold was achieved, the sensitivity analysis showed that the 2D FWI method required seismic data to be acquired directly over the top of the void. The team called this the “3D Effect.” Generally, voids that were near, but not directly under, the test line were distorted or may not have been identified. This was especially true if the test line was more than one diameter-width of the void away. For instance, if a void was two feet in diameter and the array line was at least two feet away, there was likely to be distortion.

This led to considerable effort for data collection and analysis, as multiple test lines were usually needed to locate unknown voids. It also spurred Phase III of the project.

“Since we discovered limitations in detection when we tested along one line of arrays, we asked ourselves, ‘Can we run the arrays in a grid pattern and map out the whole area at one time?’” Horhota said.

Phase III: Completing the Picture

Phase III is underway; the goal is to collect data in a grid pattern without setting out multiple arrays of receivers and then repeat the process along parallel lines. This should capture all the data in one pass and allow effective testing over a large volume of ground. It will also provide a third dimension to the site map, improving on the current 2D method.

That granular data can then be used to plan out an invasive boring program, improving the chances of detecting sinkholes and identifying their extent.

If successful, improvements proposed for this phase should increase the efficiency (and thereby decrease the testing time in the field) of the FWI method.

The benefit could be more efficient boring programs that result in cost savings (reduced numbers of borings) for sites with consistent geotechnical features. However, it might result in higher costs for highly variable sites which require additional borings. Nevertheless, even for sites that accrue additional costs for site investigation during design, identifying inconsistencies earlier should greatly minimize the chances of cost and time over-runs during construction due to potential unforeseen changes in site conditions.

Another concern with the added resolution is computing time. Adding a third dimension to the analysis adds that much more information to be processed, while the 30-minute threshold still has to be maintained.

“There is more information to process, but we expect computing power to keep increasing,” McVay said. “We’re also considering just analyzing certain frequencies to maintain efficiency. There are several options we are testing in this phase of the research.”

“Think of it as a sliding scale,” Horhota said. “You can adjust resolution up or down depending on your information and time needs. If you have a little lower resolution but a more complete picture in the same 30 minutes, it is still valuable.”

Even if the computing time increases due to the 3D analysis, the data is collected for a relatively large area, which minimizes returns to the site for retesting. In addition, the existing software can be used to analyze the results from individual lines of receivers in the field in real-time (less than 30 minutes) to optimize the placement of the receivers.

“Site analysis can potentially happen in three phases,” Horhota said. “First, the 3D technique gives you a large picture so you can hone in on trouble spots, then do quicker, targeted 2D analysis based on the 3D map. Lastly, you go back and ground-truth it with a typical boring program. That way you’re not shooting in the dark.”

Plans for the Future

If successful, the software developed under this project will be transferred to the FDOT State Materials Office for immediate use with its seismic equipment. McVay and Horhota, however, also see potential for broader use of these techniques.

“The equations driving this software are open source, published and accessible to anyone,” Horhota said. “We expect people to apply them in other platforms. There are many, many possible applications.”

For instance, Tran has already used the technology to locate abandoned mines beneath Ohio highways and plans to extend the method to detection of incipient slope failures.

“We want something that is useful out there in practice,” McVay said. “That’s what this research has always been about.”

Research Projects:

BDV31-977-82

BDV31 977-29

BDK75 977-66

(2) Project BDV31 977-74

Real-World Transportation Testbed Opens in Gainesville

Central Florida is now home to a one-of-a-kind testing ground for deploying connected and automated vehicle (CAV) technologies.

I-STREET (Implementing Solutions from Transportation Research and Evaluation of Emerging Technologies) is a smart, multimodal roadway network weaving through parts of the University

of Florida (UF) campus, the City of Gainesville (CoG), and Interstate 75 that is dedicated to advancing the state of the art in connected and automated vehicle (CAV) implementation. The project is a joint effort between the Florida Department of Transportation (FDOT), the UF Transportation Institute (UFTI), CoG, and industry partners.

The vision for I-STREET is to provide an intelligent road system where government, industry, and academia can develop and test technologies that enhance communication between personal and mass transit vehicles, pedestrians, and traffic signalization – a true “Internet of Transportation Things.”

Over 30 countries are exploring CAV technologies, with many efforts underway in the U.S. I-STREET, however, is different. It is the only comprehensive testbed that is completely on public roads.

“Everything we do is real world,” said Dr. Lily Elefteriadou, UFTI Director and Principal Investigator for I-STREET. “Our team did a thorough literature review before proceeding with I-STREET, looking for what had not been done. We studied over 400 U.S. and international activities and testbeds. This is unique.”

The I-STREET system comprises four [subsections](#), all part of existing roadway networks in and around Gainesville. Each is dedicated to studying a different transportation mode.

“The interstate section can be used for researching freight movement, the downtown segment is for pedestrian and bicycle mobility, another for cars, and a fourth for transit,” said Emmanuel Posadas, Traffic Operations Manager for CoG. “I-STREET captures them all at different scales.”

The goal is to facilitate the development of as many new products and control strategies as possible that can be deployed not just in Florida, but nationally.

“We’re looking at much more comprehensive instrumentation and operations,” Elefteriadou said. “We’re not just exploring one aspect of testing. We have a wide variety of technologies deployed so we can evaluate each individually, as well as their interactions.”

Current I-STREET projects include several [foundational efforts](#): The I-75 Florida’s Regional Advanced Mobility Elements (I-FRAME), which involves installing roadside monitoring units along stretches of I-75 and US 301/US 441 that will be used for CAV communication; a pedestrian/bicycle safety enhancement project on the UF campus; and the Gainesville Signal Phase and Timing (SPaT) Trapezium, dedicated to studying how connected infrastructure can improve travel time reliability, safety, throughput, and traveler information.

These initial projects focus on installing the core monitoring and communication infrastructure needed to set the stage for future academic and industry research projects.

“We are laying the groundwork for testing so others don’t have to,” Elefteriadou said. “Then they can just come here and implement their research.”

Safety First

But what about safety? The value of a traditional closed-course testing environment is that risk can be kept to a minimum. What about on a real-world testbed?

Dr. Clark Letter is a UFTI researcher and the I-STREET testbed manager. He is responsible for its entire operation and works closely with FDOT, CoG, the Gainesville Regional Transit System, and the UF Police Department to maintain and implement the testbed's safety management plan.

"The plan requires collaboration with all partners to approve projects and includes clear guidance to account for various safety-related scenarios," Letter said. "A level of risk is applied to each scenario that itemizes specific actions to take to reduce risk. We also require applications and technologies testing on the system to include a fail-safe mode to ensure safety."

A steering committee with representatives from each of the involved entities meets quarterly to evaluate ongoing and upcoming test activities. Each entity interested in conducting a test must submit documentation to the steering committee for review and approval. Results of the tests also have to be submitted to the committee along with any safety concerns and incidents. Testing that is deemed unsafe is rejected or, if in process, immediately stopped.

All on Board

I-STREET would not be possible without significant cooperation among stakeholders. The testbed includes state arterials, CoG roads on and off the UF campus, and sections of federal I-75. All traffic signals are maintained by CoG and FDOT has provided most of the funding for projects so far. Private industry will also play an increasing role.

How was this level of collaboration achieved?

"In a word, 'leadership,'" said Posadas. "Executives at FDOT, UF, and CoG are all behind this and pushing for it. From the top down, we all want to establish a smart city here in Gainesville and position Florida as a premier center for transportation research."

"FDOT looks forward to leveraging technology to improve the safety and mobility of all the users of our transportation system," said FDOT Assistant Secretary Tom Byron.

Open for Business

A linchpin of I-STREET's success is private industry involvement.

To that end, I-STREET issued a request for information (RFI) seeking interested industry partners. Nearly 25 companies have responded to the RFI so far, expressing serious interest in using the testbed.

“Dozens of other companies have also contacted us informally,” Letter said. “We are currently working out the details of these relationships, but we are excited to see such a response and get this momentum going.”

“We’ve also reached out to over 200 private companies and have gotten outstanding response so far,” Posadas said.

Letter said the long-term success of I-STREET depends on these public-private relationships. “The goal is to have a self-sustaining testbed. Industry partnerships will help us do that. We’re investing in the research infrastructure and equipment. Our message to industry is, ‘Come use it.’”

Related Projects:

BDV31 TWO 977-74: University of Florida Advanced Technologies Campus Testbed

BDV31-977-77: Data Management and Analytics for UF Smart Testbed

BDV31-977-79: University of Florida Testbed Initiative - Transit Components

BDV31-977-45: Development and Testing of Optimized Autonomous and Connected Vehicle Trajectories at Signalized Intersections

BDV31-TWO 977-69: Florida Driver Assistive Truck Platooning Analysis

(3) Project BDV29 977-36

[The Right Way to Look at Wrong-Way Driving](#)

Identifying Influential Variables Affecting Wrong-Way Driving Incidents

According to [Florida Highway Safety and Motor Vehicles](#), there were [1,490 wrong-way driving \(WWD\) crashes](#) in the state in 2015, resulting in almost as many injuries and 96 fatalities. In the years 2013-2015, there were more than 4,300 total injuries due to WWD crashes on Florida roads.

While WWD crashes are relatively few, they are random and often lead to head-on collisions. As such, the fatality and serious injury rates in WWD incidents are much higher than in other crash types.

The Florida Department of Transportation (FDOT), in partnership with Florida International University (FIU) is conducting research which is aimed at mitigating this crash type. In the process, FDOT has developed a comprehensive WWD mitigation initiative.

[Beyond WWD Hotspots](#)

There are several effective countermeasures for mitigating WWD crashes but deploying them in the most relevant locations can be a challenge. Traditional approaches rely on screening a roadway network to identify “hotspots,” or locations with multiple crashes of a particular type. Practitioners identify the hotspots and then implement appropriate countermeasures at those locations.

Hotspot analysis is insufficient to address WWD crashes for two reasons. First, WWD incidents are fewer in number than other crash types and spread over many disparate locations. There are rarely enough crashes at any one location to create a hotspot cluster. Second, WWD crashes are unique in that they can happen miles from where the offending driver’s original mistake was made.

“Knowing where the crash happened is not enough,” said Dr. Priyanka Alluri, Assistant Professor at FIU and Principle Investigator for the project. “To mitigate wrong-way crashes, we have to identify the point where the driver actually entered the roadway the wrong way. That is sometimes several miles from where the crash happens.”

In addition, the hotspot approach is reactive, based on responding to past crashes. A more effective approach would be proactive, identifying the locations at highest risk for WWD and focusing investments there, *before* crashes happen.

This leaves practitioners with two fundamental questions regarding WWD mitigation: Which countermeasures should be used and, more importantly, where should they be installed?

A Broader Perspective

Instead of focusing on hotspots of past crashes, the researchers for this project explored whether they could identify certain pre-conditions that make areas more susceptible to future WWD crashes.

“Wrong-way crashes are relatively random and don’t lend themselves to traditional analysis methods,” said Dr. Raj Ponnaluri, FDOT Connected Vehicles and Arterial Management Engineer, and Project Manager for the research effort. “So, we asked ourselves, ‘Is there a role for non-engineering elements?’”

The team hypothesized that if they could discover the overall demographic and land-use conditions that correlated with certain WWD crashes, then they could identify specific regions that were at risk. Agencies would then have the information they needed to proactively target countermeasure investments to high-risk areas. This method represented a significant departure from traditional hotspot analysis.

“There is an inherent sense to a risk-based approach,” Alluri said. “But it is still a paradigm shift.”

While the elements contributing to WWD incidents vary widely, studies have indicated that certain socioeconomic and demographic factors may heighten the risk of wrong-way driving.

So, the research team conducted a statewide macroscopic analysis of socioeconomic, demographic, and neighborhood land-use characteristics to provide a more holistic and accurate picture of those factors.

“This spatial analysis moved us beyond a corridor-level detail,” Ponnaluri said.

The team chose three broad demographic categories to study –drivers aged 65 years and older, tourists, and impaired drivers under the influence of drugs or alcohol.

They then assessed the land-use characteristics that relate to those demographics. For instance, locations with relatively high density of senior population and health facilities could be more prone to WWD incidents involving drivers aged 65 years and older. For impaired drivers, it was assumed that areas with establishments that sell alcohol would be more likely to have WWD crashes nearby. As such, information on restaurants, night clubs, bars, and cocktail lounges was included in the analysis.

One by one, the team used “heat maps” to overlay statewide WWD crash data onto the chosen demographic and land-use factors. The results were telling.

“There was a very strong correlation between establishments that dispense alcohol and wrong-way crashes involving impaired drivers,” Alluri said. “There was some correlation between the presence of senior population and health facilities and wrong-way crashes involving drivers aged 65 years and older; and no significant correlation between tourist attractions and wrong-way crashes involving tourists.”

The research findings can provide agencies a firmer ground on which to base their choices. “This will let the FDOT Districts make data-based decisions about where to focus their energies and investments,” Ponnaluri said.

[Customized Solutions, Widespread Benefits](#)

Knowing the best locations to implement countermeasures is the first crucial step. But one countermeasure does not fit all. Just as demographic and land-use characteristics correlate to different types of WWD drivers, certain countermeasures are more effective with each type. Knowing the type of WWD drivers in an area will allow agencies to tailor their countermeasures to those situations.

“For instance, we know that impaired drivers tend not to use their peripheral vision. They look only in front of them,” Alluri said. “So we might recommend WWD countermeasures that are in direct view and in drivers’ cone of vision at locations that are prone to impaired drivers.”

This data-based approach also provides valuable information for non-transportation entities.

“Knowing at-risk locations helps law enforcement focus their efforts and deploy their resources in the areas where they can be most effective,” Ponnaluri said.

[Planning for Success](#)

The long-term goal of this research is to develop a strategic countermeasure implementation plan that prioritizes WWD areas in each FDOT District and specifies countermeasures to deploy at the high-risk locations.

The plan should streamline efforts to mitigate WWD incidents statewide and provide a sound approach to WWD analysis going forward.

“This project is implementation based,” Alluri said. “We want to assist the FDOT Districts to mitigate WWD incidents by answering those two specific questions: Where to install WWD countermeasures and which countermeasure(s) to install?”

(4) Project BDV25 977-11

Tricks to Avoid the Tracks

It is a nightmare scenario; a driver makes a *right* turn but ends up in the *wrong* place – on railroad tracks. Cars can easily become stuck on the tracks leading to serious injuries and sometimes death. Sadly, this scenario plays out many times a year in Florida.

That is why the Florida Department of Transportation (FDOT) teamed up with the Center for Urban Transportation Research (CUTR) at the University of South Florida to set the stage for a pilot study that will test countermeasures for reducing the risk of incorrect turns at highway-rail grade crossings in Florida.

CUTR coordinated with the FDOT Central Office and Districts 1, 4, and 7 to develop a deployment and evaluation plan for the pilot implementation project. The plan identified study sites of railroad crossings with potential incorrect turn issues, proposed countermeasures, estimated costs, a data collection plan, and data analysis methodology.

To ensure the effectiveness of the pilot study and to implement the plan, the research team sought to answer four questions:

1. What are the factors contributing to these incidents?
2. Which countermeasures will be cost-effective for mitigating them?
3. Which locations should be included in the pilot study?
4. How will countermeasure effectiveness be evaluated?

Identifying Contributing Factors

There are many reasons why drivers turn onto railroad tracks.

“Some people get confused because the railroad crossings we’re talking about are very close to an intersection or interstate on-ramp,” said Dr. Pei-Sung Lin, Intelligent Transportation System, Traffic Operations and Safety Program Director at CUTR, and Principal Investigator for the

project. “They plan to make a right turn and when they see an opening in the road, they don’t realize it’s a railroad track. They turn too soon because they don’t want to miss a turn.”

To develop a focused list of factors for analysis, the team used an earlier study by the National Center for Transit Research (NCTR) that identified five primary contributors to incorrect turns at highway-rail crossings: misleading signs and pavement markings; darkness and low visibility; inaccurate GPS turn instructions; skewed highway-rail grade crossings (not at a 90 degree angle); and driver distraction.

Choosing the Best Countermeasures

Based on these factors, the CUTR team then conducted a thorough literature review to identify low-cost and effective solutions for addressing the contributing factors. The analysis revealed four.

1. Elimination of potentially misleading pavement markings and signs

While this may seem counterintuitive, directional pavement markings, if incorrectly placed, can be detrimental. For instance, according to the NCTR study, “right lane must turn right,” “left lane must turn left,” and “right-turn only” are the most recognized regulatory signs and pavement markings that may confuse drivers near railroad tracks.

“When a driver sees a right-turn arrow on the pavement just before the railroad crossing and then an opening in the road, it can be confusing,” said Catherine Bradley, FDOT Rail Capacity Production Specialist and Project Manager for the effort.

Removing these misleading markings and replacing them with clearer ones can lead drivers across railroad tracks more safely.

2. Pavement markings with guidance information

The second safety countermeasure involves the use of pavement words, symbols, and arrow markings for the purpose of guiding, warning, or regulating traffic. Pavement markings with guidance information can deter and prevent future incidents at highway-rail grade crossings near interchange ramps or at-grade signalized intersections with exclusive turn lanes.

“Instead of telling drivers to turn right, we should use the straight arrow with shields such as I-95 southbound,” said Lin. “That way people can see they’re approaching railroad tracks but are going to I-95. When they see that, they know they are in the correct lane and the straight arrow prevents them from turning too soon. After the railroad crossing, we can add the right turn arrows.”

3. Extension of edge lines at highway-rail grade crossings

Another issue associated with incorrect turns and train-vehicle crashes is that the roadway edge line may end near the stop line for the grade crossing and does not continue across the track area. Extending the edge lines across the tracks helps drivers see that the turn lane is beyond the rail crossing.

“When we see the solid line, we know the road continues and we shouldn’t cross that line,” said Lin.

Raised pavement markers or tubular delineators can also be considered to supplement edge lines.

4. Qwick Kurb

At some rail crossings there is a potential risk of drivers intentionally making a U-turn using the railroad tracks. “In this case, people are turning on purpose and using the railroad track as a place to turn around,” said Lin. “Qwick Kurb is a traffic channelization device that can deter motorists from turning around before or at railroad crossings.”

Choosing Appropriate Test Locations

After identifying countermeasures to be tested, CUTR developed an inventory of incidents between 2010 and 2014 caused by incorrect turns onto railroad tracks in Florida. The research team coordinated with FDOT using three major data sources: FDOT Crash Analysis Reporting System, Federal Railroad Administration accident/incident database, and news reports. The team also coordinated with FDOT to contact railroad companies to obtain records of events of vehicles stuck on rail tracks that were not available in the FRA and FDOT databases.

“In some locations it occurs more frequently,” said Lin. “It happens about once a month and sometimes twice a month. You don’t hear about it in the newspaper because it’s incidents, not necessarily crashes.”

This information, combined with input from FDOT Districts 1, 4 and 7, helped the CUTR team identify 10 pilot study sites to test the focus countermeasures.

The pilot locations include railroad crossings in Lakeland, Bradenton, Hollywood, Lake Clarke Shores, Pembroke Park, Oakland Park, Tampa, and Oldsmar, Florida.

Measuring Effectiveness

The pilot will include a “before-after” study to evaluate countermeasure performance. Two-stage data will be collected at each candidate site: “before,” with existing pavement markings, and “after,” after implementing the proposed countermeasures. A [Wavetronix SmartSensor](#) with video cameras will be installed to collect speed profiles and counts of turning vehicles as drivers approach the at-grade crossing for a total of two days at each site. For each day, data collection will be conducted in the daytime (10:00 AM–2:00 PM) and nighttime (7:00 PM–11:00 PM).

The vehicle speed data and camera video review will help researchers identify hesitation among drivers before the countermeasures are put into place and then afterwards. For the purposes of the study, a driver who experiences potential hesitation is defined as one who has a much lower speed and a significant headway from the previous vehicle.

“It depends if there is a lot of congestion as well,” Lin said. “We will study speed profiles and use the video to see what else may have been happening. If a car is going slow because the car in front of them is going slow, they are not hesitant.”

The researchers hope to reduce the number of hesitant drivers, and ultimately the number who turn onto railroad tracks, with the implementation of the countermeasures.

Setting the Stage for State-Wide Implementation

Based on the findings of the pilot, the team will be in a position to recommend which low-cost countermeasures were effective and have potential for wider implementation across the state. The deployment plan and performance evaluation criteria developed during this study could also become a template for others to use in their area.

“Understanding the effectiveness of these countermeasures and how drivers react to them will help us plan for mitigating these incidents state-wide,” Bradley said. “And that is our long-term goal.”

(5) Project BDV24 977-20

Can Roadside Ditches Catch *and* Clean Water?

Excessive nutrients, particularly nitrate and phosphorous, are a [growing concern](#) in groundwater aquifers and springs across Florida. This causes serious environmental issues like [eutrophication](#) and degradation of groundwater quality.

The Florida Department of Transportation (FDOT) and researchers at the University of Central Florida (UCF) are experimenting with creative ways to remove excess nutrients from water using an unlikely tool – the common roadside ditch.

Ditches, also known as swales when water infiltrates into the ground, run alongside most of Florida’s roadways. Their main purpose is to catch and divert rainwater from the road, keeping drivers safe. However, they also collect water from surrounding properties. As such, swales are an intermediate step in runoff water’s journey from ground level to underground aquifers and springs.

There are naturally occurring microbes in the ground that actually consume nitrates and other harmful nutrients, removing them from water before it filters into groundwater. For instance, they help with waste removal in home septic systems.

But can these microbes be used to remove nutrients from runoff water in swales? The answer is yes, under certain conditions. The goal of UCF’s research was to create those conditions.

“We know the effectiveness of microbes to clean water,” said Dr. Ni-bin Chang, Director of UCF’s Stormwater Management Academy and a Principle Investigator for the project. “But in Florida, our sandy soil is not naturally conducive to harboring enough of them to do the job.”

[A Home for Microbes](#)

For the right microbes to grow in the right amounts, they need enough porous surface area and consistent moisture to form colonies on soil particles, called a biofilm. For soil without those qualities, this can be achieved by amending it with specially-mixed materials called Biosorption Activated Media, or BAM.

An effective BAM has several traits:

- Good [adsorption](#) and absorption properties
- A long life expectancy
- High surface area
- Ease of water filtration
- Low maintenance (reasonably non-degradable or easily rejuvenated)

BAMs have been used to remove nutrients in runoff areas like wet detention ponds and basins to much success but had not been tested in linear roadside swales. So, the team tested two BAMs in a swale near Fanning Springs, Florida – wood chips and a product created by UCF called Bold & Gold™ (B&G).

The wood chip mixture contained both small chips and wood shavings, about 1/16-to-1 inch. B&G is a custom BAM, made of clay, tire crumb, and sand. Variations have been used in a number of unconventional applications, like [green roofs](#) and [water supply filters](#). The tests in this study compared the effectiveness of B&G versus wood chips to provide enough moisture retention and surface area for a biofilm to grow and microbes to remove pollutants in the swale.

The location around Fanning Springs was chosen because the watershed has a variety of land uses, including residential, a dairy farm, a wastewater treatment plant, and agricultural fields.

The test was conducted in a 600 ft. linear ditch. Half of the ditch (300 ft.) was filled with the woodchip mixture, the other with B&G. To study the impacts of media depth on nitrogen removal, the woodchips were installed in three 100-ft. long sections at depths of 2, 3, and 4 ft. respectively. The B&G section was divided into two 150-ft segments and the material was placed at 1 and 2 ft. respectively.

[Lysimeters](#) were placed at several depths along the entire ditch to measure water quality as it progressed through each BAM. A groundwater well with a solar-powered pump was also installed to distribute water across both sections of the ditch so researchers could study the effectiveness of the BAMs for treating groundwater as well as storm runoff.

“We wanted to know if a swale could do double duty,” said Dr. Martin Wanielista, UCF Professor Emeritus and Co-Principle Investigator. “That way the ditches could clean water almost constantly, during and between storm events.”

And the Winner is...

Over the six-month study period, B&G was significantly more effective at removing total nitrogen from both groundwater and storm runoff. This was due to a number of factors, but the key was the structural composition of the B&G versus wood chips.

B&G is a uniform material, with relatively fine grains compared to wood chips. Therefore, the B&G could be calibrated to provide the crucial surface area that microbes need to form a biofilm but hold water long enough to maintain the moisture levels that the microbes also need. The B&G performed well during large storm runoff periods as well as dry periods when only filtering groundwater.

The wood chips, while they were able to maintain a biofilm under certain circumstances, were not able to do so consistently in the unpredictable conditions of the field study. In some cases, nutrient levels even rose after passing through the chips.

“The wood chips, because of their variable size and larger air spaces between pieces, simply let water pass through too quickly to be cleaned well,” said Catherine Earp, FDOT Drainage Design Engineer and Project Manager of the study. “They could not handle the wide variations of water flow in natural conditions.”

An Untapped Resource

The possibilities for BAM-lined roadside swales to remove nutrients from water are significant. Land scarcity within the right-of-way of many roadways makes using linear ditches economically attractive, as agencies do not need to purchase new land. Ditches also require much less footprint relative to large basins to achieve removal efficiency, and the BAM can be incorporated in the swales with minimal construction impact on traffic or adjacent properties.

“Stormwater is a relatively untapped resource when it comes to meeting today’s freshwater demand,” Wanielista said. “If properly managed, it could provide another valuable source for integrated water management in Florida.”

“BAM-lined linear ditches have great potential,” Earp said. “FDOT already owns the swales, the material can be installed cost-effectively and with little impact, and the swales can remediate groundwater during non-storm periods and also treat runoff during storms. We are excited by the possibilities.”

Completed project:
BDV24-977-14

Related projects:
BDV24-977-20

(6) Project BDV25 977-30

FDOT Pedestrian Project Makes AASHTO's 'Sweet 16' Most Valuable Research

The American Association of State Highway and Transportation Officials ([AASHTO](#)) recently announced its annual "[Sweet Sixteen](#)" most high-value transportation research projects in the country, and FDOT was in the mix.

The winning projects were chosen by the AASHTO Research Advisory Committee and comprise four high-value research projects from each of the [four AASHTO regions](#).

The FDOT project, called [Application of Demographic Analysis to Pedestrian Safety](#), developed a methodology that identifies relationships between pedestrian and severe-injury crashes and demographic, social, and road environmental factors; neighborhood land use attributes; and individual characteristics in low-income areas. The study was conducted through a partnership between FDOT and researchers at the University of South Florida's Center for Urban Transportation Research (CUTR).

It all started on a drive home.

Mark Plass, FDOT District 4 Traffic Operations Engineer and originator of the study, drove a segment of Florida State Road 838 several times a month. He noticed that, despite the traditional pedestrian safety measures that were installed, there was still a high number of pedestrian and bicyclist crashes.

"A portion of that road goes through a low-income area with relatively low car ownership," Plass said. "I began to wonder if these crashes were partially a function of the demographics of the area."

About the same time, Plass read an [article in *Governing* magazine](#) reporting that, between 2008 and 2012, pedestrians were killed at disproportionately higher rates in the nation's poorer neighborhoods. That is when Plass proposed a formal demographic analysis of low-income neighborhoods in Florida's major metro areas.

The CUTR research team used Geographic Information System (GIS) mapping technology to look for correlations between demographic, road environment, and land use factors, as well as individual characteristics in low-income areas, with pedestrian crashes and their severities.

"GIS is a very intuitive tool for showing relationships between demographic factors, road environment, land use characteristics, and pedestrian crashes," said Dr. Pei-Sung Lin, Intelligent Transportation System, Traffic Operations and Safety Program Director at CUTR, and Principal Investigator for the project. "We generated maps that layered these characteristics and found pretty much the same thing everywhere we looked."

Some of the common factors that correlate with pedestrian crashes in low-income areas include:

- Higher-density, minority-dominated population
- Zero-car ownership neighborhoods
- More intersections, bus stops, and higher speed limits
- Presence of big-box stores, fast food restaurants, convenience and grocery stores
- Areas near bars and alcohol retail locations
- Non-crosswalk locations, impaired pedestrians, and aggressive drivers
- Poor lighting conditions

Knowing those pre-conditions helped the team research and recommend an integrated strategy to help reduce pedestrian crashes and their severities in low-income areas.

“For instance, we know that the vast majority of pedestrian fatalities occur at night. Many also happen along corridors, not at intersections,” Lin said. “So we recommended lighting improvements and treatments at non-intersection locations besides signalized intersections, among others.”

Other countermeasures recommended in the report were bus stop reallocation, installation of medians and crossing islands, and speed reduction treatments, including slow speed zones, road diets, and roundabouts.

Education, outreach, and enforcement were also part of the strategy. The team recommended social media campaigns, grassroots education, distribution of education tip cards, and law enforcement training.

According to the research, this multi-faceted approach has the best chance for success. Plass and Lin said it also provides an opportunity to help an underserved population.

“Pedestrians are killed at disproportionately higher rates in poorer neighborhoods,” Plass said. “And that population sometimes doesn’t have much political clout. We have a methodology now, a way of thinking, to help them.”

“We must pay extra attention to these factors,” Lin said. “If we don’t, it will be very difficult to reduce pedestrian fatalities statewide.”

(7) Project BE77

Going the Last Mile

According to the American Transportation Research Institute, roadway congestion cost the trucking industry almost [\\$64 billion](#) in 2015.

There are many factors that contribute to trucking slowdowns, but the first step to reducing congestion is to know where problem spots are so transportation agencies can mitigate them.

A persistent gap for these agencies involves truck movements at the local level, the so-called “last mile.” Last mile is a term for the final leg of a roadway network connecting a trunk or main backbone to the end user. For example, from an Interstate to a local distribution center.

Understanding last mile freight movement in detail—“last mile observability”—is essential to making informed planning and investment decisions. However, transportation agencies are often blind to freight flows in the last mile, historically due to data limitations. The data existed but was too costly to acquire or was proprietary to private trucking companies.

Another difficulty is that freight moves in different ways and times than typical traffic.

“Traffic flows and peak times are different for freight than they are for cars. For instance, freight runs on a 24-hour clock,” said Jeremy Upchurch, FDOT District Freight Coordinator. “If we could see exactly where trucks are traveling, as well as time of day, on specific routes or segments, we could better refine our network.”

Newer applications of GPS and other data are now available and have the potential to provide a clearer understanding of last mile truck movements without relying on commercially sensitive private sector data.

To set the stage for better last mile observability on Florida roads, the Florida Department of Transportation (FDOT) worked with consulting firm CPCS on a research effort to develop strategies, methodologies, and other solutions that incorporate these new resources.

“FDOT is one of the best organizations to test some of these forward-looking solutions,” said Vivek Sakhrani, Global Director of Infrastructure Analytics at CPCS. “The way they’ve been thinking about the problem across the state from a research point of view puts them in a good position.”

The research included analysis of existing FDOT data and tools, a review of literature and national best practices, and consultations with freight data stakeholders, industry vendors, and other transportation agencies around the country.

The analysis revealed two high-level opportunity areas for FDOT to pursue, called freight fluidity and real-time corridors. Neither approach involves building new roads.

“Our basic finding was that FDOT and other DOTs with similar make-up cannot build their way out of this problem,” Sakhrani said. “A lot of the fixes they can make are on the operations side.”

Fluid Freight

For freight to move most efficiently and cost-effectively, truckers must be able to predict travel times across their routes. Any variation from the prediction, a slowdown or bottleneck, causes “friction” in the trip and adds travel logistics costs like fuel and wages. Also, firms and service providers may penalize carriers for delays or service disruptions.

“If you are a trucker hauling cargo types like fresh-cut flowers from the Miami International Airport into other parts of Florida, you really need to be able to solve the reliability problem,” said Donald Ludlow, Vice President, United States at CPCS.

Freight fluidity is a broad concept and set of approaches that addresses these frictions. Properly done, freight fluidity performance measures can identify where bottlenecks and other issues are and allow agencies to address them.

The research team recommended three applications to help FDOT achieve better last mile freight fluidity:

- Last Mile Flow Maps
- Bottlenecks Analysis
- Travel Time Reliability

“FDOT already collects and maintains a variety of data needed to develop these applications,” Ludlow said. “Including traffic counts, road network and asset data, and freight facility databases, among others.”

Last Mile Flow Maps

As the name indicates, last mile flow maps use GPS waypoint and other data to visualize truck flows through last mile road networks. The maps can be designed to assess a variety of performance measures including truck volume and density as a share of overall traffic, by time of day, and others.

“You can see at a glance which routes truckers prefer and where they might back up,” Upchurch said. “That is invaluable as a basis for freight planning and gives us a starter list of sites for further analysis.”

Bottlenecks Analysis

Bottlenecks are severe traffic chokepoints where demand for roadway use exceeds road capacity. The economic consequences of bottleneck congestion are lost time and productivity as well as increased emissions, fuel use, and noise.

The CPCS team recommended an eight-step process for identifying last mile bottlenecks that utilizes multiple forms of available data. FDOT can use the process to generate bottleneck maps that clearly show problem locations.

Travel Time Reliability Analysis

Travel time reliability (TTR) analysis is an advanced freight fluidity technique that builds on last mile flow maps and bottlenecks analysis. It is about quantifying the value of on-time truck deliveries to identify the most expensive problem segments on last mile routes.

TTR, combined with last mile flow maps and bottlenecks analysis, can provide FDOT a much better basis for making last mile management decisions.

Managing Corridors in Real Time

The second approach recommended by CPCS is real-time corridor management. It involves using multiple innovative technologies and data sources for agencies to sense and respond to freight behavior in real time.

“New traffic data collection and signal network connectivity have made it possible to not only automatically monitor signal performance, but also better connect traffic conditions and signal operations,” Ludlow said.

Real-time corridor management is done largely through more frequent and informed signal retiming and rephasing, as well as [freight signal prioritization](#) and dynamic two-way messaging.

“Seeing what is happening in the last mile in real time from a freight perspective is invaluable,” Upchurch said. “Then operators can use the technology at hand to be very responsive and reduce frictions much faster. Traffic moves better and companies save money.”

“FDOT’s efforts in Intelligent Transportation Systems and Arterial Management Programs have positioned it well for the eventual architecture of real-time corridors,” Sakhrani said.

An Integrated Approach

As freight systems and vehicles become more sophisticated and complex, it will be necessary for DOTs to marshal multiple data sources, technologies, and methods to assure the increasing amount of freight on the roads can move efficiently. In its [final report](#), the CPCS team said that FDOT is positioned relatively well for the future, but must continue to pursue new ideas.

“FDOT collects detailed traffic data and updates road network data frequently,” Sakhrani said.

“The gap in understanding truck flows over the last mile can be resolved by supplementing their existing efforts with new mobile source data on truck movements. There is no one data source or technique that solves this problem.”

Upchurch said that, while there is significant work to be done, the recommendations in the report are all achievable.

“Real-time corridor management is feasible for us,” he said. “Everything identified in the research is doable.”

Sakhrani sees the effort not as something completely new, but as an evolution of the current system.

“It’s the idea of effective capacity,” he said. “Simply getting more out of existing infrastructure.”

BE277 Analysis of Freight Transport Strategies and Methodologies

[Final Report](#) | [Summary](#)

8. Project BDV31 977-56

Parking with Precision: Evaluating Commercial Truck Parking Detection Technologies

Over the road truckers have a lot to worry about.

Their prime concern has always been to deliver goods on time, of course, but today’s drivers face many new challenges, including [increased demand for freight transportation](#) coupled with a growing [commercial driver shortage](#) and unpredictable drive times from main trunk lines to distribution centers, among others.

The Florida Department of Transportation (FDOT), in partnership with the University of Florida Transportation Institute (UFTI), recently conducted a research project aimed at reducing commercial driver stress over another difficulty they face, something most of us take for granted – finding a safe place to park.

Federal rules [regulate the number of hours](#) that truck drivers can be on the road in a given stretch of time and establish mandatory periods of rest between shifts. More recent legislation and [electronic logging devices](#) make it possible to track driver time-on-road closely. This is for driver health and safety, but also means that truckers must be strategic about where they pull over to take their break.

“If a driver is nearing the end of his shift, pulls in to a rest stop, and finds it full, he has to get back on the road to find another, which can put him over his time limit,” said Marie Tucker, FDOT Commercial Vehicle Operations Manager and Project Manager for the research study. “Driving over time limits incurs penalties, so not knowing where available parking spots are is a significant source of anxiety for truckers.”

It would be ideal for commercial drivers to know which rest stops had open parking spots before leaving the highway so they could drive by full ones without slowing down. Fortunately, there are new sensor technologies on the market that can monitor parking spots and, in theory, let drivers know if and how many open spots there are in a nearby rest stop, before driving in. This research study evaluated three of them for accuracy.

“The idea of these sensors has great promise,” said Dr. Scott Washburn, Professor of Civil and Coastal Engineering at UFTI, and Principal Investigator for the study. “But there are many factors that can influence the detectors, so we needed a field test.”

Sensitive Spaces

The research began with a review of possible vendors to identify technologies that would fit this application.

“After our review, we narrowed the list down to five possible vendors,” Washburn said. “We contacted all five, and three told us that the development of their equipment was advanced enough for testing.”

To field test the sensors, the research team chose two rest stops on Interstate 75 in Columbia County with commercial truck parking spaces, one northbound and one southbound.

Each of the three sensor companies was allotted ten parking spaces for installation and testing of their technologies, two on the northbound side and one on the southbound. Two of the technologies had similar operating frequencies, so they were located on opposite sides of the Interstate.

As the sensors were installed, the research team evaluated them for ease and timeliness of installation.

“It would not be helpful to us if installing the sensors was overly costly or complicated, even if they worked well,” Tucker said.

All three sensor types met the criteria for efficient installation.

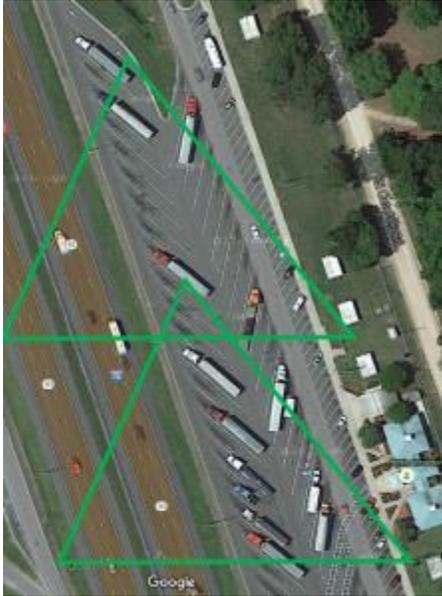
“All vendors installed the sensors and other relevant equipment in their ten spots within two to three days,” Washburn said. “And they were all installed without costly or specialized tools.”

After installation and before testing began, each vendor spent 1-2 weeks tuning and calibrating their systems.

Truth on the Ground

To ground-truth the data from the sensors, the research team installed video cameras on light poles at each location to monitor the test parking spots visually. The video would be used to verify the accuracy of each technology, matching the data from the sensors to time stamps on the video.

“Each of the vendors said their technology can detect open and taken spots with a high degree of accuracy and in diverse weather conditions,” Washburn said. “The video provided us with indisputable evidence to make sure.”



Range of video cameras at test site

After all of the sensors and video equipment were installed and calibrated, data collection commenced. Each location was monitored for several weeks.

Analysis

Analysis of the data started by reducing the many hours of video taken at the test sites to usable information. The ingress and egress of each vehicle were painstakingly recorded manually from the video footage and then entered into CSV-formatted files for further analysis. The following information was logged for each entering/exiting truck over the test period:

1. Parking space number
2. Time entered the space
3. Time exited the space
4. Vehicle type (i.e., truck with/without trailer and trailer type, single unit truck, RV, personal car, etc.)

The research team also developed an analysis software tool to process and analyze the data. The CSV-formatted files were then loaded into the software to compare with the data from the in-ground sensors.

Parking with Precision

With the data in a manageable form, the team developed two accuracy tests to evaluate the parking detection technologies: turnover accuracy and occupancy accuracy. The turnover accuracy test evaluated the sensors' ability to identify parking events (ingress and egress) correctly. The occupancy accuracy test evaluated the percentage of time that the sensors reported the status of the parking spaces (vacant or occupied) correctly.

Overall, all three sensor technologies performed quite well in both accuracy tests. Turnover accuracy ranged from 95.25 percent to 97.94 percent and occupancy accuracy ranged from 97.20 percent to 99.15 percent.

“We were very pleased with the results,” Washburn said. “Basically, it appears that any of the technologies we tested would be cost-effective and accurate.”

Integration with SunGuide®

For any parking detection technology to be truly useful, the information it gathers about open spaces must be delivered to truckers in a way they can use it. Therefore, one criteria for any sensor is that the data it gathers should integrate with the Florida SunGuide® software that is used by all regional transportation management centers across the state.

“If the information from the sensors can be gathered by SunGuide®, then it can be pushed out through the Florida 511 system and dynamic messaging signs,” Tucker said. “It can even be included in commercial navigation applications.”

This would give truckers the status of parking spaces easily in real time, letting them pull over with more confidence and removing one of the pressures they face on the road.

All the vendors involved in the testing say their sensors can integrate with SunGuide®. However, this has not yet been independently verified as it was not in the scope of this project.

The Future of Commercial Parking

Now that these technologies have proven effective, Tucker and her team are moving to broaden their use.

“Based on the results of this research, FDOT created a developmental specification for the in-ground detection technology that was tested,” Tucker said. “The approved vendors are now on our innovative products list for all to use.”

9. Project BDV25 977-41

The Ins and Outs of Access Management

You’ve probably seen it on your roads.

A new building is constructed on a main thoroughfare to house a restaurant or other business. That business needs a driveway in and out of the thoroughfare. As drivers start entering and exiting the new driveway, there are traffic delays and a few crashes. The driveway also crosses a sidewalk, creating pedestrian and bicyclist safety concerns. To mitigate these risks, a traffic light is installed at the location. However, that slows traffic even more, which means complaints about how long it takes to get across town.

Welcome to access management.

As communities across Florida continue to grow, state and local transportation agencies are striving to design roadways that promote safe and efficient use by *all* travelers. At the same time, those agencies must provide vehicular access to land parcels that promote economic growth and livable communities.

As a first step toward updating its access management program, the Florida Department of Transportation (FDOT) worked with researchers at the University of South Florida Center for Urban Transportation Research (CUTR) to conduct a national benchmarking study that identified state highway access management best practices and lessons learned from across the country that may benefit Florida’s access management program.

“Access management as a practice has changed its focus since we established the FDOT program in 1988,” said Gary Sokolow, FDOT Senior Transportation Planner (Retired) and Project Manager for the study. “In the 80’s, it was all about moving automobiles with more speed and efficiency. We now have a much broader perspective that gives more consideration to pedestrians and bicyclists, and also more livable landscapes for streets.”

Complete Streets and Context Zones

This effort is part of an ongoing national conversation about the future of the American transportation system and whom it should serve. This conversation gave rise to a new philosophy of transportation called Complete Streets, where roadways and other transportation facilities are designed with all road users in mind, not just drivers.

Complete Streets also incorporates the idea of Context Sensitive Solutions – the planning, designing, and operating of roadways based on a whole-community context that considers the needs of pedestrians, bicyclists, the elderly, transit, and disabled travelers, as well as those driving cars.

“The FDOT Design Manual has been updated to reflect Complete Streets and Context Zones,” Sokolow said. “It was time for us to include these ideas in access management.”

Surveying Other States

The research team used three methods to identify potential improvement areas for FDOT access management practices:

- A review of current FDOT access management policy, as well as the proceedings of FDOT access management meetings with District personnel, and a review of the FDOT One-Stop Permitting website.
- An online survey of 11 other state transportation agencies that have recently updated their access management policies. A follow up goal would be to engage in peer-to-peer exchanges with some of those states.
- A targeted review of relevant literature and government documents related to each state in the study.

Each of the states was examined based on five key topics:

- **Access Classification, Context, and Complete Streets:** How state access management programs are adapting to Complete Streets policies, including context sensitive roadway classification systems and access management considerations for non-auto modes.
- **Corridor Planning and Local Network Development:** How state transportation agencies are advancing whole-network planning that includes integrating access management practices on local as well as state roads, especially where the two meet.
- **Intergovernmental Coordination:** Effective coordination between state and local governments on access management issues.

- **Access Permitting Enhancements:** Automation applications, such as computerized permit processing.
- **Staff Education and Training:** Systematic approaches to staff education on access management topics.

Improving Policy and Practice

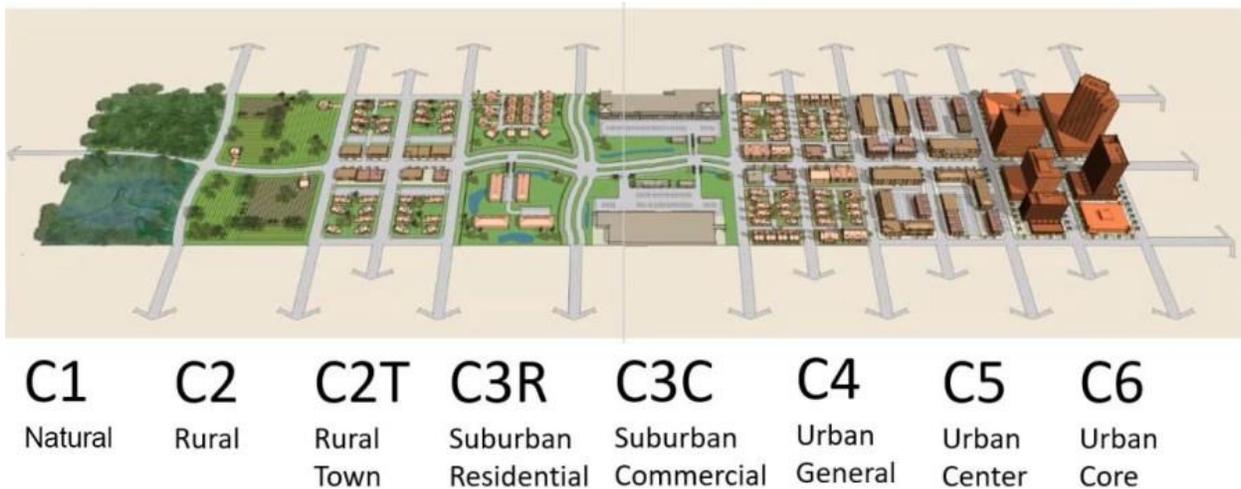
After the study, the CUTR team developed a technical memorandum [LINK] with suggested access management policy and practice improvements based on the topics of study and the practices of the other states. The memo details multiple technical suggestions for each topic; below are summaries of the findings.

Access Classification

Access management starts by categorizing a stretch of roadway based on context – rural, suburban, urban center, urban core, etc. FDOT currently uses seven access categories based on the importance of a roadway to regional mobility.

However, the current FDOT access management classification system does not completely align with the Department’s Complete Streets Implementation Plan. So, the research team suggested ways to redefine those access management categories.

“We asked, ‘How can we broaden the access categories to communicate the context of the road that we are dealing with to better manage access?’” said Kristine Williams, Planning and Corridor Management Program Director at CUTR and Principal Investigator for the project.



FDOT context classification system for state highways.

Corridor Planning and Local Network Development

Under a Complete Streets philosophy, access management does not stop at state roads. For a fully optimized system, the state must coordinate and plan with local agencies as development happens in local communities.

“Much of what happens along a corridor relates to how well the network has been designed that feeds into that major route,” Williams said. “The other states we studied were also struggling with this and had some interesting ideas for dealing with it that we think could benefit FDOT.”

One idea is to consider access management before new development has happened at all.

“There are not a lot of new major highways being built, but there is a lot of re-development happening along existing routes,” Williams said. “Which means we have an opportunity to redesign these routes based on new best practices. So much can be done during the land development process that can’t be done after the land has been subdivided and development proposals are submitted.”

Intergovernmental Coordination

Related to the topic above, the study found that better coordination between state and local governments can enhance system-wide Complete Streets access management practices. FDOT actually developed model access management regulations for local governments that were updated in 2017 to consider non-auto travel. The memo suggested better promotion of these regulations to local agencies.

“We want to promote thinking about connected networks and good network planning at the local level,” Williams said. “FDOT is in a great position to lead this and can include these regulations in training modules for local agencies. We think this will help with adoption and implementation.”

Access Permitting Enhancements

From a logistical standpoint, developers and others that need roadway access also need an efficient way to apply for and receive access permits. FDOT does have a one-stop permitting site that allows individuals to apply for utility permits online, but does not currently have “e-permitting” for access permits.

“Several of the states we studied have developed streamlined electronic access permitting processes, even for smart phones and tablets,” Williams said. “FDOT is well underway with e-permitting, but the memo suggested that it be expanded to include access permitting.”

Staff Education and Training

“FDOT has far and away the best access management training program that we found,” Williams said. “In fact, some of the other states we studied actually attend FDOT webinars.”

To build on that robust training base, the research team suggested developing targeted training for the land development community and local governments.

Access to a Better Future

There are many complex issues involved in access management but, done right, it can be a key strategy for developing thriving, safe, and efficient communities.

“One of the great benefits of access management is it is a very cost-effective way of preserving the system, from both a safety and operational perspective,” Sokolow said. “We want to make the best decisions for all travelers as well as the communities they live in. This study provides a good basis and foundation for some of that decision making.”

FDOT Releases Statewide Guidelines for Implementing Leading Pedestrian Intervals

Who has the right of way at signalized intersections – pedestrians or drivers?

As a general rule, vehicles are legally required to yield to pedestrians when there is a potential conflict in a crosswalk. In practice, however, it is not that simple. There are many instances when drivers may not yield to pedestrians, whether through driver distraction, road design, or simply taking advantage of a small delay in pedestrian traffic to get through the intersection.

The result is increased risk of pedestrian injuries and deaths.

“At signalized intersections with crosswalks, there are times when cars and pedestrians are both allowed to move through the same part of the intersection. For instance, when a car turns right on the red light,” said Alan El-Urfali, State Traffic Services Program Engineer for the Florida Department of Transportation (FDOT). “At those time, vehicles are required to yield to pedestrians, but there are still dangerous conflicts.”

Pedestrians Lead the Way

There are several countermeasures to make pedestrians safer as they cross a signalized intersection. One of the most effective is called the Leading Pedestrian Interval (LPI). LPIs are a signal timing approach that gives pedestrians a few seconds to enter a crosswalk before cars are allowed. Giving pedestrians this head start lets them establish a presence in the crosswalk so they are more visible to drivers.

LPIs are [proven to increase the percentage of motorists who yield to pedestrians](#). Then why not just use LPIs at every intersection?

LPIs can be very useful, but they are not appropriate for every intersection. Their success is dependent on many factors – location characteristics, traffic conditions, pedestrian volume, and signal timing, among other variables. In fact, if LPIs are used improperly, they can actually delay traffic unnecessarily with no benefit to pedestrians.

“Some agencies have installed LPIs and have been very successful,” said Dr. Pei-Sung Lin, Intelligent Transportation System, Traffic Operations and Safety Program Director at the University of South Florida Center for Urban Transportation Research (CUTR). “Other agencies have used LPIs and eventually had to remove them. Choosing the right situation is very important.”

“When you extend the time pedestrians can cross, those seconds have to come from somewhere, which can mean traffic delay,” El-Urfali said. “There has to be a balance between what we can provide and considering the safety of everyone involved at the intersection.”

Transportation practitioners need standard guidelines to help them properly use and calibrate LPIs. FDOT, in partnership with CUTR, recently conducted a research study to determine the best scenarios to implement LPIs and to develop statewide guidelines for deployment. “Our goal was to give practitioners a clear warrant system to implement LPIs when conditions are met,” said El-Urfali, who served as project manager for the effort.

Putting LPIs to the Test

The study started with a literature review, as well as a survey and interviews with states and localities that have deployed LPIs. Based on that research, the team developed preliminary LPI implementation guidelines with suggested warrants for LPI implementation in Florida. They then conducted a before-after study to test LPI applications at diverse intersection locations across Florida. The results of these tests were analyzed and used to refine the preliminary guidelines to create the final LPI implementation guidelines for use statewide.

Eleven testing sites from nine intersection locations statewide were chosen for the before-after study. Each location met one or more LPI implementation warrants in the preliminary guidelines. The intersections covered a geographically-diverse range of environments (urban/suburban, high/low speed approaches, north/south/central Florida, inland/coastal, etc.).

At each location, the research team recorded video of at least eight hours on a weekday before LPI implementation and another eight hours after implementation. The video covered peak and non-peak hours.

The study found that, overall, the LPIs were well-used by pedestrians and that the countermeasure did reduce pedestrian conflicts with automobiles. The research team also discovered several insights that helped inform the final statewide guidelines. A summary of the key findings is as follows:

- The LPIs were utilized by 85 percent of pedestrians at seven locations; 70 percent at two other locations; and 60 percent at another location.
- The LPIs reduced vehicle-pedestrian conflicts overall by 83 percent at the testing locations during the length of the LPIs (usually 3-5 seconds).
- Conflicts were reduced by 75 percent during the entire pedestrian walk phase (from curb to curb).
- The LPIs showed mixed results in increasing driver yielding behavior toward pedestrians. A higher percentage of non-yielding vehicles were observed during the first few seconds of the LPI, but a lower percentage of driver non-yielding vehicles during the entire pedestrian walk phase.
- The persistent driver behavior suggests that intersections should be fitted with static or blank-out “NO TURN ON RED” or “TURNING VEHICLES YIELD TO PEDESTRIANS” sign in conjunction with the LPI.

Updated Guidelines

Based on the data analysis, the research team refined the preliminary implementation guidelines and prepared them to publish for statewide use.

The guidelines start with an engineering study of any proposed location. If the study indicates that LPIs are justified, the guidelines then detail eight warrants under which they may be applied:

- Approach Crash Frequency

- Reported Visibility Issue
- Vehicle Non-Yielding Behavior
- Vehicle Peak Hour
- Pedestrian Peak Hour
- Four-Hour Vehicular and Pedestrian Volume
- Eight-Hour Vehicular and Pedestrian Volume
- School Crossing

An important factor of the warrants is that they can allow practitioners to be proactive in implementing LPIs.

“We want to stress that you don’t have to wait for a crash to happen to apply LPIs,” El-Urfali said. “Any one of the warrants gives an engineer the opportunity to implement.”

Guidelines, Not Laws

While the guidelines provide a clear and robust tool, they also allow for engineering judgment and flexibility to account for local conditions.

“The guidelines recommend adjusting the duration of the LPI based on local traffic and pedestrian volumes throughout the day,” Lin said. “That will change from location to location. Engineers can customize LPIs to fit their needs.”

“Time-of-day implementation is important,” El-Urfali said. “If you meet the warrants at the peak hour and off-peak is not warranted, engineers can consider that and adjust.”

Another suggestion in the guidelines is to possibly install blank-out “NO TURN ON RED” signs to complement the LPIs. The signs could be active during peak time when they are warranted, then turned off when pedestrian volume is lower.

“That way drivers don’t get frustrated when they can’t turn on red but don’t see many pedestrians,” Lin said. “And it removes the delay in traffic.”

The new state guidelines provide traffic engineers and managers in Florida a simple but robust tool to assess the suitability and warrants for LPI implementation; determine appropriate LPI durations; and assess the need for supplemental LPI items.

“Florida has a higher rate of pedestrian incidents than almost any other state,” El-Urfali said.

“These guidelines are a way for practitioners at every level across the state to make those pedestrians safer.”

11. Project BDV25-977-30

FDOT Uses GIS to Make Pedestrians Safer

In 2016, Florida had the [highest pedestrian fatality rate in the country](#), according to the National Highway Traffic Safety Administration. The rates are especially high in low-income neighborhoods.

To help reverse this trend, a team of researchers from the Florida Department of Transportation (FDOT) and the University of South Florida Center for Urban Transportation Research (CUTR) used Geographic Information Systems (GIS) mapping technology to identify factors that correlate with pedestrian crashes in low-income areas. Knowing these factors can allow agencies to better mitigate them.

Problem

Mark Plass, FDOT District 4 Traffic Operations Engineer and originator of the study, drove a segment of Florida State Road 838 several times a month. He noticed that, despite the traditional pedestrian safety measures that were installed, there was still a high number of pedestrian and bicyclist crashes.

“A portion of that road goes through a low-income area with relatively low car ownership,” Plass said. “I began to wonder if these crashes were partially a function of the demographics of the area.”

About the same time, Plass read an [article in *Governing* magazine](#) reporting that, between 2008 and 2012, pedestrians were killed at disproportionately higher rates in the nation’s poorer neighborhoods. That is when Plass proposed a formal demographic analysis of low-income neighborhoods in several of Florida’s major metropolitan areas.

Solution

The project started with a comprehensive review to identify broad categories or pre-conditions that are associated with high pedestrian crash rates in low-income areas. Five categories emerged for further study:

- Demographic and social factors
- Road environment factors
- Neighborhood land use attributes
- Individual drivers and pedestrian characteristics
- Other factors, including safety laws or regulation and education

CUTR then partnered with agencies identified by FDOT to discuss their findings and gather feedback on additional variables. The goal was to develop a methodology that rang true to the conditions of the study locations—Broward and Palm Beach counties—but could also be implemented statewide.

Next, the team used GIS to layer and analyze these factors in the two counties, looking for correlations to pedestrian crash clusters in low-income neighborhoods.

“GIS is a very intuitive tool for showing relationships between demographic factors, road environment, land use characteristics, and pedestrian crashes,” said Dr. Pei-Sung Lin, Intelligent Transportation System, Traffic Operations and Safety Program Director at CUTR, and Principal Investigator for the project. “We generated maps that layered these characteristics and found pretty much the same thing everywhere we looked.”

The results were telling.

Pedestrian crashes correlated with several factors, including:

- Higher-density, minority-dominated population
- Zero-car ownership neighborhoods
- More intersections, bus stops, and higher speed limits
- Presence of big-box stores, fast food restaurants, convenience and grocery stores
- Areas near bars and alcohol retail locations
- Non-crosswalk locations, impaired pedestrians, and aggressive drivers
- Poor lighting conditions

By defining these high-risk conditions in low-income neighborhoods, the team was able to recommend specific countermeasures to mitigate them.

“For instance, we know that the vast majority of pedestrian fatalities occur at night. Many also happen along corridors, not at intersections,” Lin said. “So we recommended lighting improvements and treatments at non-intersection locations besides signalized intersections, among others.”

Not every solution required engineering. The team also recommended education, outreach, and enforcement measures for an integrated, comprehensive approach.

Benefits

This methodology used readily-available data from state systems to produce useful, actionable information that can be used by others.

The benefits of this study for other agencies are threefold.

First, the research showed that there are indeed factors that correlate with pedestrian crashes in the low-income neighborhoods from the study. It is likely that this will be true in other cities, so the results of this study may give them a starting place and methodology for their own efforts. In other words, the methodology is scalable.

Second, agencies using this methodology can make more informed decisions about pedestrian safety investments and target funds appropriately. Knowing the factors associated with pedestrian crashes can let agencies proactively and systemically address high-risk locations. For instance, if a location has several high-risk features—a poorly lit non-intersection crossing near a big box store—agencies may implement safety countermeasures there *before* a serious pedestrian crash occurs. They can also deploy countermeasures to other similar locations.

Third, the methodology developed through this study gives agencies a powerful tool to create a safer environment for an underserved population.

“Pedestrians are killed at disproportionately higher rates in poorer neighborhoods,” Plass said. “And that population sometimes doesn’t have much political clout. We have a methodology now, a way of thinking, to help them.”

“We must pay extra attention to these factors,” Lin said. “If we don’t, it will be very difficult to reduce pedestrian fatalities statewide.”

12. Project BDV26 977-05

Strength in Numbers: Using Crowdsourcing to Improve Transit

Crowdsourcing is part of your life, whether you know it or not.

Since the advent of smart phones and Web 2.0, crowdsourcing has blossomed into a mainstay of two-way communication between customers and the organizations with which they engage online. It is used for everything from emergency management to hailing a ride downtown to finding the best dim sum restaurant. Crowdsourcing is the basis for the ubiquitous star rating system that is used by the likes of Facebook, Uber, Google, Amazon, and nearly all other online platforms.

But can crowdsourcing be used to improve our public transit systems?

The answer is yes. The Florida Department of Transportation (FDOT), in partnership with the University of South Florida’s Center for Urban Transportation Research (CUTR), conducted a research project to link several crowdsourcing technologies and create a platform for citizens to help agencies maintain and improve the transit system.

“Most of the technologies we need already exist,” said Dr. Sean Barbeau, Principal Mobile Software Architect for Research and Development at CUTR. “Each provides a valuable piece. However, there are some unique challenges to applying them efficiently to the transit system.”

The research project addressed three of those challenges:

1. **Valuable information must be gathered.** Citizens need a single, reliable platform to send transit agencies enough relevant information to make informed decisions, like location information and images.
2. **Information must be triaged.** Once that information starts to flow, it must be organized so transit agencies can best use it to address problems.
3. **Work tasks must be assigned properly.** Customer service tickets must be assigned to the agency with jurisdiction over the problem.

Problem 1: Gathering Information

There are many transportation crowdsourcing technologies available. Barbeau and his team chose OneBusAway, a free open-source project designed for use by transit agencies. OneBusAway includes mobile apps for real-time transit information and its code can be modified for particular agency needs. It has been used in cities across the country, including Seattle, San Diego, Washington D.C., New York City, and Tampa.

“Transit riders really like apps like OneBusAway,” Barbeau said. “The real-time information they provide reduces anxiety and, as a result, riders have a better perception of transit service generally.”

OneBusAway served as a foundation for this project, providing a portal through which citizens could funnel information from the ground about what is and is not working along the transit system.

Problem 2: Triaging Information

OneBusAway provided the mechanism for gathering feedback from the public, but that can be a double-edged sword. Sorting through the vast amount of information received from the public and determining its relevance or actionability can be overwhelming.

“Agencies nationwide are struggling with this,” Barbeau said. “Providing that open channel of communication is great, but when you have thousands of people using these apps, it is a challenge to manage all of that information in a meaningful way so agencies can take action.”

The research team’s solution was to build an interface that would link OneBusAway with existing customer service management platforms using a standard called Open311.

Open311 provides a channel of communication between the public and transit agencies that can operate much like social media. Users report issues and agencies can respond directly to them. Others can then comment, providing additional feedback.

“This way, the person reporting the problem knows they have been heard,” Barbeau said. “They are not talking to an automated system. They know there is a real person on the other end. At the same time, this communication effort is very streamlined for the agency, allowing them to interact with a large number of users.”

Combining OneBusAway’s transit information gathering capability with Open311-based multi-faceted issue management systems into a single interface provided a focused way to solve the research team’s first two problems.

“We didn’t want to reinvent the wheel,” Barbeau said. “We thought it would be better to just create a streamlined interface where agencies could plug and play with existing issue management tools that support the Open311 standard.”

Problem 3: Assigning Tasks

Transportation systems are complex, both technically and administratively. For any given roadway segment, multiple agencies may be responsible for maintenance of different elements.

“Intermodal travel always covers multiple jurisdictions,” Barbeau said. “Transit agencies are managing the bus stops, local departments of transportation are responsible for the roads, and local municipalities maintain the sidewalks. Getting public feedback to the right people is another difficult part of the whole process.”

Therefore, knowing the exact location of a particular issue reported by a citizen is crucial. Then service tickets contain the right information which can be delivered to the responsible entity to address.

Using the system designed by Barbeau's team, users can upload images and other specifics of where they see an issue, allowing representatives receiving the Open311 tickets to deliver the information to the appropriate agency. The transit agency can also follow up with the user, adding completion and a personal touch to the interaction.

13. Project BDV24-977-21

Dynamic Flashing Yellow Arrow Signals Point to Safer Intersections

A left turn is one of the most dangerous movements a driver can make.

Opposing traffic can be travelling at high speed and drivers making the left turn must cross in time. Because their cars are perpendicular to the oncoming traffic, left-turn crashes can be fatal. In recent years, a technology called flashing yellow arrow (FYA) signals have proven to help drivers make safer left turns.

Flashing yellow arrow signals alert drivers that they can make a left turn but must yield to oncoming traffic. They are an improvement on the traditional method of allowing drivers to make left turns during a solid green signal when there are gaps in the oncoming traffic. FYAs, a "permissive" signal, can be used in conjunction with a "protected only" red/green arrow, switching between the two depending on controller programming and pedestrian activity. A challenge to using this system is knowing the best times of day to use the FYA (permissive) versus the red/green arrows (protected only). If traffic volume is too high when the flashing yellow is on, drivers may try to make a left turn in a gap that is too small. Conversely, if the red arrow is used when there is low traffic volume, drivers have to wait unnecessarily for the next green arrow to make their turn.

"Currently, flashing yellow arrows are programmed by time of day," said Jim Stroz, FDOT District 5 Traffic Operations Engineer and Project Manager for the study. "They may be on for a 12-hour period during the day when general traffic volumes are up, but that does not account for lulls and gaps in traffic throughout that period."

The Florida Department of Transportation (FDOT), in partnership with the University of Central Florida Center for Advanced Transportation Systems Simulation (CATSS), developed a new technology to make FYA signals much more responsive to fluctuating traffic conditions. The research team wanted to know if FYAs could activate in sync with real-time traffic conditions throughout the day. In other words, could they be *dynamic*? The team developed a three-phase study to find the answer.

Phase 1: Determining Gap Acceptance

The first step was to gather and analyze robust data on how drivers behave at current left-turn configurations. Knowing this behavior would help the team configure a more dynamic system. "We wanted to study in a microscopic manner what was happening during the permissive phase," said Dr. Hatem Abou-Senna, Transportation and Air Quality Program Director for

CATSS and Principal Investigator for the project. “Specifically, how drivers would accept the gaps in the opposing traffic at different times of the day.”

Understanding this “gap acceptance” and programming the FYA to turn on and off in rhythm with traffic flow could help drivers and pedestrians make better decisions at busy intersections. The researchers analyzed approximately 1,400 hours of video data from 50 intersections in the Central Florida area.

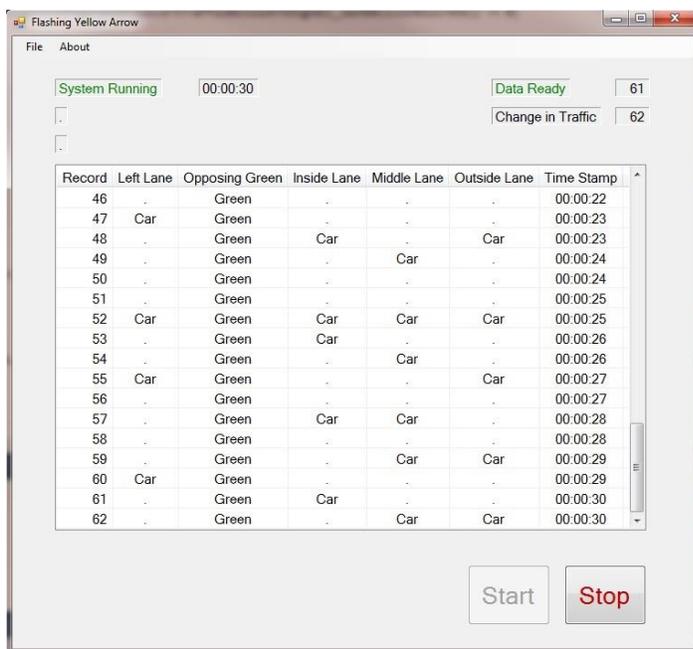
“Through that analysis, we were able to define specific thresholds of gap acceptance and determine when the FYA should be activated,” Abou-Senna said.

Phase 2: From Hour-by-Hour to Second-by-Second

Based on the gap acceptance thresholds defined in phase one, the team created a decision support system (DSS) that analyzed traffic patterns at an intersection several times a second, looking for gap patterns.

Once a gap threshold was met or traffic counts exceeded acceptable levels, the DSS provided recommendations about whether to activate or deactivate the FYA. This unprecedented level of detail could make the FYA truly a responsive, dynamic signal.

“This phase provided a good proof of concept. We knew the DSS had great potential,” Stroz said. “However, we wanted to fully automate this system so the DSS could communicate directly with traffic controllers. That was our main objective in phase three.”



Record	Left Lane	Opposing Green	Inside Lane	Middle Lane	Outside Lane	Time Stamp
46	.	Green	.	.	.	00:00:22
47	Car	Green	.	.	.	00:00:23
48	.	Green	Car	.	Car	00:00:23
49	.	Green	.	Car	.	00:00:24
50	.	Green	.	.	.	00:00:24
51	.	Green	.	.	.	00:00:25
52	Car	Green	Car	Car	Car	00:00:25
53	.	Green	Car	.	.	00:00:26
54	.	Green	.	Car	.	00:00:26
55	Car	Green	.	.	Car	00:00:27
56	.	Green	.	.	.	00:00:27
57	.	Green	Car	Car	.	00:00:28
58	.	Green	.	.	.	00:00:28
59	.	Green	.	Car	Car	00:00:29
60	Car	Green	.	.	.	00:00:29
61	.	Green	Car	.	.	00:00:30
62	.	Green	.	Car	Car	00:00:30

The researchers developed a Decision Support System (DSS) that analyzed traffic patterns several times per second to give real-time results. Source: UCF

Phase 3: Offline Testing with Online Data

With the DSS in hand, the team needed a plug-and-play hardware platform that would automate FYAs but would also be compatible with the various traffic control systems used throughout Florida.

“There are three or four different types of controllers used in District 5 alone,” Abou-Senna said. “We want this technology to be implemented as widely as possible, so we built it to be compatible across multiple controller systems.”



The research team designed the timing technology to work with multiple controller systems. Source: UCF

Once the hardware platform was complete, the whole system was tested in a controlled environment. At the UCF research lab, the researchers created a “peer-to-peer logic” test. The DSS and hardware package were connected to control cabinets in the lab, but the system gathered real-world, real-time vehicle detection data from intersection approaches and mapped it to the controller and cabinet in the lab.

“This gave us a real, but safe, test of our equipment,” Abou-Senna said. “Peer-to-peer logic was a crucial step prior to field testing.”

FYAs in the Field

The final step was to install and test the DSS and hardware at intersections in the field. The system was tested at six intersections in Seminole, Orange, and Volusia Counties. One possible issue was that the system might be *too* responsive.

“We were concerned that the system would switch between permissive and restricted too often and confuse drivers,” Abou-Senna said. “But we found that it changed appropriately.”

“From the FDOT standpoint, driver expectancy is a key concern,” Stroz said. “We want to make sure that drivers know exactly what to do when they approach an intersection. It was a really successful test.”

The field testing confirmed that the DSS algorithm and hardware can allow traffic signal controllers to alter left-turn restriction throughout the day based on real-time conditions. This provides great potential to improve efficiency and safety for drivers during one of their most vulnerable movements.

Next Steps and Wider Implementation

Stroz said that the next step for this project is to expand deployment and testing to more intersections.

“We’d like to do before/after studies and maybe two dozen intersections,” he said. “We would certainly test safety, but we would also like to analyze efficiency of traffic flow, among other things.”

Stroz said that, based on the success of this initial effort, he already has ideas for the future. “Going forward, and especially as we implement wider, we will continue to optimize the system and set standards for other districts and agencies that they can use to implement easier and faster,” Stroz said. “We would love to see this deployed on a statewide basis.”

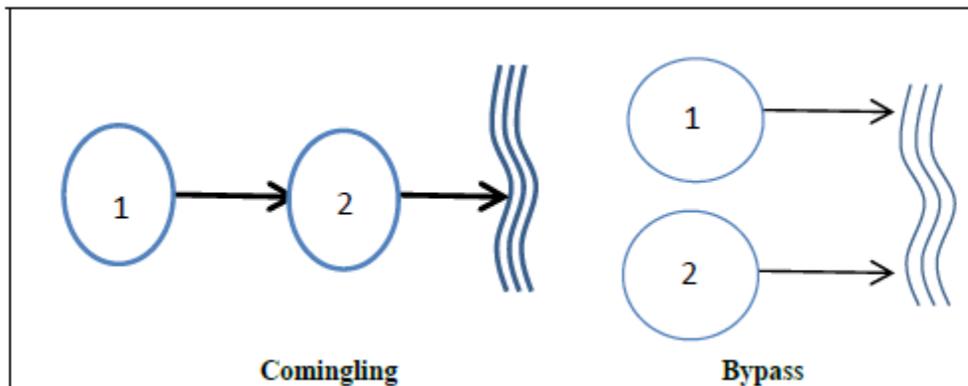
14. Project BDV24-977-16

Better Together: Stormwater Facilities Target More Than Roadway

Stormwater management is more than just keeping streets dry. It also means keeping water clean.

The Florida Department of Transportation (FDOT) is responsible for managing the water that runs off the state highway system. Regulations require an annual target amount of nitrogen and phosphorous to be removed from stormwater runoff. To do this, FDOT constructs best management practice (BMP) facilities in the roadside right-of-way to capture and treat the runoff.

However, water from places other than the road system also makes its way into the BMPs, even if they are designed just for roadway runoff. The two sources of runoff “co-mingle.”



Schematic showing co-mingling and bypass configurations of Best Management Practice (BMP) facilities. This research project tested the effectiveness of BMPs to treat co-mingled runoff water. *Source: UCF*

FDOT has two options for dealing with co-mingled water. First, the agency is allowed to bypass the offsite water away from the BMPs, but that can be costly. The second option is to accept the extra water in existing BMPs that are designed for roadway runoff.

That raises the question: Does the extra volume of offsite runoff overwhelm the BMPs and lessen their ability to remove pollutants?

That is the question that FDOT and the University of Central Florida Stormwater Management Academy set out to answer.

Training BMP Trains

The core challenge for the project was with the model that practitioners use to assess the effectiveness of BMPs. The model, called BMP Trains, had no method to assess the effects of co-mingling. Because BMP Trains is the platform that water management regulating agencies and consultants use in the state of Florida, it was difficult for FDOT to know the best circumstances to co-mingle offsite water or to bypass it.

The purpose of the project was to modify BMP Trains so it could assess the effects and value of co-mingling.

“Bypassing offsite flow is costly and time consuming,” said Dr. Martin Wanielista, UCF Professor Emeritus and Co-Principle Investigator for the project. “In many cases, it may not be necessary to bypass. In fact, co-mingling may remove more pollutants at a very low cost. Quantifying the effects of co-mingling in our BMPs could garner significant cost savings for FDOT and other agencies.”

Hypothesis: A Runoff Race

The research team’s hypothesis was that, since roadways are made of impervious materials, roadway runoff reaches BMPs faster than water from surrounding areas. That runoff would then have a head start and more time to be treated before offsite water co-mingled. Because onsite and offsite water largely enters the BMPs at different times, there would be available capacity in the onsite BMP to treat offsite waters.

“Roadway runoff and offsite runoff are rarely going to be in the BMP at large volumes at the same time,” said Catherine Earp, FDOT Drainage Design Engineer. “Given that, we wanted to know if existing treatment facilities could handle both.”

To test this hypothesis, the team created a series of simulations to expand and test the Excel-based BMP Trains tool. They created 75 simulations for each of the five Florida meteorological zones that are used for stormwater treatment. The simulations re-created stormwater runoff scenarios using three main parameters:

- Ratio of offsite to onsite runoff volume
- Delay of offsite runoff to reach an onsite BMP
- Treatment size of the onsite BMP

To make the simulations as realistic and nuanced as possible, the team also incorporated data that match real-world sites. This included complex land use such as a mixed residential and commercial

area with a highway; directly-connected impervious areas like roof tops, driveways, and roads adjacent to each other; and varying soil conditions. A cost analysis routine was also added.

15. Project BDV24-977-34

The Heat is On – Using Thermal Profiling to Inspect Auger-Cast Piles

A structure is nothing without its foundation.

Underground concrete columns called drilled shafts support many large structures, including bridges. The entire weight of the structure rests on the shafts, so their integrity is crucial. The traditional method for constructing shafts involves drilling a deep cylindrical hole with a short drill tool and then reinforcing the hole with a steel reinforcement cage. Once the reinforcement is in place, concrete is poured into the shaft, forming what is called a pile. This method requires repeated drilling, removing small quantities of soil from the shaft each time. An alternative approach to constructing piles is called auger-cast-in-place (ACIP), or auger-cast piles. ACIP piles are created using a drilling tool that is the entire length of the pile. The longer auger digs the hole for the pile in one continuous sequence. As the auger is slowly removed, grout or concrete is injected directly into the space beneath the auger, creating the pile. The full pile can be constructed in a continuous operation.

“Auger-cast piles are typically a more cost-effective type of deep foundation element to support bridges and structures,” said Dr. David Horhota, the FDOT state geotechnical materials engineer. “In Florida limestone, we’ve seen examples of 24-inch auger-cast piles going down 50 to 60 feet that took approximately 15 minutes to drill and grout. The speed and efficiency of installation in that example was incredible.”



Drill tool for drilling auger-cast piles

Despite the advantages of ACIP piles, they have yet to gain footing in transportation projects nationwide. That is because, while ACIP piles are easier to install than traditional ones, there is no way to visually confirm the final dimensions or search for anomalies on the pile. Their speed of installation precludes traditional “stop and check” control measures, which leaves many transportation agencies hesitant to use auger-cast piles for major bridge foundations.

“Talking to geotechnical engineers that were working with the structures and designers, they didn’t even want to consider auger-cast piles because of the questions and uncertainty from using them,” Horhota said. “This is why auger-cast piles were only used with noise walls or non-structural elements and not considered for bridges, etc.” Recently, researchers at the University of South Florida, in partnership with the Florida Department of Transportation

(FDOT) Research Center, tested a method that has the potential to inspect finished ACIP piles and let practitioners measure them as accurately as traditional drilled shafts. It all has to do with heat.

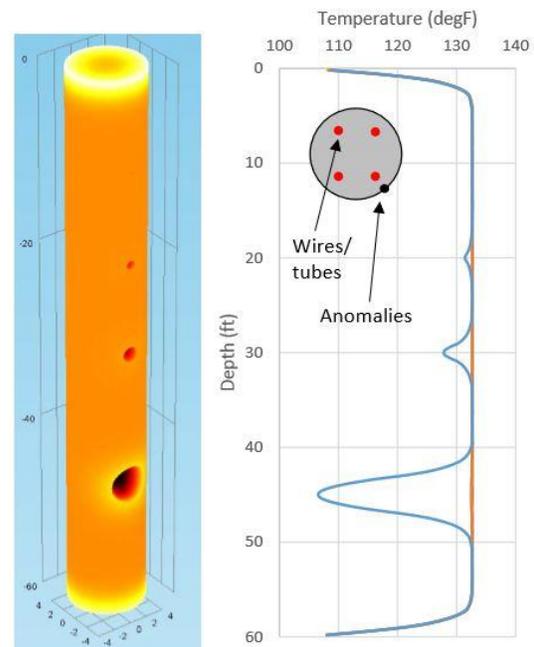
Thermal Integrity Profiling

“Concrete releases a tremendous amount of heat as it cures,” said Dr. Gray Mullins, department of civil and environmental engineering professor at the University of South Florida and principal investigator for this research. “A shaft 6 feet in diameter and 100 feet deep puts off the same amount of energy as that consumed by driving a Hummer cross-country twice.”

Thermal integrity profiling (TIP) evaluates the way this heat dissipates from a shaft to the surrounding material and uses that information to determine the condition of the pile. With a cylindrical shaft, temperature distribution is nearly uniform throughout the length of the shaft, except near the ends where the temperature sharply decreases. Any other temperature variances reveal potential bulges, necks, or inclusions in the shaft.

“When curing concrete is present, the thermal output will be there,” said Mullins. “If it’s missing, that output will also be missing. At depth, using thermal testing, we can learn details that we previously couldn’t detect.”

Thermal integrity profiling has proven to be an effective method to evaluate newly constructed traditional drilled shafts. FDOT already incorporates this method into construction specifications as a primary quality assessment tool. However, very few auger-cast piles have been tested with this method.



When anomalies are present in a pile, temperature profiles from thermal testing show variances that reveal the locations and extent of the anomalies.

Does TIP work with ACIP?

The research team assessed 28 ACIP piles from four locations using some form of thermal integrity evaluation, testing differences and commonalities between techniques.

The team tested several embedded wire systems with sensors:

- Simple single-wire systems installed along a center bar
- Four-wire systems connected to reinforcement cages installed either full-length or partial-length of the pile
- Probes with installed access tubes in the piles



Four-wire systems were fixed to ACIP pile reinforcement cages like this one as part of the team's research.

After collecting the temperature data, the team analyzed it using a wide range of techniques.

The Proof is in the Piling

Four-wire systems were found to be much more robust than single or two-wire systems. That aligned with current State requirements for drilled shafts.

The research team also extracted one pile from the ground to verify visually what the thermal profiling had told them. Another purpose of this was to compare the quantity of grout being pumped versus what was present in the pile. The team found what they expected. The pumped grout profile and the actual pile were very close.



An extracted auger-cast pile allowed researchers to physically inspect and verify the results of thermal testing.

The thermal integrity profiling confirmed the piles' integrity. The test also met the minimum standards required to move forward with implementing thermal profiling as a quality assurance measure for auger-cast piles.

In the future, the team hopes to discover even better ways to record the exact quantity of grout that goes into the piles.

“Right now, thermal tests are good as a qualitative tool (particularly with necking), but if we could get more accurate volume measures, it would provide better results of the actual diameters that we're looking at down the full length of the auger-cast pile,” said Horhota.

Conclusion and Implementation

Results of the research showed that thermal integrity testing could be used to determine as-built condition and integrity of ACIP piles. Larger piles (24 inches in diameter or more) instrumented with four measurement locations provided the best integrity assessment. The research also determined that larger diameter piles provide even better data for evaluation using thermal integrity testing.

Since this research was completed, the FDOT Structures Design Office created a developmental specification for using auger-cast piles in bridge projects. This project contributed key information towards its development.

“Dr. Mullins's work has been incorporated into the developmental specification as a primary quality assessment tool for the auger-cast piles along with a robust monitoring system and load testing,” said Horhota.

Horhota said this project answered the questions FDOT had about whether ACIP piles could be properly evaluated and included in statewide specifications. Pending results of the developmental specification, it appears that auger-cast piles are on the path to be used for bridges and tested with TIP methods.

FDOT has selected several demonstration projects that use those design specifications and integrate ACIP piles as foundation elements for the selected bridges. One such bridge replacement pilot project in West Palm Beach is scheduled to start accepting bids in September 2019.

“With strong research partners like Dr. Mullins’s team at the University of South Florida,” Horhota concluded, “FDOT can continue to press forward with innovative ways to provide safe, effective transportation infrastructure while being as efficient as possible with our taxpayer resources.”

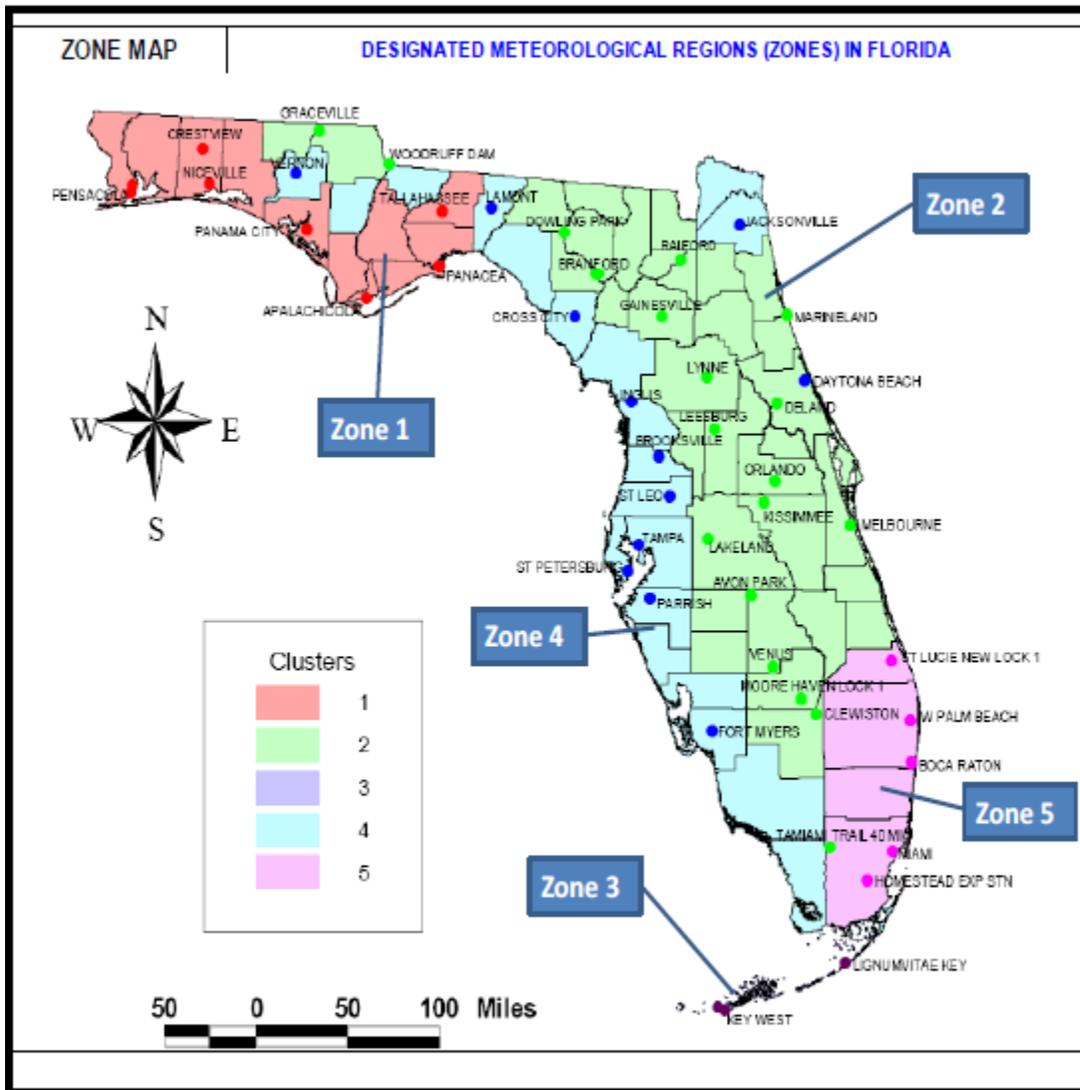


Figure 38 – Meteorological Zone Map Description

Map of the five meteorological regions used for stormwater management. This project tested multiple co-mingling scenarios for each region. *Source: UCF*

Single or Co-mingle?

The simulations calculated the average annual capture volume of pollutants for each scenario. The results were impressive.

“In almost every case, it was more beneficial to route offsite flow through an existing BMP, even if the facility was designed just for roadways,” Earp said. “That is very valuable information when making decisions about how to deal with co-mingling situations.”

“The results were extremely positive,” Wanielista said. “Agencies can save money by co-mingling and remove more pollutants.”

Based on the results of the project, BMP Trains was modified to include calculations for pollutant removal effectiveness of co-mingled water; cost calculations; and an improved routine for estimating runoff from catchments with multiple soil and land uses.

Improving the State of the Art

For the updated model to be fully implemented state-wide, it had to be approved and adopted by regulatory officials and other practitioners.

“Once we verified the results of this research, we took it to the regulators,” Earp said. “They agreed that, in many cases, there was no need to bypass offsite flow and that there would be environmental benefit from co-mingling, without expanding the size of our BMPs.”

Wanielista said the real power of the updated model is that it lets practitioners and regulators make more informed decisions. For example, BMP Trains can also aid in determining when co-mingling should not be done.

“If it is not cost effective to run offsite water through an existing facility, agencies are still allowed to bypass it,” he said. “This project provided a method for assessing the opportunity to co-mingle and quantifying the benefits.”

This new methodology is now the standard practice for evaluating stormwater runoff, not just for FDOT, but also for many local agencies.

“Cities and counties that have the option of treating offsite water in an onsite BMP are using the results of this research,” Wanielista said. “We’re seeing more and more of them utilizing this tool and realizing real cost savings.”