Final Report

Financial Achievability Model (FAM): Operationalization Case Studies and Analysis

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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)				
^oF	Fahrenheit	5(F-32)/9 or (F-32)/1.8	Celsius	^oC
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)				
^oC	Celsius	1.8C+32	Fahrenheit	^oF
Force and Pressure or Stress				
N	newtons	2.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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16. Abstract

In a prior research project (BDK83 977-24), the Financial Achievability Model (FAM) was created for the Florida Department of Transportation Research Center. The Research Center can use the FAM in all phases of research to meet strategic objectives, including demonstrating the potential benefits of proposed projects, allowing for a more cost-effective allocation of research funds. In all phases of research, the FAM produces values that can be used to highlight the benefits of FDOT research activities. Application of the FAM requires significant 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. While a formal approach to collecting this information from PMs has been successfully implemented by the FDOT Research Center, application of the FAM requires additional expertise in conducting economic analysis. This project addresses this need.

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EXECUTIVE SUMMARY

The purpose of this project was to enhance efforts to operationalize the Financial Achievability Model (FAM) in the Florida Department of Transportation Research Center. The activities build on those initiated through several previous projects that first developed the FAM framework (BDK83 977-24), and subsequently developed a work process flow and instructional webinars (BDV30 977-12 and BDV30 977-24). Prior research indicated that the primary barrier to full implementation of the FAM is the availability of data and expertise for quantifying research costs and benefits. A major objective of this project was to determine the appropriate way to overcome this obstacle. Consequently, this project included a variety of activities to assess the availability and accessibility of data needed to implement the FAM and an assessment of the capabilities of research project managers (PMs).

Throughout the project, the research team communicated with, and provided feedback to, the FDOT Research Center staff and several project managers (PMs). Efforts were geared toward identifying opportunities for engaging PMs in FAM operationalization. In a series of face-to-face workshops, the research team received input that allowed a more accurate assessment of: (1) PMs' understanding of the FAM; (2) their acceptance of the general approach and willingness to implement the model; and (3) the sources of reluctance or resistance to applying FAM to their projects. While many of the PMs have the expertise that is needed, the research team noted a degree of apprehension to the overall approach that stems from the additional workload involved, and not from any lack of support for the FAM itself. Overwhelmingly, PMs support the culture change that has taken place, where research outcomes are valued and recognized.

The research team concludes that the operationalization of FAM requires additional expertise which can be secured when research funds are awarded. Specifically, project scopes can be modified to require that principal investigators (PIs) are responsible for applying the FAM whenever such application is reasonable. While the Research Center staff and PMs would need to provide support in this endeavor (e.g., provide any necessary internal data), we believe that shifting the responsibility to PIs – the party that is most focused on the research project – is the most efficient way to operationalize the FAM in the broadest way possible.

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CHAPTER 1 – INTRODUCTION

The Florida Department of Transportation Research Center is committed to improving and protecting Florida's transportation system through "the ethical scientific conduct of research that increases global knowledge of products, processes, and practices; to transfer information; and to encourage the implementation of research results. This mission is achieved through a contract research program that emphasizes applied research, implementation, performance monitoring, and technology transfer." The objective to conduct research with practical, implementable benefits poses a variety of challenges, which have been addressed through a series of projects beginning with the development of the Financial Achievability Model (FAM).

The FAM – a framework for evaluating the net benefits of research – was created for the Florida Department of Transportation Research Center in a prior research project (BDK83 977-24). Research conducted in two additional projects (BDV30 977-12 and BDV30 977-24) has moved the implementation of the FAM forward and has attempted to address various barriers to fully using the FAM in the research process. The research results suggest that the primary barrier to full implementation of the FAM is the availability of data and expertise for quantifying research costs and benefits.

The Research Center can use the FAM in all phases of research to meet strategic objectives. First, the FAM may be used to demonstrate the potential benefits of proposed projects, allowing for a more cost-effective allocation of research funds. Next, the FAM can be used to demonstrate the potential value of projects currently underway, which can facilitate timelier implementation of positive research results. Finally, the FAM may be used to evaluate research results that are implemented. In all phases of research, the FAM produces values that can be used to highlight the benefits of FDOT research activities.

Application of the FAM requires significant 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. For most projects, application of the FAM requires a solid understanding of the engineering implications of the research, which PMs and PIs

are well-equipped to explain. A formal approach to collecting this information from PMs has been successfully implemented by the FDOT Research Center. However, application of the FAM requires additional expertise in conducting economic analysis. This project addresses this specific need.

1.1 Objectives and Tasks

The purpose of this project is to evaluate options for incorporating economic analysis into the current research process. The project objectives include:

1) Conduct a survey of PMs and other relevant parties to determine the level of familiarity with basic economic principles and the FAM approach. This information can also be collected via interviews.
2) Reviewing internal (FDOT) and external sources of data that may be generally useful for applying the FAM (across a wide range of projects) and are readily available. This may be compiled into a data repository.
3) Conducting focused workshops with small groups of PMs to develop project-specific FAM models and train PMs on how to update their models throughout the project (i.e., from kickoff to closeout and implementation).

This project had its official kick-off in May 2021. This report is a synthesis of all work performed by the research team between May 2021 and June 2022. The completed tasks, along with their descriptions, are provided in Table 1.

Table 1. List of Tasks Completed

Task	Description
Task 1 Survey of PMs	In consultation with FDOT personnel, the principal investigator will issue a survey to all current and regularly-active PMs to determine their familiarity and comfort level with basic economic concepts and the availability of data in their functional area. The purpose of the survey is twofold: (1) to inform PMs of new efforts to operationalize the FAM and assess their comfort level with respect to enhancing the current process of collecting information to incorporate economic analysis; and (2) to identify and collect sources of data in each PM's functional area that may not be obvious. The survey will also be used, in part, to identify projects that are suitable for application of the FAM. Additional projects may be identified through further discussion with FDOT personnel. Projects identified in this task may include new and ongoing research.
Task 2 Review of Data Sources	In consultation with FDOT personnel, the research team (principal investigator and students) will identify internal and external sources of data that would be generally useful for applying the FAM (across a wide range of projects). Information collected in Task 1 will be used as initial input. The research team will evaluate the availability, validity and reliability of the data sources and specific data elements identified by PMs.
Task 3 Conduct Workshops	In consultation with FDOT personnel, the research team will conduct small, focused workshops with PMs to develop project-specific FAM models and train PMs on how to update their models throughout the project (i.e., from kick-off to close-out and implementation). Specifically, the research team will conduct a total of three workshops as follows: • One half-day initial workshop with PMs from Structures, Materials, and Maintenance • One half-day initial workshop with PMs from Traffic Operations • One half-day initial workshop with other PMs as identified by the Research Center The objective of the workshops is to instruct the PMs in the functional area(s) in the specific FAM-oriented process of data collection and analysis needed for their projects. Follow-up calls will be used to review the data collection and analysis to ensure application of the FAM is reasonable and accurate.
Task 4 Case Studies and Evaluation	The research team will review the progress in Task 3 to determine the extent to which the FAM may be reasonably operationalized. This will include an assessment of the effectiveness of the workshops and the development of 3 short case studies based on projects that offer insights that will help PMs in other areas to apply the FAM to their projects. The evaluation will consider: (1) if additional workshops should be provided to the PMs in the targeted functional areas (i.e., Structures, Materials, Maintenance, and Traffic Operations) to ensure sustainability of the FAM

	process; (2) if workshops should be provided to the PMs in other functional areas; and (3) whether additional expertise may be required (e.g., retaining an economist to assist with the FAM analysis to ensure sustainability of the FAM process). Each case study will summarize the application of the FAM throughout the research project, interpret the spreadsheet results, and highlight specific challenges, if any, in the application of the FAM to the project. The objective of these case studies is to provide a set of examples for PMs going forward.
Task 5A. Draft Final Report Task 5B. Closeout Teleconference	
Task 6. Final Report	

CHAPTER 2 – SURVEY OF PROJECT MANAGERS

The PI developed a survey containing 16 questions using Qualtrics. A copy of the survey is provided in Appendix A. The survey was approved by the Research Center on July 9, 2021, and an announcement was distributed to 75 current and former project managers (PMs). The announcement that was sent included only a short description of the FAM, as shown in Figure 1 below.

Figure 1. Survey Announcement

Dear FDOT Project Manager,

My name is Patty Born, and I have been working with the FDOT Research Center for several years on projects related to valuing your research activities. You may already be aware of the Financial Achievability Model (FAM), and you are likely familiar with the Research Centers' efforts to collect information on the expected and realized benefits of your research. Now, we are looking to fully operationalize the FAM across all research activities!

I have developed a brief survey that will assist me in identifying the remaining challenges to applying the FAM to your research projects. One of my key interests is in the types of data available in your office, and other sources of data that would be useful for valuing your projects. Your responses will also help me determine the additional training that may be needed as we move forward.

Please complete the survey located here:
https://fsu.qualtrics.com/jfe/form/SV_2au9TJXUF4RsuGO by next Wednesday, July 21. Thank you, and please do not hesitate to contact me with any questions.

Responses were collected beginning on July 14, 2021. Several reminders were sent by the PI and the Research Center staff over the next month. The last survey included in this analysis was received on September 4, 2021.

The following sections provide univariate statistics and cross-tabulations for the survey questions. Although some survey responses were incomplete (e.g., missing responses to individual questions), all usable data is included in the summary.

2.1 Respondent Information

Tables 2 and 3 provide summary statistics for the respondents. Table 2 shows the distribution of responses by the PM's Office. A majority of responses were obtained from State Materials and Traffic Operations.

Table 2. Offices Represented in Survey

Office	**#**		**Office**	**#**
Construction	1		Safety	1
Freight and Multimodal	1		State Materials	10
Geotechnical	1		Structures	5
Planning	2		Systems Implementation	1
Public Transportation	2		Traffic Operations	9
Research Center	2		Transportation Data and Analytics	1
Roadway Design	2		Other/missing	4

Table 3 provides a tabulation of two questions designed to collect PMs' experience with managing research projects. The figures in the table indicate that all of PM respondents have had experience with managing projects. Among the three respondents that are not currently managing projects, all have managed projects in the past. The respondent with no projects over the past five years is currently managing a project. To provide a sense of the projects being managed across different areas, Table 4 presents a cross-tabulation of the responses to the number of current projects being managed by the respondents' office.

Table 3. Offices Represented in Survey

Projects currently managed		Projects managed in the past five years	
# Projects	**# Responses**	**# Projects**	**# Responses**
0	3	0	1
1	20	1	9
2	8	2	8
3	6	3	9
4 or more	4	4 or more	14

Table 4. Projects currently being managed, by Office

	Number of Projects					
Office	**0**	**1**	**2**	**3**	**4+**	**Total**
Construction	1	0	0	0	0	1
Freight and Multimodal	0	0	0	1	0	1
Geotechnical	0	0	0	1	0	1
Other (not specified)	0	2	0	0	0	2
Planning	0	1	0	0	1	2
Public Transportation	0	1	1	0	0	2
Research Center	0	2	0	0	0	2
Roadway Design	1	1	0	0	0	2
Safety	0	0	1	0	0	1
State Materials	0	6	2	1	1	10
Structures	0	2	1	1	1	5
Systems Implementation	0	1	0	0	0	1
Traffic Operations	1	4	1	2	1	9
Transportation Data	0	0	1	0	0	1
Total	3	20	7	6	4	40

2.2 Familiarity with FAM and FAM Concepts

The tables in this section illustrate the PM respondents' familiarity with the FAM model and basic economic concepts that are employed in the model. The PMs were asked, "Which of the following best describes your familiarity with the Financial Achievability Model (FAM) that has been implemented by the FDOT Research Center?" While the invitation email (shown above in Figure 1) contains a short mention of the FAM, no additional introduction on the FAM was provided for

this question. The responses are tabulated below in Table 5. A cross-tabulation with the respondents' office is included to further assess whether the FAM is more familiar among certain groups of PMs.

Table 5. Familiarity with FAM, by Office

	I have heard of the FAM but am not familiar with the model	I have heard of the FAM and know that it is an attempt to capture the net (quantitative) benefits of research	I have heard of the FAM and have attempted to apply the model to one or more of my research projects	I have never heard of the FAM
Construction	0	0	0	1
Freight and Multimodal	1	0	0	0
Geotechnical	1	0	0	0
Other (not specified)	0	0	0	2
Planning	1	0	0	1
Public Transportation	0	0	0	2
Research Center	0	1	1	0
Roadway Design	1	0	0	1
Safety	0	0	1	0
State Materials	2	1	3	4
Structures	0	2	0	3
Systems Implementation	0	0	0	1
Traffic Operations	4	0	1	4
Transportation Data	0	0	0	1
TOTAL	10	4	6	20

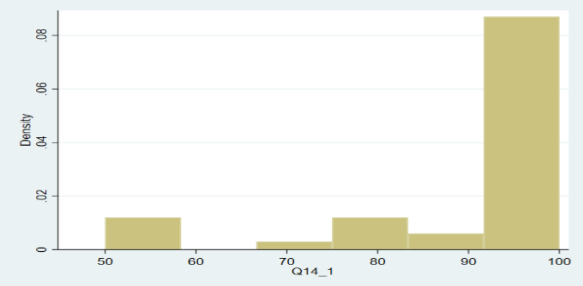
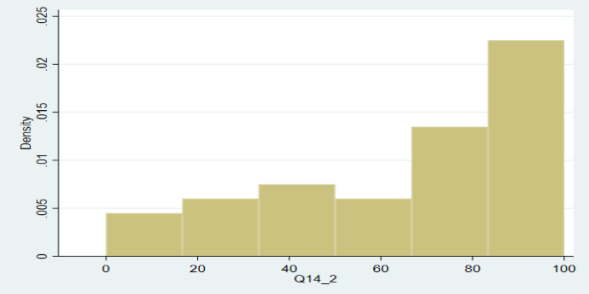
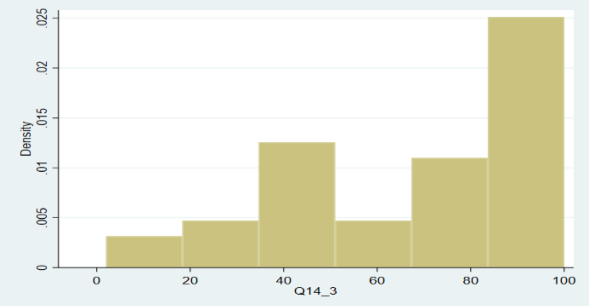
The responses in table 5 indicate a striking lack of familiarity with the FAM. Half of the PM respondents indicated that they had never heard of the FAM model. Among the remaining responses, 70% (14/20) indicated only a passing familiarity with the model. Only 15% (6/40) of the total respondents reported any experience with applying or attempting to apply the model to their research projects.

A series of training videos was provided in summer 2019 to the Research Center as part of a previously funded FDOT project related to FAM Implementation. Among the 20 respondents to

the survey that reported some familiarity with the FAM, only two PMs reported that they watched these videos (note: one of these respondents is from the Research Center staff).

Implementation of the FAM requires an understanding of several basic statistical and financial concepts. Namely, one must understand the concepts of interest, probability, and discounting. Respondents were asked to rate their familiarity with the concepts on a scale from 0-100. Table 6 provides the text that was used to explain each concept and shows the distribution of responses to familiarity of these three concepts using histograms.

Table 6. Familiarity with Statistical and Financial Concepts

Interest Calculating interest, when given an amount of principal and an interest rate. For example, you borrowed $100 for one year at a 6% annual interest rate - what do you owe at the end of the year? (ans. $106)	
Probability Calculating an expected value, when given probabilities of possible outcomes. For example, there is a 10% chance of winning $50 and a 90% chance of winning $0 - what is the expected value of your winnings? (ans. $5)	
Discounting Calculating the present value of a future amount. For example, if I need $50K in four years, how much do I need to put away today, assuming a 5% discount rate? (ans. $39,605)	

Among the three concepts, respondents reported the highest degree of familiarity with the calculation of interest (average response = 0.91) and the lowest degree of familiarity with probability (average response = 0.67).

Spreadsheet skills are helpful for FAM implementation for several reasons. Most importantly, a spreadsheet can be used to enter all relevant information and calculate the net benefit of a research project, since all required calculations (i.e., interest, probability, and discounting) can be easily performed in a spreadsheet. Also, data is often stored in Excel files and a basic understanding of how to read and compile data from various sources is essential. For these reasons, the survey included a question to ascertain PMs' familiarity with using Excel. Table 7 below provides a breakdown of the responses.

Table 7. Familiarity with Excel

Response	#
I have never used Excel and have never worked with spreadsheets.	0
I have never used Excel, but I have some experience with spreadsheets.	0
I have experience with Excel, but have not used Excel formulas or Data Analysis tools	5
I have experience with Excel and have used Excel formulas and/or Data Analysis tools	35

The PMs report a high level of sophistication with using Excel as more than 87.5% (35/40) report having used formulas and the Data Analysis tools that are useful for FAM implementation.

2.3 Identification of Data Sources

Survey respondents were informed that "one of the challenges to operationalizing the FAM is obtaining the appropriate data for the model" and asked to help in assessing the availability of data needed to apply the FAM to their past, current, or future project(s). This was followed by four questions designed to elicit sources of data. The responses to each question are provided in tables 8-11 below.

Table 8. Relevant Sources of Data for Past or Current Projects

Question: First, we would like to know about any data collected and stored in your Office that is relevant to projects that you have managed or are currently managing. Feel free to list any data that you are aware of and, where possible, provide specific details. For example, "Miles of roads surveyed, by week, by county, 2010-current."
Project data stored in MAC, Mass concrete project data
Some specialized test results performed by the State Materials Office, but the majority of routine geotechnical test results are conducted at the district level, typically performed by consultants. Test results are per project basis.

In terms of FDOT data, there are many server locations where data might be needed, such as MAC, the PCS data, friction data etc.
Trainings offered, number of attendees
Asphalt mix design data and asphalt production data
Driver speed along a road due to different countermeasures
Number of bridges built using shored construction procedure.
Strain, load, and deflection data acquired during structural testing
Number of acceptance tests performed.
Transit agency performance data such as ridership and revenue miles
Wrong Way Crash information, 2016-current, Secondary Crash information, 2016-2018, FDOT Crash Analysis Reporting (CAR) data
Crash, fatality, serious injury data (2015-2019); 65+ population and licensing data (same years)
RCI Data
Crash data; Traffic volume data
Sea level risk projections, flooding, storm surge, evacuation routes
Traffic Volume data - hourly, by direction - from permanent counters 24/7/365; Traffic Classification data - daily, by direction, binned by class - from permanent counters 24/7/365; Traffic Speed data - daily, by direction, binned by speed - from permanent counters 24/7/365; Current and historical data exists for all of the above, date ranges dependent upon the individual traffic monitoring sites used
Currently, this is my first project as a DOT PM. However, there are several performance measures within the Research Center and in my role as a Research Performance Coordinator. For example, we collect data listed below: Milestones/Goals of the Research Center by the Quarter # of projects in a fiscal year On time and on budget; # of FDOT NCHRP panel members # of TPF projects # of projects by Office # of projects by Project manager Project Funding Type (state, SPR, etc.) # of partners? UTCs and Universities # of projects published in Research Showcase Implementation status for the project How diverse is our research pool? National, Regional, UTCs Some performance measures that are not necessarily reported to leadership in my role are as follows: Types of Amendment for projects by % - time extension, increase in funds, decrease in funds, rebudget of funds, change to scope, other. Implementation status for projects by % - active implementation, passive implementation, currently being implemented, will be implemented later, should not be implemented, information only.

Process improvement feedback during the Closeout from the Project Manager on the processes of the Research Center. # of projects awarded a Sweet Sixteen or Supplemental # of projects eligible for Demonstration or pilot funding # of projects that reach publication (journals, articles, etc.)
Project design files, roadway AADT, future traffic projections, environmental, socioeconomic, cultural resources information and more
Traffic Counts, Crash data, Roadway Characteristics, Bike and Ped data.
Urban Fixed Route Transit Revenue Miles
Railroad crossing numbers, railroad safety: incidents/accidents, large truck crashes, traffic volumes. All data is captured over a time period by a day up to a year; and the data is sometimes converted to GIS platforms.
Crash records and analyses from the FDOT State Safety Office (SSO) in the Crash Analysis Reporting (CAR) database are relevant to projects (research or otherwise) that I have managed or currently manage. Public mileage reports from FDOT Transportation Data Analytics are also relevant. Both sources provide data needed to determine the number of fatal or serious injuries from traffic crashes and to compute fatal or serious injury rates per hundred million vehicle miles travelled (HMVMT). FDOT SSO is focused on eliminating all fatal or serious injuries on public roads in Florida, so these data sources are pertinent to all projects managed by FDOT SSO.
The benefits from implementation for my projects (TSMO) are generally on the ITS network, as this is where travel time, crash, and other items we regularly measure are stored.
Traffic volumes and speeds

Table 9. Other Useful Types of Data

Question: Thinking about your past, current and/or future projects, what additional types of data do you think would be useful for evaluating the **costs** associated with these projects? Please consider the current costs, if any, and the expected costs if the research is implemented. Provide specific details and note possible sources for the data (e.g., internally at FDOT, from the Principal Investigator, some other source), if any.
Cost of materials (i.e., equipment, etc.)
All material, construction, and maintenance costs that would be reduced by increased concrete durability (longer service life). Detailed data on costs for each concrete construction procedure and projected future costs. Detailed data on costs for each concrete maintenance procedure and projected future costs. Estimated future budget expenditures on each category of construction and maintenance procedures. Concrete raw material costs and projected future costs. For perspective, if we develop a more durable concrete, we will need to calculate the savings from reduced construction and maintenance that would come from the concrete lasting longer.
For geotechnical projects, time savings associated with more efficient means of performing the process is a critical component to potential time savings. Also, more efficient testing which

might mean less testing (for direct cost savings) but might also mean more testing when it makes sense to do so (more direct cost but better quality of geotechnical information to improve design or reduce construction delays or potential claims).
It really depends on the project, but asphalt unit costs are often important.
Detailed cost of implementation would be of benefit. The cost of implementation is often overlooked because it does not cover the increased risk the contractors are putting on implementation of a new innovation. Sometimes the early projects will cost more until the contractors/end users gain a comfort level, however this will be difficult to quantify.
Bid prices; Pavement performance data, life span
Number of equipment, types of equipment, how often the equipment is used and on what types of projects, how it is maintained
Long term maintenance costs of bridges built using shored construction methodology
Historical cost data
In my case, the implementation cost should include the data collection equipment acquisition cost (data available from the State Materials Business Office)
Final Pay Quantities for individual Pay Items; Cost of materials purchased by asphalt plants, concrete plants or earthwork contractors not included in Pay Items. Some contractors consider this information proprietary.
Staff hours to collect and analyze data
Costs of various design options for resilience and adaptation
Video data, used for data verification. Smart cameras with AI to do individual vehicle recognition / classification and provide counts and classification from images. This technology could be used for all modes of transportation, including motorized and non-motorized.
The costs in my current project is staff augmentation time. At the close of the FAM project, the Research Center will understand the labor/costs it will take in implementing the FAM and the need for more staff to help monitor the Divisions use of it.
Design, construction, and PD&E study costs within FDOT's Work Program
Capturing landed cost used by the freight and rail industry would enhance more accurate planning, and cost/benefit per project. These data are usually proprietary.
Equipment costs, travel expenses, timesheets (give the research a specific number we can charge to).
Implementation costs and related items to support such as infrastructure, data storage, staff, impact on construction
There are estimated costs for each injury severity reported in traffic crash records. These estimates are available through the FDOT Roadway Design Office and the FDOT State Safety Office. The injury severities are fatal, serious, or incapacitating, non-incapacitating, possible, and none or property damage only. Using these estimates, projects may be evaluated by any change in the number and severity of injuries.

Table 10. Other Data to Evaluate Benefits

Question: For many projects, the expected "benefits" of the research is a lower "cost" going forward, e.g., as a result of a change in a process or material. Thinking about your past, current

and/or future projects, what additional types of data do you think would be useful for evaluating the **benefits** associated with these projects? Provide specific details and note possible sources for the data (e.g., internally at FDOT, from the Principal Investigator, some other source), if any.
Cost of materials (i.e., equipment, etc.)
Our main goal is to continually improve the long-term durability/service life of structural concrete. When improvements are made, we can only make a guess as to how much longer an improved concrete could remain in service; therefore, cost-saving calculations have an additional source of uncertainty. Also, how would we evaluate the benefits of improvements such as fewer interruptions of the driving public, improved aesthetics, more environmentally friendly, and enhanced safety?
Many times, geotechnical benefits are qualitative in that higher quality or more information is provided to obtain better geotechnical parameters or more information is obtained to optimize and increase confidence in designs which have the additional benefit of reducing construction delays or potential claims and better long-term performance of the foundation. A direct benefit of many of the geotechnical research projects is answering immediate questions about Department's policy and procedures (design guidelines or specifications), and implementation is immediate by providing the information, data, recommendations to be able to make rational changes to policy/procedure (which can be backed up by the documented research efforts).
Safety is important but hard to value. Environmental benefits. Reduced construction time is a benefit to the public. Longer life cycle.
Increased repair and maintenance on structures due to deterioration causes increased MOT efforts. Using better materials reduces these efforts and thus reduces the MOT efforts. This not only is a long-term cost savings but also a significant safety improvement due to the minimized interaction with traffic. Not sure how this could be tracked but a thought.
Number of lives saved, slower speeds, less sudden braking
Inspection reports of bridges built using shored construction.
Historical cost data
To evaluate the benefits of the research project is to compare the cost per mile before the implementation (using the manual method) and the cost per mile after the implementation of the automated system. There is an intangible benefit with the automated system which is improved safety which is hard to put a dollar value to it. A possible index to use (in lieu of B/C) is Utility Value/Cost or something similar.
Usually, the PI has no information after the project is complete. In some cases, maybe FDOT Maintenance could maybe provide information on costs of repairs or elimination of cost of repairs.

Crash reduction factors
Damages avoided
The above-mentioned technology would benefit the Department by reducing man-hours to analyze the images by automating the process and will enable TDA to calibrate data collection equipment accordingly to increase accuracy and enhance reporting of all statistical traffic data.
Crash reductions (Crash modification factors), reduction in travel times (transit/motorist/pedestrian), increased transit reliability, mode share shift to transit. Increase of air quality.
Project implementation or operational costs
Similar to the previous cost question, capturing the related benefits to the landed cost used by the freight and rail industry would enhance more accurate planning, and cost/benefit per project. These data are usually proprietary.
Monitoring if the project facilitated production (perhaps as a time saver, or if implementation helps get a controversial project approved with stakeholders).
To get a good idea of the benefits of the research, contract/labor costs would have to be monitored after implementation of updated design tools, or procedures. Without actual contract costs, it would be more of a guess.
Function of implementation, PM would be resource for data
In addition to the benefits associated with reducing fatal or serious injuries on public roads in Florida, we should consider benefits to how FDOT operates. An example includes reducing the time of non-value-added tasks.

Table 11. Any Other Sources of Data

Question: We plan to produce a catalog of all of the data sources obtained through this survey, so that it will be useful for applying the FAM to future projects. Please list here any other sources of data (internal or external) that you think may be useful for FAM implementation in your Office or any other functional area.
A significant amount of the data we need is not collected or compiled yet. A database is not very useful unless it contains all the data needed for evaluation, so the first step should be to ensure that the data will be collected and entered into an accessible database. For example, if a newly placed concrete bridge deck cracks, the cracks will need to be sealed and if the cracking is severe enough, the concrete will have to be replaced. However, maintenance does not track the costs involved with mitigating the cracking because the contractor is responsible for the repairs. This drives up the cost to the contractor and makes the construction more expensive (costs are passed on to the FDOT in the form of higher bids).

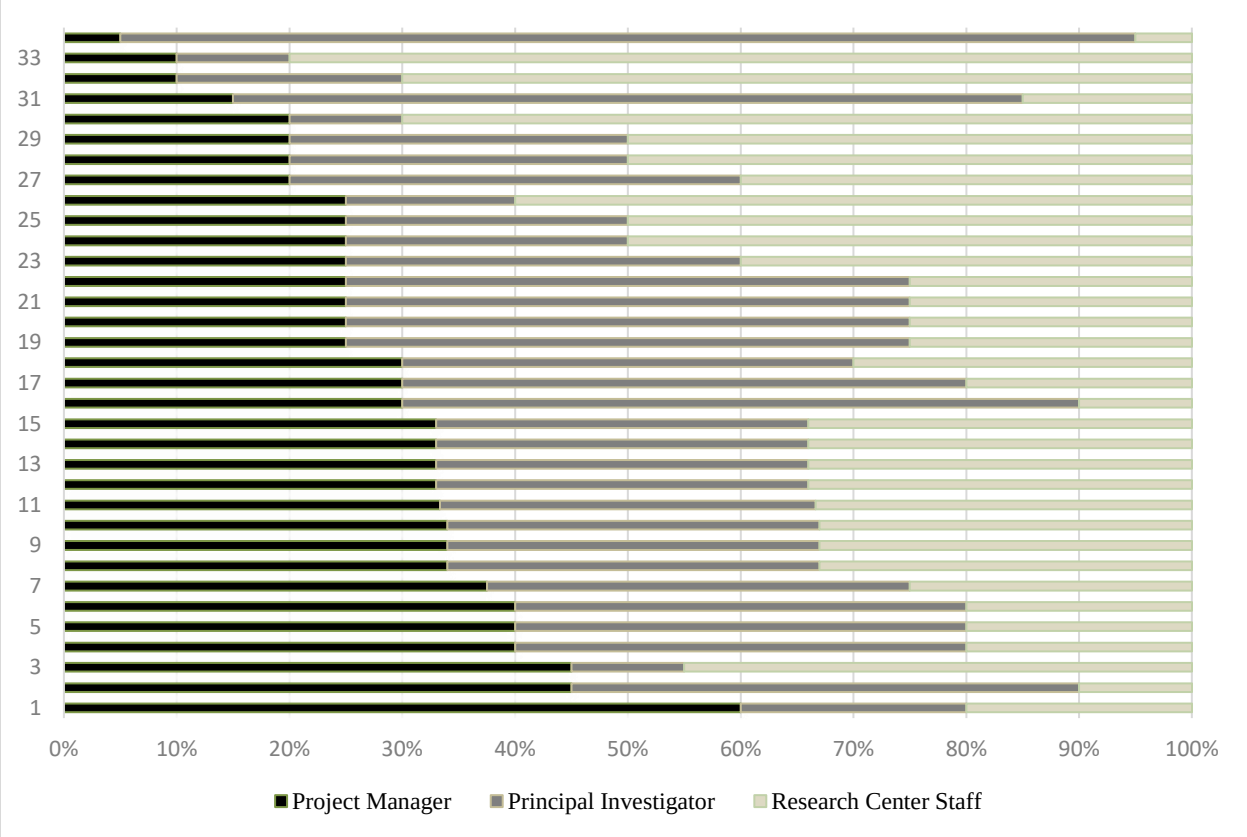
Thus, FDOT indirectly pays for these construction problems, but does not keep track of them, and we don't have access to data needed to estimate maintenance savings.
Estimates Office - Historical Item Average Costs Design Staff Hours- Production Support Office - Sometimes projects are refining the process of design elements to simplify the process which reduces the design staff hours required. Tracking this is difficult but tracking the staff hours would be the method. Not sure how detailed it can get but maintenance, repair and associated MOT costs of structures/bridges is beneficial, but it always difficult determining how much FDOT spends on these efforts due to the complexities involved.
All data in MAC
Traffic volume, growth in traffic volume, number of crashes, number of near misses
FDOT Safety Data Portal
Most of the data on the Transportation Data & Analytics home page (https://www.fdot.gov/statistics/default.shtm)
Producing an implementation report - The data would come from the implementation status of the projects, articles being produced, Divisions that seem to implement projects, Division that are least likely to implement projects.
Crash Data, Crash Modification Factors Clearinghouse, FDOT Work Program, PD&E studies.
An increase in rider's access to public transit and reliability, as shown in the annual Public Transit Handbook publication.
Bill of Laden data
Crash Analysis Reporting (CAR) database; Public mileage reports from FDOT Transportation Data Analysis

Most of the PM respondents provided some information for these four questions. The sources of data provided are very general but provide a good starting point for the next stage of this research project. One issue to note is that several PMs noted that the PIs are the source of the data that would be needed for the FAM model, suggesting that the task of implementing the FAM may require significant cooperation with PIs. The next stage will include follow-up with the PM respondents to determine additional details about these data sources including the method of collection, period of time covered, etc. The extent to which PIs can be involved in the project is discussed further below.

2.4 Opinions

A final question was included in the survey to capture the PMs opinion as to the proportion of involvement required for full operationalization of the FAM. Specifically, the FAM can be implemented by the PM, the Principal Investigator (PI), Research Center staff, or some combination of these individuals. The survey asked, "Thinking about past, current, or future projects, indicate the proportion of involvement you believe is necessary from these three parties in order to fully operationalize the FAM." Responses to this question provide an indirect gauge of PMs' willingness to operationalize the FAM for their projects. The proportions
provided for the 34 PM respondents with valid responses in the bar chart below, ordered by the proportion assigned to the PM.

Figure 2. Perception of the Proportion of Involvement Needed to Implement FAM



On average, the PM respondents place nearly equal proportions on each of the three parties provided. The mean proportion of involvement assigned to PMs was 29.0%, the mean for PIs was 36.7%, and the mean for the Research Center staff was 34.4%. The figure shows, however, that some respondents may be willing to take a much larger role in implementing the FAM on their projects. About 53% of the respondents indicated the PM should take at least one-third of the responsibility.

Of note is that 79% of the PM respondents assigned the same or more responsibility for FAM implementation to PIs than to PMs. The potential for requiring FAM implementation as part of the scope of research should be considered, as the cost of data collection and analysis could be absorbed into the PIs' research grant. However, it is important to also consider: (1) if PIs would need additional training, and (2) the extent to which internal FDOT data required for the model (e.g., historical cost data) could be shared with the PIs. Ultimately, the responsibility for implementing the FAM will require the cooperation of the three parties – PMs, PIs and the Research Center staff – and the next stages of this project will continue to explore reasonable options for this cooperation.

2.5 Discussion

Over the past few years, FAM concepts have been integrated into the research project workflow through targeted questions on various research-project related documents (e.g., proposals, kick-off survey, etc.). Nonetheless, the survey results presented in this report indicate that awareness of the FAM approach remains low.

The main objectives of the survey were: (1) to assess the familiarity and comfort level of PMs with basic economic concepts and the FAM, and (2) to begin a process of collecting sources of data that are needed to implement the FAM. As such, it also provided an opportunity to remind PMs of the

desire to implement the FAM more widely across their research projects and gauge their interest in cooperating in this effort.

The survey responses helped to guide the collection of data sources described in the next chapter. They also provided useful input for developing the appropriate materials for the training workshops described in chapter 4.

CHAPTER 3 – REVIEW OF DATA SOURCES

The Research Team, including the PI and three student assistants, used a variety of approaches to identify data sources that may be used for FAM implementation. These approaches included: (1) an interview with Christine McDonald, FDOT Data Governance Administrator; (2) contact with FDOT staff to obtain injury statistics; (3) interviews with FDOT project managers; and (4) a discussion with individuals involved in FDOT project estimates. The information obtained from each of these approaches is discussed in the following sections.

3.1 Interview on Data Sources

On October 1, the PI had a Zoom meeting with Christine McDonald to discuss various sources of data internal and external to FDOT. The conversation was extremely fruitful as we learned about many sources of data that could be of use in implementing the FAM. Moreover, many of the data sources are accessible through a convenient portal and, in some cases, the data are organized according to functional areas. These are described in the following sections.

3.1.1 FDOT Open Data Hub

The FDOT Open Data Hub is available at http://gis-fdot.opendata.arcgis.com. This site provides a search tool for identifying data sources as well as listings, by category, of data sources. The categories on this site, and examples of data that is open to the public in each category include:

Roads: Functional classification of roads, county road location data, divided roads, facility crossings (river, railroad, etc.).

Safety: Florida NonMotorist Fatal and Serious Injuries (2014-2018), Night Time crash segments on the state highway system (last updated 2015).

Traffic: Annual average daily traffic, Portable and Telemetered Traffic Monitoring sites, Truck Traffic Volume (annual average daily), Weigh in Motion locations.

Projects: District 4 study and design projects (last updated September 23, 2021), Five-year listing of transportation projects (last updated August 2017).

Road Characteristics Inventory: Access Management Roadway locations, Bike Lane and Bike Slop locations, spatial information on Maximum Speed Limits, Median Types and Widths, Mile Markers, locations of designated National Highways, Off System and On System roads, Shoulder Types and Widths, locations of Rest Areas/Welcome Centers, Traffic Signal Locations, locations of Bridges.

Facilities: Location of FDOT facilities including Headquarters, Offices, Labs, and other FDOT facilities (last updated December 2020).

A review of the data sets on the Hub indicates many of these data sources are updated weekly (as recently as December 19, 2021). Exceptions are indicated in the list above. Contact information (email address) for the individuals responsible for each data source are also provided along with the descriptions of the data. Thus, PMs needing the particular sources of information have a contact for more information.

The data sources on the Hub are easy to access. When selecting a source, one option is to view the data table. From there, one can filter the data to obtain a subsample, if needed. To illustrate, the PI accessed the Bike Lane data table and filtered to include only Bike Lane data for Leon County. This filter resulted in a reduction in records from 12,164 to 299. Filtering for Madison County yielded four records.

3.1.2 FDOT Transportation Data Portal

The Transportation Data Portal is another platform for locating data related to FDOT's core mission to "coordinate the planning and development of a safe, viable, and balanced state transportation system serving all regions of the state, and to assure the compatibility of all components, including multimodal facilities." The site is located at https://www.fdot.gov/agencyresources/mapsanddata.shtm, and contains links to geospatial data, maps, and mobile and web applications. Data includes Aerial Photos, Mileage Data, Properties, and Crash Data. The site contains a link to the Open Data Hub (noted above) - and ArcGIS, which is limited to FDOT employees - which provides additional links to much of the same data that is available on the Hub. Some types of data that appear to be available only through this site include the Aerial Photography, Outdoor Advertising Database, Safety Program Tracking Tool, and various types of permits (e.g., oversized vehicles).

3.1.3 Geographic Information System (GIS)

Most of the same information in the Hub is available on this site at as well: https://www.fdot.gov/statistics/gis/default.shtm. Access is similar but this site also contains additional links that may be of use for implementing the FAM, e.g., Federal Aid Eligibility Maps and information from the Mobility Measures Program (MMP).

3.1.4 Materials Acceptance and Certification (MAC) System

The MAC system is a platform that provides documents, videos, and data related to the use of materials for FDOT projects. In the surveys collected for Task 1 of this project, PMs from the State Materials Office were familiar with the MAC and the types of data available. The system is limited to FDOT employees and non-employees that are provided guest access. There is no public access to the system.

3.2 Discussion of Data Sources

While each research project will require unique data for FAM implementation, it is clear that FDOT researchers have access to much of the data that can be used to establish the potential scope of implementation and provide adequate context for the need for the research (or the research result). For example, estimating the value of a new material that can replace an old material requires details on the locations where the material may be applied, currently, or in the future. As another example, crash statistics that include locations can guide research to the appropriate context for motivating the research and, subsequently, applying the FAM to traffic operations research.

While it appears that there are many sources of data, there are duplicate ways of accessing some of the data sources, i.e., through the Hub or the Portal. Some consolidation and coordination will help to ensure significant sources of data are not lost or overlooked. The FDOT Data Governance Initiative (see Appendix B) addresses problems with data access and data organization across FDOT. The solution is referred to as the ROADS (Reliable, Organized, Accurate Data **S**haring) initiative, and includes many steps including enabling data consistency and accountability, establishing data awareness, and streamlining data security. Since 2014, the initiative has undertaken a variety of activities including the development of a data warehouse that includes safety date, asset (roadway characteristics) inventory, Highway Performance Monitoring System (HPMS) reporting, and pavement condition data. As the data warehouse continues to grow, access to reliable data for implementing the FAM will only improve.

Ms. McDonald explained that there is an ongoing effort to consolidate data sources across multiple state agencies. She mentioned several additional sources, including the Florida Geospatial Open Data Portal (https://geodata.floridagio.gov/). Examples of state agencies that are currently sharing data through this portal include the Department of Environmental Protection, Fish and Wildlife Conservation Commission, South Florida Water Management District, Department of Health, and the Department of Agriculture and Consumer Services.

3.3 Injury Statistics

In a prior FAM project, the PI obtained and analyzed injury statistics provided by FDOT. In March 2019, the PI obtained injury data from the FDOT Industrial Safety Programs Administrator, Mark Eacker, for the period 2013-2018. This data is available by district and contains information about the injury cause, the task, and the body part affected. This data may be useful for the FAM evaluation of projects that involve enhancements to FDOT employee safety. Appendix C contains a sample of this data in a table that presents the injuries by cause for the period 7/1/2013-6/30/2014.

3.4 Interviews with Project Managers

The PI assigned the three student research assistants a group of 9-12 PMs for interviews. The students prepared an email to send to their assigned PMs (see Figure 1 below). The initial emails were sent between October 11 - 12, 2021 and, in most cases, PMs responded quickly and were able to arrange meetings with the students. Telephone and Zoom meetings were conducted over the next four weeks. Appendices D, E, and F contain notes submitted by the student research assistants. Note that some interviews were one-on-one and some, for expediency, were conducted with groups of PMs. The PMs interviewed were largely from the State Materials Office, Structures, and Traffic Operations. Specific PMs were chosen based on their responses to the survey described in section 2. Each PM had at least one project, either currently or in the past.

Figure 3. Email Notification to Project Managers

Hello < Name of PM >

As a Research Assistant with Florida State University, I am reaching out to schedule a time with you to speak about potential data sources pertaining to the FDOT research program. During our initial meeting, we will briefly discuss the Financial Achievability Model (FAM), a framework that will help determine the fiscal applicability of certain projects. In order to gain a more robust understanding of the data that would be practical to research projects, we must ascertain the availability, validity, and reliability of said data. Since it may be difficult to meet in person, I suggest that we take advantage of a remote meeting system. If a phone call is more convenient, I can also arrange that. Though I am a full-time student, I am available to speak during the day (when not in class) and during non-business hours.

Best Regards,
< Name of Student >

Overall, the interviews helped the research team get a better understanding of PMs' understanding of data that is readily available and applicable to their research. The information from these interviews proved valuable to develop the appropriate strategy for operationalizing the FAM more broadly. This is discussed further in the following sections.

3.5 Discussion with FDOT Program Management and Construction

On December 7, the PI joined a discussion with staff in Program Management and Construction. The call included a state estimates engineer, a state preliminary estimates engineer, and two staff members from the office of construction. The PI learned that project estimates are largely obtained through a consultant (Balmoral). Also, labor costs – which may be useful for evaluating research projects that may involve a change in the time or expertise needed for a process – are usually "baked in" to project estimates, as a proportion of the furnish and install (F&I) price. This means that actual labor costs are not currently available for most FDOT construction projects.

Overall, the meeting was not useful for identifying any internal sources of data. However, this group of individuals has expertise in obtaining estimates of project costs and indicated that they are willing and able to serve as a resource for project managers, as needed.

3.6 Conclusion

The research team identified many sources of information that can be useful for FAM implementation on most projects. For example, these sources can be used to indicate the current inventory of materials and equipment as well as the scope of potential application.

Each research project is unique and will require some unique data as a result. This data should probably be generated as part of the research project, in collaboration with the project PI. The next phases of this project will include an assessment of the usefulness of existing data (e.g., in the data portals) and the extent to which it is feasible to collect the unique data needed for a sample of projects.

CHAPTER 4 – WORKSHOPS

The Research Team, including the PI and three student assistants, conducted three face-to-face workshops with PMs. The objective of the workshops was twofold: (1) In consultation with FDOT personnel, the Research Team conducted small, focused workshops with PMs to develop project-specific FAM models and to train PMs on how to update their models throughout the project (i.e., from kick-off to close-out and implementation).

In lieu of follow-up workshops, the Research Team conducted follow-up phone calls with workshop participants. These phone calls included a review of the data collection and analysis to ensure application of the FAM is reasonable and accurate.

The face-to-face workshops were approximately 3-3.5 hours in duration. A sample agenda for the workshops is provided in Appendix G. Following general introductions, each workshop began with a presentation of the FAM. For this presentation, the PI used the FAM webinar slides that were created for a previous project (BDV30 977-23). The slides used for this presentation are provided in Appendix H.

The following sections provide an overview of the three workshops.

4.1 Workshop #1: Tallahassee

The first workshop was scheduled for the Structures and Traffic Operations offices. On November 15, 2021, the PI met with FDOT personnel from the Traffic Operations offices. PMs from the Structures Office were not in attendance and had to attend another workshop at a later date. The four attendees from Traffic Operations were currently involved in some stage of a research project (i.e., scope development or in-process). Throughout the workshop, the PI gave specific tasks to the PMs. The attendees were provided a template to record their responses. A sample of the templates provided to the PMs is provided in Appendix I.

4.2 Workshop #2: Gainesville

On November 18, 2021, all members of the Research Team traveled to Gainesville to meet with FDOT personnel from the State Materials Office. The eight attendees at this workshop were currently involved in some stage of a research project (i.e., scope development or in-process). As in the previous workshop, the PI gave specific tasks to the PMs, and these were recorded on a template by the attendees.

4.3 Workshop #3: Tallahassee

On February 17, 2022, the PM and one student met with FDOT personnel from the Structures Office. The four attendees were currently involved in some stage of a research project (i.e., scope development or in-process). As in the previous workshop, the PI gave specific tasks to the PMs, and these were recorded on a template by the attendees.

4.4 Workshop Feedback

The workshops proved to be quite valuable for assessing PMs interest in the FAM and their ability to apply the FAM to their research. Some of the PMs in attendance were more aware of the FAM than others. Most were familiar with the ongoing effort to identify the benefits of their research projects, but they were mostly unprepared for how to quantify the costs and benefits. Listed below are some of the major concerns that were addressed during the workshops. Other minor concerns, or issues that were project-specific, are summarized in the next sections of this report.

Concern 1:
PMs expressed different opinions as to whether quantification of benefits is even possible.

Response:
We spent a lot of time at the workshops addressing how each project is unique and that the FAM might have to be more “creatively” applied. For example, one project may be well-suited for deriving an annual net savings figure while another may only be suitable for deriving a net savings per mile. Still other projects entail costs that cannot easily be matched to quantifiable benefits (e.g.,

fewer accidents), but we discussed some ways to account for these, such as using aggregated, national data.

Concern 2:

It is difficult to disentangle costs for some projects because a vendor does not share the details.

Response:

We discussed whether vendors could be approached to provide more details on invoices. While it may be difficult at this point to gather historical data from vendors, requiring more information from vendors would be extremely valuable going forward. We discussed that a lack of necessary detail does not necessarily preclude application of the FAM, but just requires the analysis of project costs and benefits at a more aggregated level.

Concern 3:

PIs are in the better position – relative to PMs – to evaluate whether potential benefits from the research are changing over the project period.

Response:

We discussed whether PIs could be required to implement the FAM, with assistance from the PM, as needed, for historical context. This need for collaboration is discussed further below.

Concern 4:

Historical data is not available and/or not suitable to establish baselines.

Response:

In each workshop, PMs were asked to provide a "Situational Overview." Our review of their responses suggests a solid understanding of the baseline materials/methods and costs. For example, one PM noted, "The traditional method for steel box girders will use a thick bottom steel flange at pier locations. By providing concrete in these locations the costs can be reduced." However, eliciting this information on the baseline costs of methodologies or materials was not easy. We asked the PMs to think about the ongoing costs of "doing nothing" versus implementing the

research findings. The Research team concluded this approach should be considered when soliciting benefits of the research, e.g., during the scope development or kick-off.

4.5 Conclusion

As we continued to work with the PMs who attended the workshops, some projects were identified as candidates for case studies. The remaining participants received surveys and/or follow-up calls to assess the degree to which the FAM has or will be applied to their projects. In these calls and surveys, described in the next section, we focused on the remaining obstacles to operationalizing the FAM.

The workshops proved especially helpful for gauging the PMs' interest in proving the value of their research. All participants were engaged and looking for suggestions, but the main obstacle identified was data collection. While the Research Center continues to document sources of internal (FDOT) and external data, projects are all unique and will require some significant effort in collecting project-specific information at an appropriate level of detail. For this reason, we recommend that future projects require collaboration between PMs and the PIs on the FAM implementation. This may entail requiring PIs to conduct the analysis, with help from the PMs when establishing a baseline. This is discussed further in Chapter 6.

CHAPTER 5 – CASE STUDIES AND EVALUATION

As noted in the previous section, the Research Team, including the PI and three student assistants, conducted three face-to-face workshops with PMs. The objective of the workshops was twofold: (1) In consultation with FDOT personnel, the research team conducted small, focused workshops with PMs to develop project-specific FAM models and train PMs on how to update their models throughout the project (i.e., from kick-off to close-out and implementation).

Following the workshops, the Research Team conducted follow-up phone calls to six PMs that were identified in consultation with the Research Center staff. The selected PMs represent three different functional areas, and all have an active research project that was deemed suitable for application of the FAM. All subsequent interactions with these PMs are noted in the case studies

provided in Appendices J-M. Further discussion and interpretation of the case studies if provided in section 2.

The Research Team also reached out to the PMs that participated in the workshops but were not selected for developing a case study. Information was collected from the PMs via a survey that was first distributed on April 20. The results of this survey are informative for determining the follow-up that is necessary to keep PMs on the task of implementing the FAM. Responses were obtained from 13 PMs between April 20 and May 6. The results are provided and interpreted in section 5.2.

The next section provides a high-level overview of the case studies that were completed by the Research Team. This is followed by a presentation and discussion of the post-workshop survey results in section 3. Section 4 concludes with recommendations.

5.1 Case Studies

At the outset of this project, the objective for creating case studies was to record all efforts, including interactions with PMs, that might be helpful as future training aids for applying the FAM. Because every research project is unique, we planned to use the case studies to illustrate the more general considerations that might apply to every project and the more unique considerations for applying the FAM to a specific project. As such, the case studies are designed to offer insights that will help PMs in applying the FAM to their current or future projects.

In consultation with the Research Center staff, we identified projects that were more amenable to applying the FAM. We selected projects in various stages that are or will be managed by PMs from either Structures, Materials, or Traffic Operations that attended one of the workshops.
Follow-up meetings with the PMs yielded several different results, due to the nature of the projects and to the respective efforts of the Research Team and the PMs. We had the best interactions and produced the most complete case studies with two PMs from Materials. The two case studies prepared with the Materials PMs are provided in case studies 1 and 2 in the Appendix.

The Research Team member assigned to conduct interviews with the PMs in Structures had some personal issues that delayed discussions that should have followed from the workshop conducted in February 2022. Consequently, the PI reached out to the two PMs from Structures on May 24 to discuss whether any progress had been made in implementing the FAM on the two identified projects. The summaries of these discussions are included in case studies 3 and 4 in the Appendix.

The Traffic Operations projects presented more of a challenge for developing case studies. In conversations with PMs and the Research Center staff, we realize that extracting quantitative data is a real struggle with these traffic operations projects. The PM on one project noted that it may be just too hard of a task to figure out benefits associated with the identified projects due to their lack of data. As a result, the Research Team was not able to produce any case studies to guide the implementation of the FAM in Traffic Operations. Nonetheless, we would not completely abandon the possibility of implementing the FAM on these projects. We discuss the challenges and provide recommendations in section 4.

Overall, our ability to produce helpful case studies that will help in operationalizing the FAM reflects a combination of factors that should be noted going forward. First, PMs are busy with full-time jobs and the time required for considering FAM modeling is limited. We believe the PMs that participated in the workshops are on board with the approach and appreciate the value of the FAM approach. Overwhelmingly, PMs expressed buy-in with the approach and confirmed their interest in highlighting the value of their research. However, while they are all capable, we believe they may be overwhelmed with any additional requirements associated with managing research projects, such that the implementation of FAM may lead to a reduction in the number of research projects proposed.

5.2 Post-Workshop Survey

The purpose of the post-workshop survey was two-fold: (1) to gauge the effectiveness of the workshop and associated processes used for training the PMs, and (2) to assess further the challenges faced by the PMs when asked to implement the FAM on their projects. We received

eleven complete responses to the survey, which contained 15 questions. Table 12 shows the areas represented in the survey:

Table 12. Responses by FDOT Area

Area	Number of Responses
Office of Maintenance	1
State Materials Office	5
State Safety Office	1
Traffic Engineering and Operations	3
State Structures Design Office	1

Given the small number of observations overall and for any particular area, we do not test significance of any of the subsequent questions. Rather, we provide a breakdown of the responses for the group as a whole.

The PMs were first asked their familiarity with the FAM process. Table 13 provides a breakdown of their responses to five statements related to the FAM. It appears as though the efforts over the past few years to introduce the FAM to the PM community has been successful, as most PMs surveyed were at least familiar with the FAM and the broader goal of capturing the benefits of the research conducted. Moreover, of the nine respondents that were familiar with the FAM before the workshop, seven of these indicated some attempt to apply the model to one of their projects.
The PMs were unanimous in suggesting that the workshop was helpful in explaining the FAM and the pieces required for implementing the FAM in their research activities.

Table 13. Familiarity with FAM.

Statement	TRUE N (%)	FALSE N (%)	Not Sure N (%)
Prior to the workshop, I did not know about the FAM	2 (18%)	9 (82%)	0
Prior to the workshop, I was aware of the FAM, but had not tried to apply it to my projects.	2 (18%)	8 (73%)	1 (9%)

Prior to the workshop, I was aware of the increasing emphasis on stating the benefits of research at all stages of my research projects (e.g., kick-off).	5 (46%)	4 (36%)	2 (18%)
I learned more about the FAM by participating in the workshop.	11 (100%)	0	0
The workshop provided a good overview of the necessary pieces for implementing the FAM.	11 (100%)	0	0

Next, the PMs were asked to indicate their level of comfort with applying the FAM to their research projects, generally, before and after the workshop. Figures 4 and 5 show the responses to these questions, which asked for a comfort level between 0 (none at all) to 100 (very comfortable). Note that only six PMs responded to the first question, while we obtained a response from all 11 PMs for the second. All six respondents to the first question reported an increase in their comfort level with the FAM following the workshop and all of the PMs that responded to the second question indicate at least some comfort with the FAM, with responses ranging from 15 to 90.

Figure 4: Comfort Level with FAM Before the Workshop (N=6)

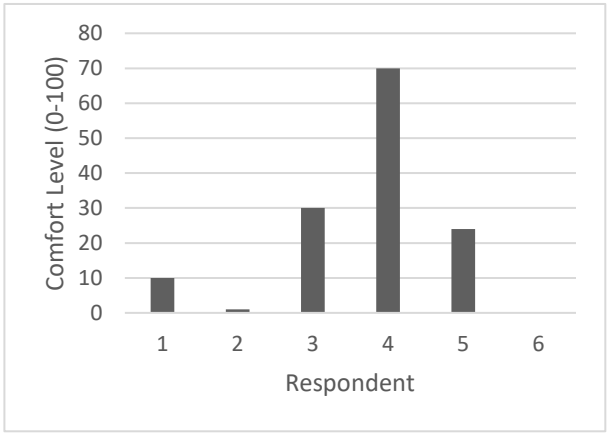
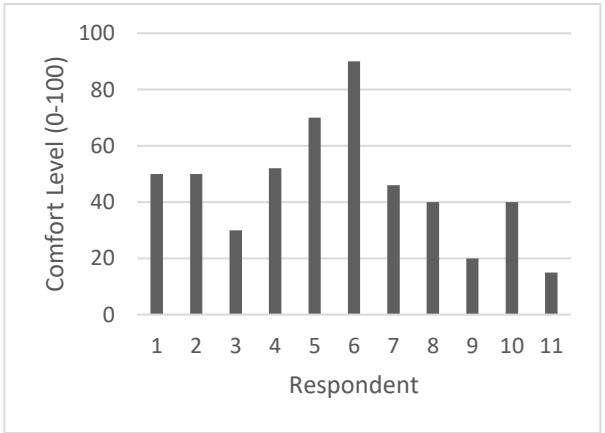


Figure 5: Comfort Level with FAM After the Workshop (N=11)



When asked about whether any activities were undertaken after the workshop, most respondents reported that they had not given the FAM any further thought (64%) and the remaining 36% reported that they had considered how to apply the FAM to their project but had not done any data

collection or calculations. When asked to explain why no actions were taken, the responses varied. One PM noted that the measurable impact of his/her project would not be known until the end of the project. This was a disappointing finding, as the Research Team had emphasized repeatedly that the FAM can be implemented with estimated values. Moreover, we emphasized that research should probably not be funded if there is not at least some suggestion of a benefit, and that benefit can be estimated with the right data. Another PM noted that they are too busy with other projects to spend time on applying the FAM.

For the PMs that have given the FAM more consideration after the workshop, we received three comments that reflect varying degrees of effort, i.e.:

- I have not performed any calculations or spoken with the PI specifically about the FAM. The project is also still in the early phases and data is not yet available.
- I find difficultly estimating relevant benefits for this project. I need a methodology or model that may equate more accurate safety analyses (i.e., a result of the research project) to cost savings. I am entertaining an approach that quantifies the difference in expected injuries when comparing our current practice with our proposed practice. Then I may quantify expected benefits.
- My project was almost complete at the time of the workshop. It is wrapping up. I didn't plan to apply the FAM on this project but will do so on future research projects.

In a previous survey (see Chapter 2), we asked the PMs to indicate the relative share of responsibility for PMs, PIs, and the Research Center staff for applying the FAM. We noted that, on average, respondents suggested an equal level of responsibility, but there was a good degree of variability, with some PMs indicating a willingness to do more than half of the work. In the post-workshop survey, we asked the same question. While there was also a good degree of variability, more than half of the responses indicated a preference for pushing a larger share of the requirement to PIs. Reasons provided included the following:

- “Ideally, the PI will understand the importance of determining financial benefits and include this step in the research plan.”
- “I will be adding this cost to the project because if I do not, I may not have the time to pull it off effectively.”

- “I’m concerned that overloading project managers will discourage them from asking for research.”

Notably, the final point was also raised by the PMs involved in Case Studies 3 and 4.

CHAPTER 6 – CONCLUSIONS AND RECOMMENDATIONS

The primary benefit of conducting the focused FAM workshops with PMs was gauging the developing culture of capturing the benefits of research. Each interaction between the Research Team and PMs has yielded important information to inform the operationalization within FDOT of the FAM modeling process. Most PMs are ready and willing to participate in evaluating their research projects with the FAM; they are attuned to thinking about the benefits of research and are becoming more aware of the data and resources needed for applying the FAM. The Research Team believes, however, that the time needed to develop the FAM for each individual project may be too overwhelming for PMs, especially for those that are managing more than one project. The PMs seem to grasp the basic methodology, but throughout this project, they have raised important challenges. For one example, PMs recognize the need for specific data elements but noted that the data is currently aggregated into a larger cost figure. The time needed to parse out specific data elements is significant. The Research Team members, with little to no experience in any particular areas of FDOT research, noted a steep learning curve with each project discussed during the workshop. We concluded that additional workshops focusing on training the PMs would probably not be effective, as there is only so much information that is useful, in a general sense, to a group of PMs versus the unique information each PM requires to apply the FAM to his/her unique project.

Conversations with the PMs, further confirmed by the survey results, suggest that the most efficient approach to operationalizing the FAM should involve the greatest degree of participation from PIs. Since a FAM model for one project is particular to that one project, and, consequently, a PI is retained to focus on that one project, the PI could be incentivized, or preferably required, to produce FAM estimates as part of the funded research project. The PI faces fewer distractions than a PM who may be dealing with multiple projects and regular duties. We would also note that we

consider the Research Center is similarly a less efficient resource for estimating the FAM because of the large number of unique projects that are constantly being evaluated.

We recommend that the Research Center consider requiring the FAM application as a deliverable on every funded research project. Early in a project, the PI could be asked to provide a preliminary FAM modeling plan that would identify necessary data and would address how various sources of uncertainty would be resolved during the research period. Within reason, a PI would be allowed to request an exemption, e.g., with an explanation as to why the project would not be amenable to FAM application. The Research Center staff would subsequently decide whether to allow the exemption. Scope development would need to involve a discussion with the PM and/or Research Center staff to determine any internal (FDOT) sources of data that might be needed by the PI to meet the requirement. Further, the final deliverable should then include a discussion of how the preliminary FAM estimates are affected by the research. For example, did the research suggest a greater cost savings than what was previously indicated? Is the potential use of the research result more broad than previously estimated? Etc.

In order to push the FAM modeling requirement to the PIs, it will be important to develop clear guidelines to assist the PMs in communicating this new requirement to PIs. We propose adding these guidelines to the FDOT Research Manual, section 4.1, in the discussion of developing the Scope of Service, and potentially adding a new section to Chapter 4 entitled "Plan for Implementing the Financial Achievability Model." This new section would provide an overview of the FAM, which can be excerpted from a previous project, BDK83 977-24, and instructions for communicating the model to potential PIs in the RFP process. The Research Center would ideally be engaged in this conversation with prospective PIs to offer insights regarding the appropriate personnel – e.g., economists – that might be engaged to ensure the FAM can be applied appropriately to the research project. Notably, the Research Team suggests that as more and more projects include some degree of the FAM implementation, scope of service documents and final reports can serve as case studies for future projects.

While we believe this is the path forward that will be most efficient in operationalizing the FAM, we recognize that PIs will request additional funds to cover the cost of this task. We believe the

increase in efficiency of having PIs focus on the FAM activities will outweigh this cost, freeing up the PMs to focus on new research ideas and opportunities for implementing valuable research results.

Appendix A. Survey of PMs on FAM Concepts

FINANCIAL ACHIEVABILITY MODEL: Assessment

The Research Center has been making major steps to operationalize the FAM in the research process. This survey was designed for two main reasons (1) to determine where additional training is needed by the PMs, and (2) to assess the extent to which data are available (internally or externally) to fully operationalize the model. Please complete all of the following questions to help us in this assessment.

Page Break

Q1 Please enter your First Name:

_____

Q2 Please enter your Last Name:

_____

Q3 Please select your office from the following list:

- ○ Construction (1)
- ○ Forecasting and Trends (2)
- ○ Freight and Multimodal (14)
- ○ Geotechnical (3)
- ○ Maintenance (4)
- ○ Modal Development (5)
- ○ Planning (6)
- ○ Public Transportation (7)
- ○ Research Center (15)
- ○ Roadway Design (8)
- ○ Safety (9)
- ○ State Materials (16)
- ○ Structures (10)
- ○ Systems Implementation (11)
- ○ Traffic Operations (12)
- ○ Transportation Data and Analytics (17)
- ○ Turnpike (18)
- ○ Other (specify): (13) _____

Page Break

Q4 About how many research projects have you managed in the past five years?

- ○ One (1)
- ○ Two (2)
- ○ Three (3)
- ○ Four or more (4)
- ○ I have not yet managed any research projects. (0)

Q5 How many research projects are you currently managing?

- ○ One (1)
- ○ Two (2)
- ○ Three (3)
- ○ Four or more (4)
- ○ I am not currently managing any research projects. (0)

Q6 Which of the following best describes your familiarity with the Financial Achievability Model (FAM) that has been implemented by the FDOT Research Center?

- ○ I have never heard of the FAM. (1)
- ○ I have heard of the FAM, but am not familiar with the model. (2)
- ○ I have heard of the FAM, and know that it is an attempt to capture the net (quantitative) benefits of research projects, but I have not had an opportunity to apply it to my project(s). (3)
- ○ I have heard of the FAM, and have attempted to apply the model to one or more of my research projects. (4)

Display This Question:

If Which of the following best describes your familiarity with the Financial Achievability Model (FA... != I have never heard of the FAM.

Q7 Have you watched any FAM training videos or participated in any FAM-related workshops in the past?

- ○ Yes (1)
- ○ No (0)

Q8 The FAM was designed to facilitate the capture of the net benefits of research that is funded by the Research Center. It considers all the costs associated with a research project and compares them to the expected benefits of implementing the research.

Operationalizing the FAM requires some knowledge of statistical and financial concepts. Please indicate your comfort level with each of the following types of calculations, where 100 indicates completely comfortable with this type of calculation.

	0 10 20 30 40 50 60 70 80 90 100
Calculating interest, when given an amount of principale and an interest rate. For example, you borrowed $100 for one year at a 6% annual interest rate - what do you owe at the end of the year? (ans. $106) ()	
Calculating an expected value, when given probabilities of possible outcomes. For example, there is a 10% chance of winning $50 and a 90% chance of winning $0 - what is the expected value of your winnings? (ans. $5) ()	
Calculating the present value of a future amount. For example, if I need $50K in four years, how much do I need to put away today, assuming a 5% discount rate? (ans. $39,605) ()	

Q9 The FAM can be applied to most FDOT research projects and can be operationalized through the creation of an Excel spreadsheet that summarizes and compares all relevant costs and benefits of a research project.

Which of the following describes your experience using Microsoft Excel and the Excel Data Analysis tools?

- ○ I have never used Excel and have never worked with spreadsheets. (1)
- ○ I have never used Excel, but I have some experience with spreadsheets. (2)
- ○ I have experience with Excel, but have not used Excel formulas or Data Analysis tools. (3)
- ○ I have experience with Excel and have used Excel formulas and/or Data Analysis tools. (4)

Q10 One of the challenges to operationalizing the FAM is obtaining the appropriate data for the model. The next set of questions will help us to assess the availability of data that is needed to apply the FAM to your past, current, or future project(s).

Q11 First, we would like to know about any data collected and stored in your Office that is relevant to projects that you have managed or are currently managing. Feel free to list any data that you are aware of and, where possible, provide specific details. For example, "Miles of roads surveyed, by week, by county, 2010-current."

_____

_____

_____

_____

_____

Q12 Costs associated with research projects include the cost of the funded research project, the time spent by the PM and FDOT staff in managing the project, and the costs of implementing the research results, if appropriate.

Thinking about your past, current and/or future projects, what additional types of data do you think would be useful for evaluating the **costs** associated with these projects? Please consider the current costs, if any, and the expected costs if the research is implemented. Provide specific details and note possible sources for the data (e.g., internally at FDOT, from the Principal Investigator, some other source), if any.

_____

_____

_____

_____

_____

Q13 For many projects, the expected "benefits" of the research is a lower "cost" going forward, e.g., as a result of a change in a process or material.

Thinking about your past, current and/or future projects, what additional types of data do you think would be useful for evaluating the **benefits** associated with these projects? Provide specific details and note possible sources for the data (e.g., internally at FDOT, from the Principal Investigator, some other source), if any.

_____

_____

_____

_____

_____

Q14 We plan to produce a catalog of all of the data sources obtained through this survey, so that it will be useful for applying the FAM to future projects. Please list here any other sources of data (internal or external) that you think may be useful for FAM implementation in your Office or any other functional area.

_____

_____

_____

_____

_____

Q15 Fully operationalizing the FAM will require collaboration among PMs, PIs, and the Research Center. Thinking about past, current, or future projects, indicate the proportion of involvement you believe is necessary from these three parties in order to fully operationalize the FAM:

Project Manager : _____ (1)
Principal Investigator : _____ (2)
Research Center staff : _____ (3)
Total : _____

Thank you for your input!

End of Block: Default Question Block

Appendix B. FDOT Data Governance Initiative

Case Study

U.S. Department of Transportation
Federal Highway Administration

BACKGROUND

Arguably, the most valuable part of building information modeling (BIM) for infrastructure is the information delivered in each three-dimensional (3D) model. The information carried by each element informs every part of design, construction, and asset management. However, the data are only useful if structured in a way to be handled predictably by the agency programs that use and interface with the data. For any state agency to get the full value of the BIM for infrastructure process, a complete understanding of the data and the data schemas are essential.

FDOT DATA GOVERNANCE INITIATIVE

MANAGING VITAL DATA ASSETS

The process of organizing internal data is called data governance (see Figure 1). This case study is a review of how the Florida Department of Transportation (FDOT) decided to create and implement a data governance program and the benefits that have been realized from that program to date.

Adobe Stock

Figure 1. Data governance concept

THE PROBLEM

In the fall of 2014, FDOT began to develop an enterprise-wide information technology strategy. Its review identified five problems that should be addressed:

1. **It was difficult to know which data were available**—Information was organized around applications instead of being organized around end-user perspectives.
2. **Data were difficult to access**—Security controls were scattered across many different tools and processes throughout 170-plus centralized and local systems.
3. **Lack of standardized approach**—Many FDOT districts were moving toward the adoption of the geographical information system (GIS) as the entry point for information searches; however, the approach had not been standardized across the districts.
4. **No enterprise-level view of data**—A majority of the district data efforts appeared to focus on singular business issues without the added benefit of looking at the data from an overall business view to improve performance or reduce risk.
5. **Teams wanted a "one-stop shop"**—Teams consistently stated they would like a one-stop shop to access all of the information that they needed in one place with a robust search capacity.

THE SOLUTION

As a response to the problems discovered, FDOT created an initiative to improve data reliability, simplify data sharing, and make accurate data readily available for the purpose of making informed decisions. This initiative was called Reliable, Organized, Accurate Data Sharing, or ROADS.

The first step for ROADS was to evaluate FDOT's needs. This was achieved through employee surveys and district interviews. The employee survey included 70 questions and took about an hour to complete. FDOT received more than 230 responses. The employee interviews were two hours long. Staff were able to conduct 24 interviews in the central office and the 7 districts, with a total of more than 270 participants.

The results from the assessment showed 63 distinct information gaps. These gaps were organized into 12 key enterprise information management areas.

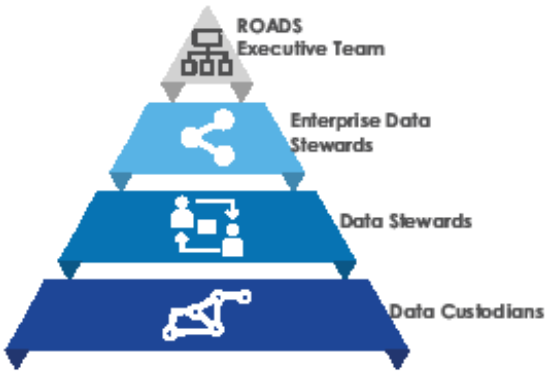
To address the gaps, the FDOT team documented the solutions that needed to be implemented:

- Implement new system architecture
- Move and synchronize data
- Implement solution management
- Address bandwidth issues
- Enable data consistency and accountability
- Implement change management
- Establish data awareness
- Institute enhanced reporting capabilities
- Implement organizational alignment
- Streamline data security
- Implement data governance

With its issues identified, as well as solutions, FDOT created an executive team and a data governance structure to implement the plan (Figure 2). The executive team consisted of technical and business members from the central office, turnpike, and district offices. The data governance structure broke the team into four distinct groups with different responsibilities.

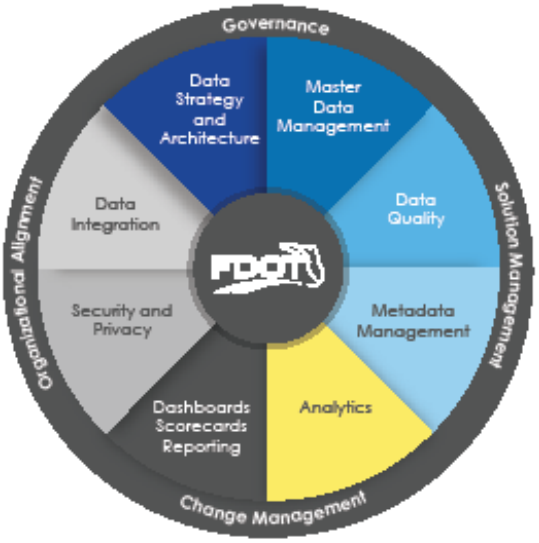
ROADS Executive Team

The executive team provides leadership from across the district, turnpike, and central office to support the ROADS initiative. The ROADS executive team members are responsible for overall data governance and provide decision-making, oversight, and strategic direction to the organization. High-level responsibilities include the following:



FDOT, used with permission

Figure 2. FDOT data governance structure



FDOT, used with permission

Figure 3. FDOT ROADS component model

- Approve actions, resolve issues, and provide advice/feedback to the enterprise data stewards (EDS) and data stewards/data custodians (DS/DC)
- Adopt the ROADS Component Model (Figure 3) and ensure data governance compliance
- Establish overall data governance rules, processes, and procedures

- Drive cultural changes needed to communicate data as an asset and manage this asset effectively across business functional area boundaries
- Balance business priorities with operational needs across the enterprise
- Review and evaluate current data governance performance and effectiveness
- Encourage active participation from both the business and information technology (IT) areas

Enterprise Data Stewards

The enterprise data stewards are business-focused individuals from across the district, turnpike, and central office supporting the ROADS initiative. The enterprise data stewards are responsible for managing their functional area working groups. They report directly to the ROADS executive team. High-level responsibilities for this group include the following:

- Lead the data stewards working group for their functional area/office
- Ensure data governance compliance
- Advocate for future data initiatives for the department
- Operate in alignment with functional managers
- Adopt the ROADS Component Model
- Work with data stewards and data custodians regularly to provide leadership and guidance
- Act as a liaison between the ROADS executive team and the data stewards and data custodians

Data Stewards

The data stewards are business functional experts supporting the ROADS initiative and ideally the functional application coordinators or other delegates within the business functional areas that are responsible for the business aspects of data management and governance, including data element definition, control, and accountability for their data sources, such as applications or purchased/collected data. Individuals that are selected as data stewards are typically already doing many of the activities of a data steward, just in an informal manner.

A data steward works with business personnel to define data needs for their particular functional area. High-level responsibilities for these stewards include the following:

- Understand strategic priorities of the business (enterprise, central office, district, and/or turnpike) related to their functional area along with the processes and data that support the business
- Participate in defining rules, processes, and quality metrics
- Act as a strong communicator and champion of data quality within their functional area
- Help in gathering requirements for tools used in the transformation of data into meaningful and useful information for business analysis purposes, including reporting

Data Custodians

Data custodians are technical functional experts supporting the ROADS initiative, ideally from a business office. They are responsible for supporting and implementing data governance and best practices for data elements within their data sources, such as applications or purchased/collected data.

Data custodians may work with other technical resources within the business functional area, or Office of Information Technology (OIT) resources may be relied on to support their responsibilities. Individuals that are selected as data custodians are typically already doing some or many of the activities of a data custodian, but in an informal manner. High-level responsibilities of data custodians include the following:

- Respond to research and information requests of the data stewards
- Escalate any items that have an impact on data quality requirements for reporting tools
- Implement data transformations, resolve data issues, and collaborate on system changes
- Maintain the quality of the data that they manage

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DISTRIBUTION AND AVAILABILITY
This case study can be found at https://www.fhwa.dot.gov/construction/technologies.cfm.

KEY WORDS
BIM case study, building information modeling, enterprise-wide information technology, FDOT ROADS, Florida DOT data sharing

U.S. Department of Transportation
Federal Highway Administration

RESULTS

Since 2014, FDOT's ROADS initiative has come a long way. The following timeline highlights some of the more important milestones:

- **March 2015**—ROADS initiative begins
- **Spring 2015**—Employee survey and interview results determined
- **Summer/Fall 2015**—Establishment of data governance structure
- **Fall/Winter 2015**—Determination of tool requirements completed
- **Spring/Summer 2016**—Invitation to Negotiate (ITN) completed with more than 45 vendors responding
- **Summer 2016**—Applications and Reporting Inventory assessments
- **Summer/Fall 2016**—Charters created to define responsibilities and the path forward
- **Fall 2016**—ROADS Town Hall and Knowledge Sharing sessions occurred to educate stakeholders
- **Fall 2016**—Three shortlisted vendors performed test cases and oral presentations for ITN
- **Winter 2017**—ROADS initiative aligned under the Civil Integrated Management Office
- **Spring 2017**—SAS announced as intended award vendor for business intelligence/data warehouse ITN
- **Summer/Fall 2017**—SAS contract executed and pilot of data governance project kicks off with the Safety Office
- **Fall/Winter of 2017**—Knowledge sharing sessions begin on select data sets
- **Present Day to Summer 2021**—Data governance continues to roll out to other parts of FDOT with continued knowledge-sharing sessions

To date, the data warehouse includes safety data, asset (roadway characteristics) inventory, Highway Performance Monitoring System (HPMS) reporting, and pavement condition data.

LESSONS LEARNED

Through this process, FDOT learned more than just a new way to organize its information. Participants in the process also learned more about the value of data along the way and, in particular, the idea that the true value of data is not realized until it becomes meaning information. The distinction between data and information is that data are like a book on a shelf: a book does not provide you with any value until you read it. The implementation of ROADS is helping FDOT move from a culture that collects data to a culture that makes data-informed decisions.

Appendix C. FDOT Injury Statistics

Appendix B

INJURY by District FY 2013-2014

CROSS TAB REPORT - INJURY BY CAUSE - FROM 07/01/2013 TO 06/30/2014 -

Cause	01	02	03	04	05	06	07	08	12	15	Total
exposure to/contact with/or struck by...	1	-	2	-	-	-	-	9	-	-	12
...airborne particle/substance/foreign body	-	1	-	2	-	1	-	1	-	-	5
...animal/insect	2	1	3	1	-	-	1	7	-	-	15
...environmental condition	-	11	1	-	-	1	-	1	-	-	14
...falling object	-	1	2	1	3	-	-	5	3	-	15
...harmful plant	-	-	-	-	-	-	1	-	-	-	1
...moving equipment/parts	1	1	3	1	2	-	1	-	-	-	9
...noise	-	-	-	-	-	-	-	2	-	-	2
...person	-	-	-	-	-	-	-	3	-	-	3
...pinch point	-	-	-	-	-	1	-	1	-	-	2
...temperature/pressure extreme/fire	-	-	-	-	-	-	-	1	-	-	1
...toxic substance	-	-	-	-	4	-	-	1	-	-	5
body movement/mechanics/repetitive motion (non-material handling)	5	2	3	4	2	3	2	8	-	-	29
equipment use (any type, office or field)	-	4	-	1	1	-	2	2	-	-	10
material handling (lifting, pushing, pulling, etc)	5	3	3	3	5	1	4	3	-	-	27
motor vehicle crash	4	2	4	3	3	-	1	2	-	-	19
slips/trips/falls	3	5	9	5	3	1	5	26	-	1	58

Appendix D. Notes from Interviews, State Materials Office

(1) Abdenour Nazef:

Through my conversation with Mr. Nazef, he was successfully able to provide the final report documentation for his completed project, "Experimental Evaluation of a Pavement Imaging System – Florida Department of Transportation's Multipurpose Survey Vehicle". Mr. Nazef went to then on explain the abstract of his project which involved FDOT squiring a multifunctional survey vehicle that collected highway pavement related data to determine the quality of the pavement from wear and tear. He carefully explained the objective of the project is to test the precision and accuracy of the pavement imaging system. After our meeting he checked in the status of the automated crack analysis under Laser Crack Measurement System (LCMS) in which they have 3 vehicles currently under operation. He then stated in his email:

> *"Staff is still processing the images to extract crack data from the images using different alternative algorithms. Once the data extraction is completed, they plan on doing some comparison between the results from the traditional windshield visual survey and the results output by the alternative algorithms. This is a lengthy process and still a work in progress. It will be some time before we have anything to share."*

Overall Mr. Nazef was very willing to help, contribute, and answer questions regarding the FAM while also realizing its use.

(2) Greg Sholar:

My conversation with Mr. Sholar resulted in him providing me the final report for his project BE719, "Development of A Laboratory Testing Protocol to Evaluate Alternative Materials for use in Modifying Asphalt Binders and Alternative Materials for use in Modifying Asphalt Mixtures." Mr. Sholar carefully explained that any new alternative material used in asphalt must be approved by his section within the state materials office in Gainesville, FL. The project consisted of developing various testing protocols in labs to evaluate different type of materials not normally used in asphalt mixtures. A supplier will meet with the Greg's section to propose different materials they claim can be added into their asphalt mixture (i.e., pig manure or crushed glass). The reason behind changing materials is either if the new component provides equal or better performance at a lesser or same cost. The driving factor behind measuring performance of asphalt mixtures is friction resistance.

The final report mentions two databases:

1) Traffic Accident Database
2) Friction Resistance Database

Overall Mr. Sholar was very willing to help, contribute, and answer questions regarding the FAM while also realizing its use.

(3) John Shoucair:

Through my conversation with Mr. Shoucair, he was able to provide me the final report for his project BEB28, “Development of a Test to Quantify Organic Content in Silica Sand”. He diligently explained that his section handle rock and sand quarries where they derive materials that makeup all the building blocks for another asphalt and concrete utilized by FDOT. He explained in the case of this project case we have quite a few sand sources that are contaminated with leftover formation of muck or peat. This is because in Mr. Shoucair’s words, “we have no control over what mother nature has put there, it is all happening underwater.” The objective of the project is to test (hopefully $60 range) that can quantify the negative affects organic content on FDOT materials (concrete, pavement) underwater. He was successfully able to provide me an excel file that points towards MAC ID’s for the companies that contracted that tests to be executed by FDOT, the mine/quarry number, and the date of execution.

Additionally, he was able to provide the final report for project BDV-31-977-28, “Application of Imaging Techniques to Evaluate Polishing Characteristics of Aggregates”. The objective of this project monitors how polishing affects aggregates made up of our Florida roadways through aims device on roadway over time to see how aggregates maintain their skid resistance. Unfortunately, the project ran into issues when FDOT realized the device purchased from Texas was only designed to monitor gray colored aggregates (not colored)! However, he was still able to email the final report which provides tabulated outputs from the aims device which could prove to be of some use.

Overall Mr. Shoucair was very willing to help, contribute, and answer questions regarding the FAM while also realizing its use.

(4) Howard Mosely:

Through my conversation with Mr. Mosely, he was able to point me in the direction of the final report of his Project BE55, “Study of Anti-Strip Additives on Granite Based FC-5 Asphalt Mixtures”. Mr. Mosely went in great length in trying to explain that whilst there might not be hard data on why they have chosen to implement this new Granite Based FC-5 asphalt mixture they know for certain that it will improve the performance life of the mixture as whole. However, the question then comes to be how long? He explained this is obviously because even after the new material has been implemented, they must observe its performance for years in order to reach a definite answer. The final report he provided does include the date of change, which is when the new mixture will be implemented, along with the life change benefits from the mixture versus the previous mixture, and also includes a cost benefit analysis section that could provide some use.
Overall Mr. Mosely was very willing to help, contribute, and answer questions regarding the FAM while also realizing its use.

(5) Ronald Simmons:

Through my conversation with Mr. Simmons, I was able to retrieve the final report for project BDV-29-977-44, “Accelerated Testing of Grouts for PT Steel Strand”. The project in

Mr. Simmons words, “looks at basically what it says” which involves completing what he referred to as fast visual tests to see what will happens with tendons on grouts. From my understanding a grout is a kind of steel beam used on bridges and serves as integral part of its infrastructure. He lastly explained that corrosion takes a long time to occur and there may not be as much hard data out there for this project to his liking, but he is trying to develop a more concrete test that could run anywhere between a week to 6 months.

There was another project he mentioned called, “Effects of Service of Aluminized Steel Corrugated Pipe with Visible and Not Visible Coating Deficiencies within the Lock System.” However, as Mr. Simmons stated the project expired before it was finished, and an extension is still pending. It does however seem promising to our research as Mr. Simmons alluded to a dataset containing a sample size of corrosion readings compared to some benchmark, but an official report does not exist anywhere.

Overall Mr. Simmons was very willing to help, contribute, and answer questions regarding the FAM however did not relay much of any tangible data sources.

(6) Timothy McCullough:

Very unwilling to help. “Believes he is not working on or has worked on anything that would be of use to our research”. Did not remember/recall most recent PM survey (his responses were minimal to none). I pressed him very hard but respectfully to try and speak about projects he may be of excited about or anything that could be of use but unfortunately to no avail. He was very respectful though but did seem like he wanted to get off the meeting as soon as possible.

Overall, this was one of the lesser productive conversations I had during task 1 and I hope our workshop might have changed his mind on usefulness of the FAM.

(7) Guangming Wang:

Very unwilling to help. Had minimal to no knowledge on the FAM and protested that the “FAM cannot be feasibly applied to any of his current or precious projects!” This was very surprising me to considering he described his current project details as overseeing the centralization database pertaining to 25,000 miles of highway operated and maintained under all FDOT’s districts. In Mr. Wang’s words, “a lot of data is collected by third party vendors and is then centralized into a primary FDOT database with my help as the PM for thus project. When I asked if he could provide further details on the project, he protested that there would be no point as it would provide no use to our research efforts.

Overall, Mr. Wang was extremely unwilling to help throughout the entirety of our conversation. He seemed to look for any opportunity to leave the meeting and was hesitant in discussing any project specific information.

(8) Harvey Deford

Through my conversation with Mr. Deford, I was unable to derive little to any data sources pertaining to any of his specific projects. However, He did claim that for each project his section initiates they discuss a series of items that includes:

1) Costs
2) Benefits
3) Level of Implementation

These items are researched and documented via a request for research funding which he gave an example that could be submitted to the FSU Research Center as a third-party job. In his words he explicitly said, “the request for research funding is the best we can do”. He then went on to explain that whilst we may know our project will provide some sort of benefit, we are unable to quantify it. Mr. Deford did allude to one of his projects that involved adding supplemental material to cement to create the optimal “synergy” of materials.

Overall Mr. Deford whilst attentive and willing to answer any question, did not see the use of the FAM as it pertains to his projects. This led to our conversation regarding data sources to be very stale and highlighted the problem of how some project managers are scared and unwilling to make assumptions for tangible cost benefit analysis outputs.

Appendix E. Notes from Interviews, Structures Office

(1) Joey Gordon

Mr. Gordon has a couple of projects that he has put through the Research Center. Data Sources – traffic data collection, quality control, 350 permanent data; Survey responses – TDA collects data 24/7, 365; 13 classes, motorcycle, car, truck, etc. Solar power – Verizon, permanent count sites, always educating firmware, hardware, software; TDA work with Traffic Engineering and Research Lab on Springhill rd. (TERL); There is a test site on Capital Circle SE; Always looking for congestion factors; Short term counts – 18,0000 (districts manage with third-party vendors); TDA collects speed data, Weigh in motion (WIM); Oracle table will migrate/sequel servers; Motorcycle-Vehicle miles traveled (VMT)-come up with a way. Interrelated – Roadway Characteristics Inventory Database (RCI) - Mainframe, Admin; GIS – ties all the traffic and roadway data for roadway mapping. Traffic Characteristics Inventory (TCI) – separate database/kept in sync; has a lot less features in TCI; TDA – Always looking for efficiencies with time savings and cost savings. Could use improvement with qualitative and quantitative benefits.

(2) Will Potter

Mr. Potter has several DOT projects. Data Sources -primary; Specification/Estimates office; Items specific; Cost savings is typically 75 years down the road; (Bridges), corrosion, maintenance; Benefit – not as spending money to maintenance is savings; Could look at staff hours on projects; laboratory hours; Time spent with Concrete.

He noted that just because research findings are not implemented, it does not mean the project is a failure; Cost Estimates/processing the data will not be easy – past and present; simplified equations – design time; Bridge expertise to understand the data (Bridge inspections reports, plans); University will need to fill out form for access to some of the data, but info is redacted and protected. There are tangible items – look for these (Installation perspective); Maintenance office ties into all of this.

(3) David Horhota

Mr. Horhota has had many projects with DOT. I would consider him an expert/SME and Veteran with DOT projects; spoke directly about ways the FAM could help in his area; Cost for spread footing and the use of VIP around the districts; Could look at cost items/pay items, spread footing, test costs? Could compare cost of new tests versus cone penetration tests? Some Assumptions – Standards test; develop a new test method – no data to compare; No system in which data goes in; It's tough to quantify. Time savings – Geotech uses this/a lot of testing is done to increase the knowledge of variability of the site; Adds to the confidence and quality of the process.

(4) Group of PMs in Public Transit

The members in this group have had several projects. We spoke directly about BDV29-977-66 (MEP) and BDV31-977-127 (East Gainesville Micro transit); Data sources – ACS, GTFS, RTS, External COG; public available for possible contact to the PI – FITS; Internal – Traffic counts; safety issues; TDA website and ADT; Signal 4 Analytics, CARS, Mapping road system, Ridership information, Financial data, service characteristics, operational costs, share files, data exchange, Beber – Bureau of Economic and Business Research; DEO – office of Stats.

(5) Rickey Fitzgerald

Mr. Fitzgerald has had several projects; spoke directly about the data sources and data collected in Freight; Work with TDA; Have to be careful with rail and freight (protected); American Research Institute; Sunshine law with the data; IP address for truck parking; They use RCI and TCI; Consultant works with them every 3 years; (crossings, signals, gates, trucks, some traffic and railway). How many trains per day, per month? TTMS-inground counters/traffic counts; put into map source; Rail – weigh bill 1%; controlled by survey transportation board; competitive (proprietary) AAR (tentative data); DEO – workforce validity data; parcel data from Department of Revenue; Interviewing with other stakeholders.

Appendix F. Notes from Interviews, Traffic Operations

(1) Jeremy Dilmore

Mr. Dilmore talked about sources of data in which helped him throughout his projects. He stated data within traffic ops, signal 4 data, ITS network (crash, travel time), truck routing, speed-volume occupancy, ATSPM measures, and camera feeds are all beneficial during his projects. Some problems with his projects he said have been measurement error and safety data not being accurate.

(2) Edith Wong/ Dana Knox- 10/26/2021 11:00am - 11:45am

During our call, I was able to hear about some of their projects, they explained that a lot of their data (specifically crash data) comes from the safety office (Benjamin Jacobs (AARF request to get access)). They describe that they had to take many field measurements. Field measurements boils down to planning your data collection. Certain factors to take into account are traffic, weather, timing, availability of people going out to the field despite challenges, awareness of data repositories. The outcome should be saved lives, time, and money.

(3) Raj Ponnaluri, Jim Stroz, Gail Holley, and Mark Plass

- Mark Plass has several projects. The most beneficial data sources to his projects are CARS, Signal 4 data, income data, land use, transit agency data, demographic data, data with the safety program, and road safety audits. The benefits stated are crash reduction, cost savings, and the actual research itself.
- Jim Stroz elaborated on his project dealing with research in the left turning phase. He measured data from 6 different intersections. The benefits he stated are reducing crashes and cost savings.
- Gail Holley has had several projects. Data that helped with her projects were human factors, crash data, licensing data, land use data, census data, and natural household survey data.
- Raj Ponnaluri has managed several projects. Data he dealt with is safety/mobility, connected vehicle data, proxy measures, and converting transportation metrics into benefits. He used the cost benefit ratio to find cost savings. Also, his projects helped with qualitative and societal benefits.

Appendix G. Sample Workshop Agenda

FAM WORKSHOP – NOVEMBER 15, 2021

AGENDA

8:30 – 8:45 AM	INTRODUCTIONS
8:45 – 9:00 AM	GENERAL DISCUSSION OF OBJECTIVES FOR WORKSHOP
	Overview of Financial Achievability Model
	Accounting for risks and uncertainty
9:00 – 9:30 AM	PREPARING A SITUATIONAL OVERVIEW (MOTIVATION)
	Background
	Baseline (no-build) performance measures
9:30 – 10:00 AM	ESTABLISHING FRAMEWORK AND PARAMETERS OF ANALYSIS
	Appropriate stakeholder group(s) for analysis perspective
	Appropriate time frame, "assumed life", payback period, discount rate
	Estimated scope of implementation
	Consider baseline vs. future assumptions
10:00 – 11:30 AM	IDENTIFYING AND MONETIZING COSTS AND BENEFITS
	Internal costs (e.g., PM time) and costs of research
	Data sources of current and expected costs related to project
	Measuring benefits, cost reductions, valuing other benefits
11:30 – 12:00 PM	DISCUSSION AND NEXT STEPS
	Data collection
	Estimated net benefits (NPV) of the research
	Sensitivity analysis
	Consultations and submitting worksheets (pborn@business.fsu.edu)

Appendix H. Workshop Slides

Tracking Financial Achievability Part I

A Webinar prepared for the
Florida Department of Transportation

Agenda

- Introduction to the Financial Achievability Model
- The FDOT Research Process

Introduction

Goals of tracking financial achievability

- General reasons for tracking financial achievability include:
  - Confirming the benefits of research activity
  - Justifying research operations
  - Funding decisions- improving efficiency in the allocation of resources
- Tracking financial achievability throughout a project allows for:
  - Monitoring changes in expected benefits of the research
  - Refocusing of research activity to include new potential stakeholders

Goals of tracking financial achievability

- The value of research activities is assumed to be positive
- The value of a research activity is usually discussed in qualitative terms and ignores important inputs
- The value of a research activity may be under - or overstated for many reasons, such as:
  - Assuming savings without a clear understanding of current costs
  - Missing/ignoring indirect effects
  - Bias as to the domain for implementation
  - Invalid, missing, or non-reliable data

Challenges to effectively track financial achievability

- There is no formal process, or the process is not understood
- A methodology for identifying and quantifying costs and benefits does not exist, or is not understood
- Data is difficult to obtain
- The established research culture is hard to change

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.,

$$Benefits - Costs = Net\ Benefits$$

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

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 Multipurpose 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

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

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 into a process for implementation tracking.

Appendix I. Workshop Template

PM Worksheet
FAM Workshop, Nov. 15, 2021

Project Manager:
_____

Title of research project that will be evaluated:
_____

SITUATIONAL OVERVIEW: *Describe the current situation with emphasis on performance measures. How will the project alter the baseline?*

ESTIMATED TIMELINE FOR MODELING

STEPS	DATE
Beginning: proposal drafted	

STAKEHOLDER GROUPS: *List anyone that may benefit from the research including internal and external stakeholders.*

SCOPE AND SCALE OF IMPLEMENTATION: *Describe how positive research results might be implemented and phased in (e.g., over what time period(s), geographical areas, etc.)*

COSTS AND BENEFITS: *How will these be measured?*

Costs (include fixed and variable, direct and indirect)	Data Source(s)
Benefits	Data Source(s)

Appendix J. Case study #1. Development of a Laboratory Testing Protocol to Evaluate Alternative Materials for use in Modifying Asphalt Binders and Alternative Materials For Use in Modifying Asphalt Mixtures

Project Manager Name: Greg Sholar
Department: State Materials
Project name: Development of a Laboratory Testing Protocol to Evaluate Alternative Materials for use in Modifying Asphalt Binders and Alternative Materials For Use in Modifying Asphalt Mixtures
Project Number: BE719

Project Objective

The objective of this project is to develop separate approval protocols for alternative asphalt binder additives and alternative asphalt mixture additives. In order to develop these protocols, four entities were subjugated to several rutting and cracking tests to develop the first set of protocols. These entities included a binder, a mix including granite, and two alternatively asphalt binders the team felt would produce favorable results. Control mixtures were also used to compare these prospective "entities" to determine some sort of benchmark. Test results showed that the FDOT-mandated Superpave performance tests of asphalt binders, the Hamburg wheel-track and Ideal cracking tests of asphalt mixtures were able to show whether alternatively modified binders and mixtures would perform equivalent to or better than the control binder or mixture. Results obtained by utilizing these protocols on one additional alternatively modified asphalt binder and two alternatively modified asphalt mixtures seconded these conclusions.

Contact

Our initial conversation with the PM took place on October 22, 2021 and lasted for a duration of about 1 hour. Following the interview, the PM provided the final report for his project BE719, "Development of A Laboratory Testing Protocol to Evaluate Alternative Materials for use in Modifying Asphalt Binders and Alternative Materials for use in Modifying Asphalt Mixtures." He carefully explained that any new alternative material used in asphalt must be approved by his section within the state materials office in Gainesville, FL. The project consisted of developing various testing protocols in labs to evaluate different type of materials not normally used in asphalt mixtures. A supplier will meet with the PM's section to propose different materials they claim can be added into their asphalt mixture (i.e., pig manure or crushed glass). The reason behind changing materials is either if the new component provides equal or better performance at a lesser or same cost. The driving factor behind measuring performance of asphalt mixtures is friction resistance. The final report mentions 2 databases – the traffic accident database & friction resistance database. Overall, the PM was very willing to help, contribute, and answer questions regarding the FAM while also realizing its usefulness.

Model Results

As per our final conversation with the PM, he stated that any new created binder is evaluated against rutting, cracking, and existing binders/materials used by FDOT. If the new binder under testing does not equal or outperform existing FDOT materials/binders it will be disregarded. Part of the study is attempting to get equal number of years relative to active binders or at least 2 additional years. The base measurement of years most FDOT binders remains active is about 17 years. Therefore, if FDOT's minimum hurdle rate of success is producing an 8.5% increase in the life of the new binder. Note that the research project was funded for $248,628 and the PI is at Texas A&M Transportation Institute.

The PM indicated that usually new materials tested against the existing materials do not usually produce less of cost, but rather and environmental or safety benefit. Cost per unit for the binder use to be $600 per ton, but keep in mind that the binder only makes up about 5.5% of the overall mixture. The bulk of the mixture includes aggregate, asphalt, and rock mixture usually costing around $100 per ton. The recent inflationary pressures observed in 2022 may have pushed the overall increase of the mixture up.

Appendix K. Case study #2: Development of a Test to Quantify Organic Content in Silica Sand

Project Manager Name: John Shoucair

Department: State Materials
Project name: Development of a Test to Quantify Organic Content in Silica Sand
Project Number: BEB28

Project Objective

The objective of the project is to select a chemistry test that adheres to section 902-2.2. This section outlines the requirements of organic impurities that must be adhered to on Florida roadways including the color, the appropriate tests, and strength ratio threshold. The new test should cost hopefully $60 which I am told should be a marginal improvement compared to the current tests costing around $100 plus. It should also not take a commercial laboratory more than 5 days to replicate. The objective of the project is to quantify the negative affects organic content on FDOT materials (concrete, pavement) underwater. Upon testing the researcher shall provide a basis for recommended Quality Control test frequencies to be performed at the silica mines. Collaboration across university departments is permitted with the PI responsible and currently the bulk of collaboration has stemmed from The University of Florida.

Contact

The Research Team initially spoke with the PM on October 25th, 2021, for a duration of 1 hour. Following the initial conversation with him, he provided the final report for his project BEB28, "Development of a Test to Quantify Organic Content in Silica Sand". He diligently explained that his section handles rock and sand quarries where they derive materials that makeup all the building blocks for another asphalt and concrete utilized by FDOT. He explained in the case of this project case we have quite a few sand sources that are contaminated with leftover formation of muck or peat. This is because in the PM's words, "we have no control over what mother nature has put there, it is all happening underwater." He was able to provide the Research Team with an Excel file that points towards MAC IDs for the companies that contracted "tests" to be executed by FDOT, the mine/quarry number, and the date of execution. Overall, the PM was very willing to help, contribute, and answer questions regarding the FAM while also realizing its use.

Model Results

Last year price is $800 →
Positive results → 100 parts per million →
The new developed Walkley-Black, Modified Walkley-Black, and loss on ignition tests have reported a cost of lower than $100. A more specific cost breakdown:
Walkley-Black Test: $52 - $62
Modified Walkley-Black Test: $52 - $62
Loss on Ignition Test: $10 - $65

The Research Team was told by the PM that initially before these tests were created the costs would easily range to $100 - $800 depending on what type of old test or laboratory was contracted to carry out the test.
The PM was happy to report that the most recent tests have showed very positive results and have been reported to take less than 5 days to report. The Wet combustion methods such as the Walkley-Black and modified version can be performed in approximately 1 hour. The Loss on Ignition Test can take anywhere between 40 – 48 hours.

The cost of this research project was $92,477 and the PI is at the University of Florida.

Appendix L. Case study #3: Double Composite Construction Method

Project Manager Name: Zach Behring
Department: Structures
Project name: Strength and Constructability of a Double Composite Steel Box Girder
Project Number: BE950

Project Objective

The overall objective of this research is to develop design guidelines and analysis procedures for double composite steel box girder bridges. This research will also identify and provide potential solutions for constructability challenges associated with double composite steel box girder bridges.

Contact

The PM attended the workshop conducted on February 18, 2022. He completed a worksheet for his project and indicated that the proposal for this multi-year project was first drafted in April 2020. A final draft for the project is due in June 2023.

The PM identified multiple stakeholders for the project outcomes including the Structures Design Office, Construction, and Maintenance. First, the Structures Design Office may need to consider implementing design duties into the FDOT structures manual(s), in particular where construction of long-span bridges is addressed. As the method is new, Construction will need to evaluate potential changes in labor associated with the new construction method. Finally, the PM indicated that Maintenance may require additional inspection efforts.

The Research Team spoke with the PM on May 24, 2022. He indicated that he had not made any progress toward implementing the FAM on this project, largely because he was waiting for more guidance. Overall, the PM is very willing to help implement the FAM. He identified the main types of data that are needed – e.g., the amount of steel used in past projects, additional cost of labor for construction and the additional cost of bridge inspection – and noted that some of this information would be available internally. However, in our conversation, he noted that the main complication is that project components (costs and amounts) are often lumped together. If the data from past projects could be disaggregated, it would be straightforward to implement the FAM.

Model Results

While the data was not collected, the Research Team believes that the necessary data is available. The model would need to consider three main costs: new material, additional labor, and additional maintenance/inspection costs. These, in addition to the cost of the research project ($549,998), and the PM's time spent on the project would be compared to the overall savings resulting from a reduction in steel.

Appendix M. Case study #4: Evaluation of Glass Fiber Reinforced Polymers (GFRP) Spirals in Corrosion Resistant Concrete Piles

Project Manager Name: Christina Freeman
Department: Structures
Project name: Evaluation of Glass Fiber Reinforced Polymers (GFRP) Spirals in Corrosion Resistant Concrete Piles
Project Number: BDV30-977-27

Project Objective

The objectives of this project are: (1) Develop impactor and test setup for pile driving simulation to extend the capabilities of Florida Department of Transportation (FDOT) Structure Research Center Pendulum. (2) Experimentally evaluate the response of CFRP, GRFP and steel ties under impact loading and bending. (3) Experimentally evaluate the confinement behavior at a pile cut-off location. (4) Develop analytical and numerical models to explain the observed behavior, to provide guidelines for piles that are not experimentally tested. (5) Design GFRP/CFRP hybrid ties that meet the loading requirements.

Contact

The PM attended the workshop conducted on February 18, 2022. She completed a worksheet for her project and indicated that the multi-year project began in Fall 2018. The project is due to be completed by December 2023.

The PM identified multiple stakeholders for the project outcomes including the precasters who construct the piles, FDOT Maintenance, GFRP suppliers, and the FDOT Structures and Design Office (SDO). She noted that FDOT SDO would need to revise standard plans and specifications if the GFRP spirals were found, through the research project, to be useful.

The Research Team spoke with the PM on May 24, 2022. She indicated that she had made some progress toward implementing the FAM on this project without any intervention by the Research Team. Specifically, following the workshop, she hired a student intern to help collect the cost data needed. The PM is very willing to help implement the FAM, especially as she is interested in highlighting the value of the work she is doing. She also indicated that evidence of valuable research would be important for obtaining funding going forward. She identified the main types of data that are needed – e.g., the cost of GFRP spirals (new), the cost of carbon fiber reinforced polymer spirals (old), the estimated cost of stainless steel spirals if sole-sourced, the maintenance costs for corroding piles, and the quantity of corrosion resistant piles used. In our conversation, she noted that this data is currently being collected for the model and some data (e.g., the quantity of piles used) should be available internally. If the data can be obtained, it would be straightforward to implement the FAM.

Model Results

While the data was not collected, the Research Team believes that the necessary data is available. The model would need to consider/compare the costs associated with the new vs. old polymer and the expected costs of maintenance. These values, in addition to the cost of the research project ($350,329) and the PM's time spent on the project would be compared to the overall savings resulting from the corrosion of prestressed concrete piles in aggressive saltwater environments.