Florida Department of Transportation

Data Governance to Data-Driven Safety Analysis

Florida's SAFE STRIDES 2 Zero

SAFETY DATA CASE STUDY

FHWA-SA-22-004

Federal Highway Administration Office of Safety

Roadway Safety Data Program

U.S. Department of Transportation
Federal Highway Administration

FDOT

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Acronyms

Acronym	Description
AADT	annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ARBM	All Roads Base Map
BCR	benefit-cost ratio
CARS	Crash Analysis and Reporting System
DDSA	data-driven safety analysis
DHSMV	Department of Highway Safety and Motor Vehicles
DOT	department of transportation
EB	empirical Bayes
EEC	excess expected crashes
ETL	extract, transform, and load
FHWA	Federal Highway Administration
FDOT	Florida Department of Transportation
GIS	geographic information systems
HPMS	Highway Performance Monitoring System
HSM	Highway Safety Manual
RCI	Roadway Characteristic Inventory
ROADS	Reliable, Organized, Accurate Data Sharing
ROI	return on investment
S2Z	STRIDES 2 Zero
SAFE	System Analysis and Forecast Evaluation
SHS	State Highway System
SPF	safety performance function
SQL	Structured Query Language
STRIDES	State Traffic Roadway and Intersection Data Evaluation System
TEOO	Traffic Engineering and Operations Office
TSMCA	Traffic Signal Maintenance and Compensation Agreement

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Executive Summary

Data governance makes data more accessible by implementing standards and assigning responsibilities to each role in the data collection, management, and analysis process. These responsibilities extend to executive leadership in addition to transportation professionals, data managers, and data stewards. This case study documents how the Florida Department of Transportation's (FDOT's) multi-year data governance effort has enabled the Agency to embark upon a robust program of safety data collection, integration, and analysis. The State Traffic Roadway and Intersection Data Evaluation System (STRIDES) 2 Zero (S2Z) program and the System Analysis and Forecast Evaluation (SAFE) subprogram represent a comprehensive safety management approach. The S2Z program aligns traffic safety and operations data applications to standardize FDOT's approach to data-driven safety analysis. The SAFE subprogram overhauls FDOT's network screening process to enable predictive methods. This programmatic enhancement supports project selection, improves program effectiveness, and helps reduce fatalities and serious injuries on Florida's roads.

Introduction

In 2019, the Federal Highway Administration (FHWA) completed the second U.S. Roadway Safety Data Capabilities Assessment (FHWA, 2019a). This nationwide survey documented the safety data processes, policies, and procedures of all 50 States plus Washington D.C. and Puerto Rico. This survey highlighted the state-of-the-practice with respect to all phases of safety data collection, management, integration, and analysis. It also revealed that State Departments of Transportation (DOTs) were eager to improve their capacity for data management and integration.

This case study presents how the Florida Department of Transportation's (FDOT's) Traffic Engineering and Operations Office (TEOO) used agency-wide data governance to support its roadway safety management process. FDOT's State Traffic Roadway and Intersection Data Evaluation System (STRIDES) 2 Zero (S2Z) program, including the System Analysis and Forecast Evaluation (SAFE) subprogram, represents a comprehensive safety management approach. FDOT's enterprise data capabilities support the S2Z program and data-driven safety analysis (DDSA) of the State's signalized intersections. Future enhancements to the S2Z program will apply DDSA to improve safety at unsignalized intersections and roadway segments.

Purpose and Need

FDOT began a review of its enterprise data strategy in 2014. This effort revealed several critical needs with respect to the Agency's approach to data, and FDOT organized the Reliable, Organized, Accurate Data Sharing (ROADS) initiative to address gaps in the Agency's strategy. The ROADS program formalized FDOT's data governance structure with the intent of making data more reliable, shareable, and integrated across business units and tools within FDOT. In 2019, FDOT's TEOO began the S2Z program to improve the DOT's network screening process using enterprise data. For TEOO, this means moving from a more reactive hot spot screening approach to using predictive safety models. With full implementation of S2Z by 2025, FDOT will be able to evaluate safety improvements and monitor program performance consistently across the Agency's seven districts.

Target Audience

The target audience for this case study is:

- Executive Leadership
- Data Governance Committees
- Information Technology Staff
- Data Managers, Analysts, and Stewards
- Traffic Safety Managers
- Subject Matter Experts in Planning and Engineering

Data Governance and Safety Data

During its preliminary evaluation in 2014, FDOT identified five problems that needed to be addressed in the Agency's revised data strategy (Christian, 2020):

1. It was difficult to know which data were available.
2. Data were difficult to access; this includes both the number of data systems, as well as the security procedures related to them.
3. There was no standardized approach to data entry. Most districts adopted geographic information systems (GIS) as the entry point, but there was no central planning, so each solution was unique.
4. There was no enterprise-level view of data. Business units and districts focused on their own issues, and there was only ad-hoc collaboration to improve performance or reduce risk.
5. Users wanted a single source of truth (i.e., a "one-stop shop") for FDOT's data. FDOT needed to identify authoritative data sources.

FDOT established the ROADS program in response to these needs. The ROADs program developed FDOT's formal data governance structure in 2015. This structure defines four roles: an executive team, enterprise data stewards, data stewards, and data custodians (figure 1).

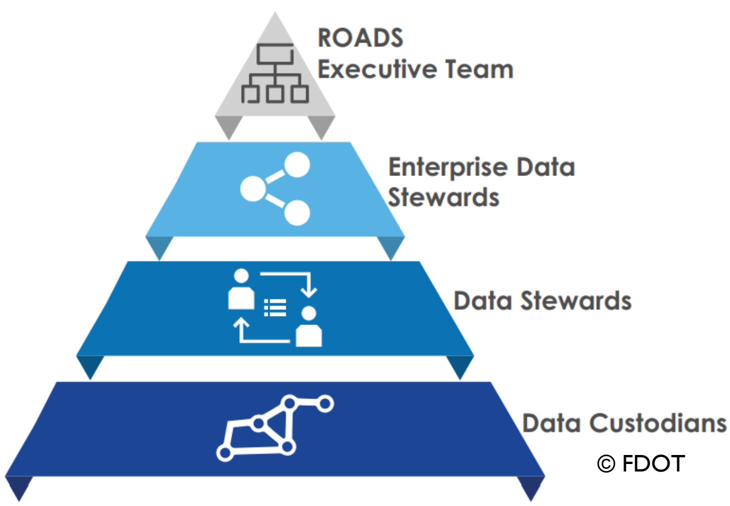

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Figure 1. Graphic. FDOT's governance structure.

These roles have responsibilities assigned to them, with the ROADS executive team ultimately responsible for the direction and execution of data governance within FDOT. This includes implementation of the ROADS Component Model, which aligns enterprise-level data governance and change management with practical applications of data management (figure 2). A more detailed summary of FDOT's data governance roles and responsibilities can be found in the 2020 FHWA case study, *FDOT Data Governance Initiative: Managing Vital Data Assets.*

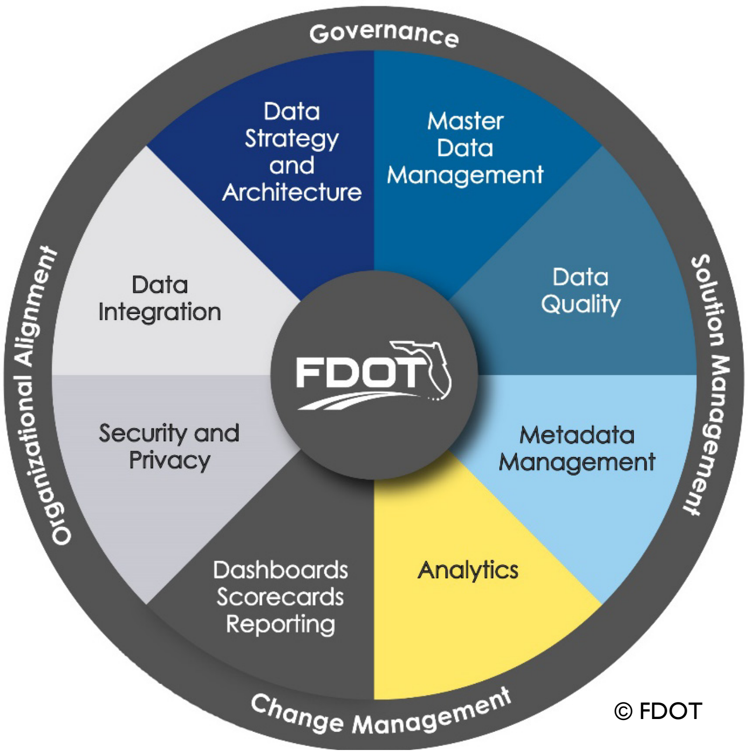

Figure 2. Graphic. FDOT's ROADS component model.

FDOT's data governance initiative is ongoing, and FDOT's data warehouse now supports enterprise data for safety analysis, road and asset inventories, Highway Performance Monitoring System (HPMS) reporting, and pavement condition. It is this foundation that supports the S2Z program and FDOT's state-of-the-practice safety management process.

Safety Data, S2Z, and Roadway Safety Management

Although S2Z is a roadway safety management program, data development and integration comprised the initial step in FDOT's eight-step strategy:

1. Develop an extract, transform, and load (ETL) process for extracting roadway and crash data.
2. Classify roadway sites into different categories.
3. Develop safety performance functions (SPFs).
4. Calculate predicted and expected crashes (FHWA, 2019b).
5. Identify safety countermeasures.
6. Collect additional roadway site data.
7. Select candidate sites and their comparison sites.
8. Summarize SAFE analysis results.

Through this program, enterprise data will allow FDOT to implement a predictive DDSA program for all roads on the State Highway System (SHS).

Data Development

FDOT integrated data from several internal and external sources (e.g., the Florida Department of Highway Safety and Motor Vehicles, or DHSMV) to develop SPFs and conduct network screening. These data also support the roadway safety management process outlined in the American Association of State Highway and Transportation Officials' (AASHTO) Highway Safety Manual (HSM). This approach used a formal, customized ETL process (figure 3).

An ETL process copies data from an origin database and translates it into a format that is compatible with a destination database. FDOT developed its initial S2Z database architecture in 2019. In 2020, FDOT developed a Structured Query Language (SQL) systems ETL process for data available to the DOT's Central Office. This included data from:

- Crash Analysis and Reporting System (CARS).
- Roadway Characteristic Inventory (RCI).
- All Roads Base Map (ARBM) for intersection legs.
- Traffic Signal Maintenance and Compensation Agreement (TSMCA) data for traffic signals.

FDOT and its university partners also collected intersection data to support specific analyses. They will collect segment-level geometric and non-motorized-vehicle infrastructure data as well. FDOT initially collected data through a manual, desktop-based effort. Future data collection efforts will include imagery-based machine learning applications, drone data from traffic studies, and other contextual studies. These data will be integrated with FDOT's existing data to support the SAFE subprogram.

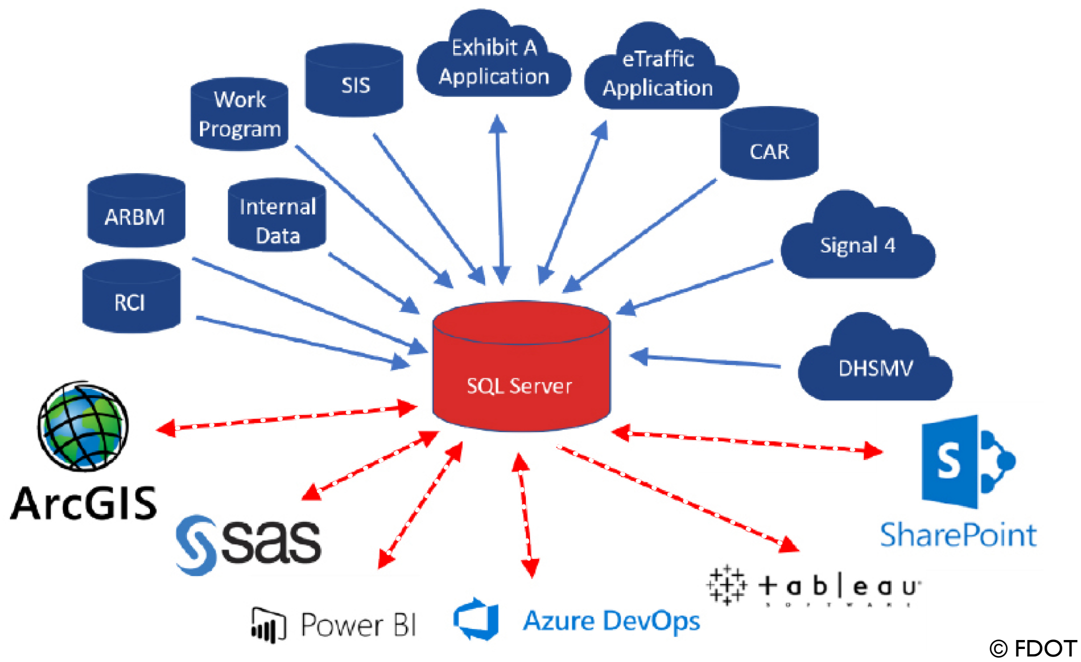

Figure 3. Graphic. Illustration of FDOT's data and application integration needs.

SAFE

The SAFE subprogram is just one component of the overall S2Z initiative. This subprogram uses FDOT's data to implement many of the best practices outlined in the AASHTO HSM. Prior to SAFE, FDOT relied on a hot spot approach based on crash frequency to identify locations with a safety need. SAFE is developing SPFs for intersections and segments in two phases. Phase I focused on intersections, and Phase II will focus on segments and midblock crossings. SAFE standardizes FDOT's approach to facility type categories, countermeasure selection, and economic appraisal. FDOT completed its signalized intersection approach in 2020, and this serves as an example of the SAFE methodology for analyses of other facility types.

FDOT used S2Z data to categorize intersections based on similar land use context, number of legs, and traffic control devices present. For instance, FDOT has several land use categories that could apply to three- or four-leg signalized intersections for SPF development:

- C1: Natural
- C2: Rural
- C2T: Rural Town
- C3R: Suburban Residential
- C3C: Suburban Commercial
- C4: Urban General
- C5: Urban Center
- C6: Urban Core

With these highly stratified and homogenous facility types, FDOT applies an SPF based on major and minor-leg annual average daily traffic (AADT). FDOT uses the empirical Bayes (EB) method to calculate expected crashes. Comparing observed crashes to expected crashes determines excess expected crashes (EECs). If the EEC at a particular site is positive (i.e., more observed crashes than expected crashes), then the site presents an opportunity for safety improvement (figure 4).

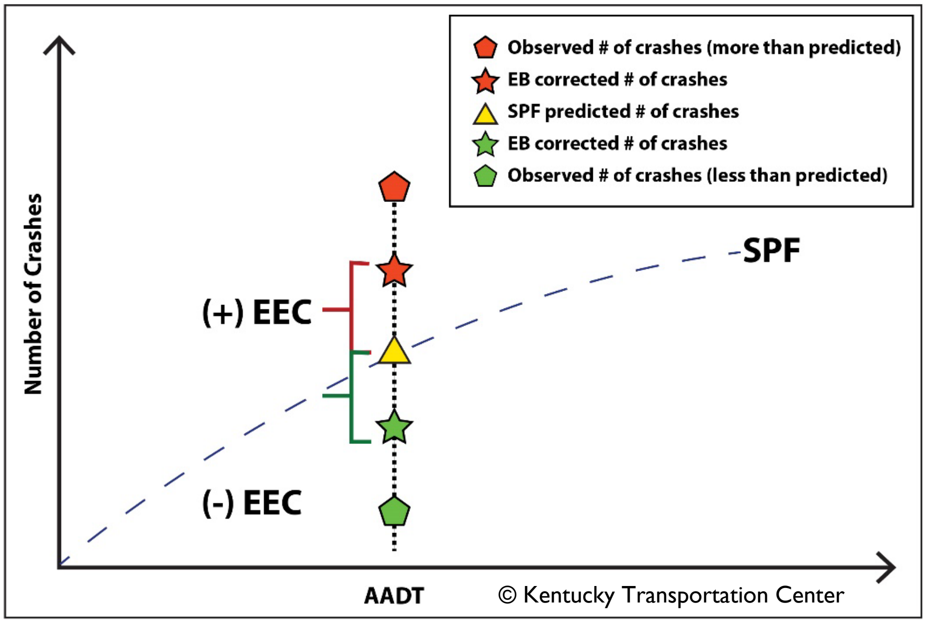

Figure 4. Graphic. Diagram illustrating predicted, expected, observed, and excess crashes.

These SPFs assess the expected and observed safety performance at each signalized intersection on the SHS. FDOT compares peer sites that perform well and poorly. These "candidate" sites (i.e., sites that experience more crashes than expected) and "sister" sites (i.e., similar comparison sites that experience fewer crashes than expected) can inform FDOT's selection of potential safety countermeasures at candidate sites. For instance, a candidate and sister site may have similar major- and minor-leg AADT, but differences at each site may indicate the need for specific treatments (table 1).

Table 1. Sample comparison of candidate and sister signalized intersection locations.

Characteristic	Candidate Location	Sister Location
Number of Legs	4	4
Land Use Category	C4	C4
Major AADT	59,000	55,332
Minor AADT	25,733	25,733
Observed Fatal and Suspected Serious Injury Crashes	4	1
Retroreflective Backplates Present	No	Yes
Lighting Present	Yes	Yes
High Visibility Crosswalk Present	No	Yes
Advance Street Name Plaque	No	Yes

FDOT posts network screening results to the project website (figure 5). These reports list candidate and sister sites identified in the network screening process, potential countermeasures for candidate sites, and the economic appraisal results (e.g., benefit-cost ratio, or BCR) for countermeasures at the candidate site. As the S2Z program grows and data are collected, FDOT will refine its methods and approach to improve the program's return on investment (ROI).

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FLORIDA DEPARTMENT OF TRANSPORTATION

Traffic Engineering and Operations Office

System Analysis and Forecast Evaluation (SAFE) Candidates

Fatal and Severe Crashes at 4-Leg Signalized Intersections 2016-2018

------------------------------District 2------------------------------

Sorted by Context Classification and Estimated BCR

RDWYID	Mile Post	Days Between Expected KA Crashes	Proposed Countermeasure: Backplates	Special Emphasis Crosswalk	Lighting	Advance Street Name Sign	Mast arm	Days Between Expected KA Crashes After Treatment	Expected Savings of Treatment	Months to Reduce One KA Crash	Estimated BCR	Comments
Suburban Commercial (C3C)												
72160000	3.63	248	✓	✓		✓		367	$732,750	25	69.79	Close to an interstate, consideration for ICE project
26090000	13.65	176	✓			✓	✓	217	$603,855	31	16.43	
26005000	7.84	271	✓	✓		✓	✓	413	$713,444	26	16.15	
72220000	7.11	256	✓			✓	✓	315	$416,351	45	11.33	
Urban General (C4)												
26050000	3.96	264	✓			✓		316	$428,018	53	138.75	
29002000	2.63	405	✓	✓		✓		597	$550,594	41	52.44	
26010000	15.21	214	✓			✓	✓	264	$609,592	37	16.59	
Urban Center (C5) or Urban Core (C6)												
26070000	20.35	319	✓			✓		381	$418,476	64	135.66	

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Figure 5. Graphic. Sample SAFE annual report of candidate locations.

Challenges

S2Z and SAFE represent the state-of-the-practice in safety data collection and DDSA. Although the program is still in its early stages with activities planned into 2025, there are a few notable challenges in FDOT's experience for peer DOTs to consider. Data governance has played a key role in enabling safety- and operations-specific data development. Without this foundation in place, TEOO would have to spend additional resources to locate, aggregate, and standardize data. Furthermore, FDOT is a highly decentralized DOT with major points of control and decision making at the district level. This has not only been an important consideration in data governance and data collection, but as FDOT continues its S2Z program, district involvement will be critical to supplement data and implement the DDSA program across the entire agency.

Next Steps

FDOT will continue to collect and integrate data into its S2Z database and associated applications. The additional data will support analyses (and countermeasure selection) for all intersections, segments, and midblock crossings on the SHS. Integrating FDOT's data and applications will support dynamic analysis, visualization, and reporting for stakeholders. This could include dynamic SAFE reports for tracking candidate locations, monitoring project status at these locations, and evaluating ROI at the district-level. By standardizing and centralizing safety data, FDOT plans to help districts fund projects based on consistent methodology and statutory requirements. This includes trainings for engineers and other stakeholders, as well as annual SPF calibration and updates to the S2Z program.

Conclusions

Data governance makes data more accessible by implementing standards that improve data awareness and interoperability throughout a DOT. Accessible and usable data are the result of effective data governance and management. This case study documents how FDOT's multi-year data governance effort has enabled the TEOO to enhance its safety analysis methodology through integrated data and DDSA. This is an example of how data can be used to standardize best practices for roadway safety management, improve program ROI, and reduce fatalities and serious injuries on public roads.

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