# Development of Safety Performance Functions (SPFs) for Motorcycle Crashes in Florida for Pre- and Post- Pandemic Conditions

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## Introduction

- Florida has the highest number of motorcycle fatalities in the United States.
- Motorcyclists represent 3.4% of Florida's registered vehicles
- Motorcycle crashes account for about 20% of traffic fatalities, represent less than 1% of total vehicle miles traveled.
- The number of annual motorcycle fatalities observed in Florida has more than doubled over the past twenty years.

In recent years, the Federal Highway Administration (FHWA) has developed safety performance functions (SPFs), or mathematical models for identifying locations and predicting the number of crashes over a highway segment. Existing SPFs are not currently used solely for motorcycle crash prediction; this study aims to develop SPFs for different degrees of severity in motorcycle crashes in Florida. Crash data from 2020 is used throughout the model formulation and preliminary results.

**The purpose of this study is to compare pre- and post- pandemic crash predictions using Safety Performance Functions.**

## Methodology

Safety Performance Functions are used to enhance traffic safety and determine which roadway elements contribute to crashes along certain segments of roadway. These specific roadway geometric characteristics and external factors, such as weather and lighting, are implemented into the SPF equation to predict the number of crashes based on certain criteria. The standard SPFs described within the HSM can be modified and calibrated to a specific roadway or jurisdiction using the following equation:

$$N_{predicted} = N_{SPF} * \left(CMF_{1x} * CMF_{2x} * \cdots * CMF_{yz}\right) * C_x$$

Where: $N_{predicted}$ = predicted average crash frequency for a specific year for site type x;

$N_{SPF}$ = predicted average crash frequency determined for base conditions of the SPF developed for site type x;

$CMF_{nx}$ = crash modification factors specific to SPF for site type x;

And $C_x$ = calibration factor to adjust SPF for local conditions for site type x.

### References

1. CRASHES OVER TIME – Ride Smart Florida. (n.d.-b). https://ridesmartflorida.com/crashes- over-time/

2. Lee, C., Wang, Z., Yang, R., Understanding Florida Motorcycle Crashes and Injury Outcomes Using the Motorcycle Crash Causation Study (MCCS) Dataset 2021-10-01 URL : https://rosap.ntl.bts.gov/view/dot/62748

3. Srinivasan, R., Carter, D., Bauer, K., Safety Performance Function Decision Guide: SPF Calibration vs SPF Development 2013-09-01 Report Number : FHWA-SA-14-004 URL : https://rosap.ntl.bts.gov/view/dot/49504

4. Federal Highway Administration. (2016). The Calibrator: An SPF Calibration and Assessment Tool User Guide. United States Department of Transportation

## Data Collection

### Data Sources:

FDOT SSOGis website are maintained by FDOT Safety Office. The database provides crash data within the state of Florida from 2011 to June 2022.

Some of the data provided includes:

- Crash types
- Roadway conditions
- Weather
- Injury severity levels
- Lighting conditions
- Moving status
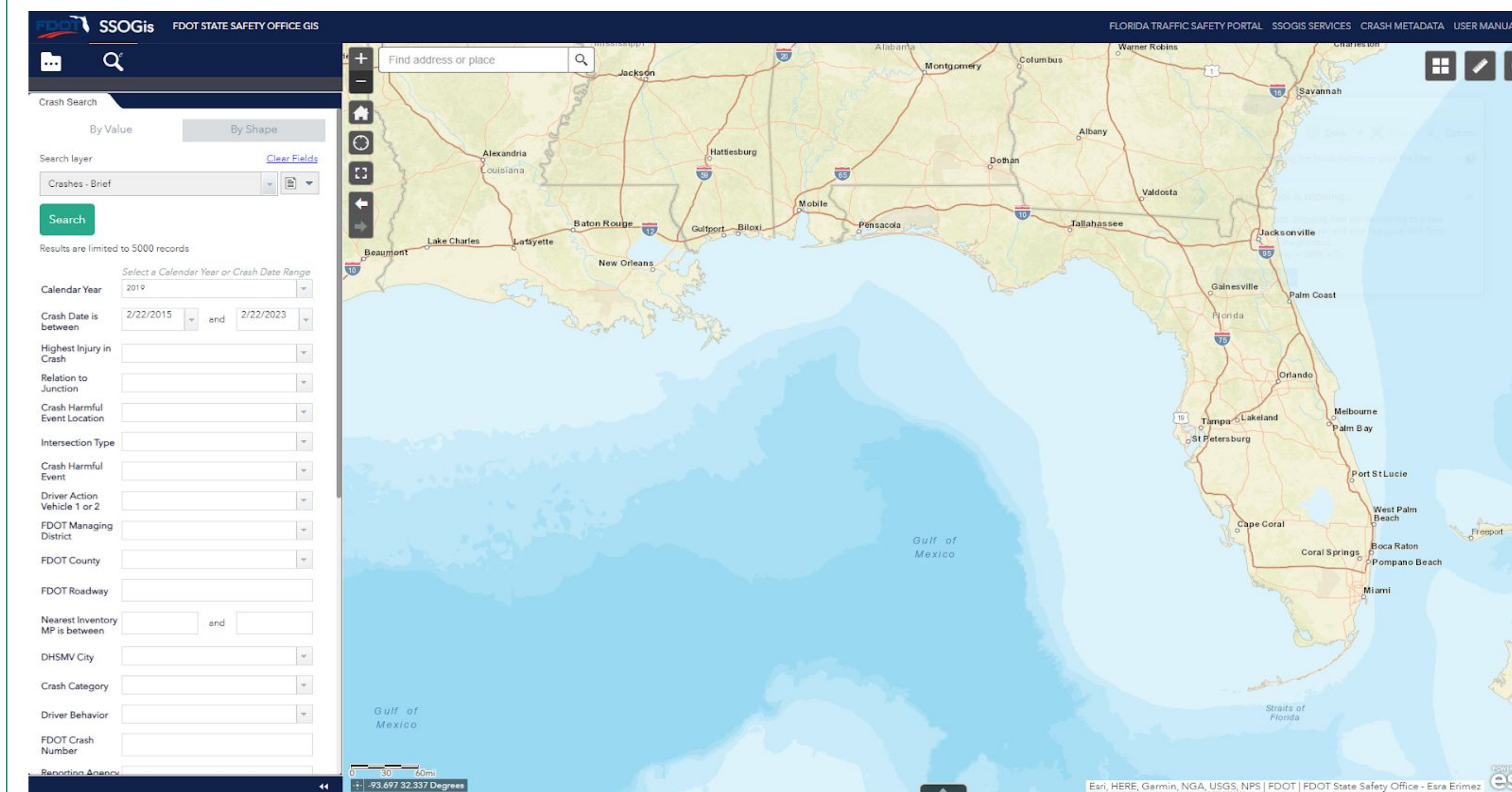- Geographical coordinates, etc



*Figure 1: FDOT SSOGis System*

### Table 1: Explanatory Variables

| Type | Variable | Value | Description | Count | Percent |
|---|---|---|---|---|---|
| | | | **No Unknown Information** | | |
| Categorical | Highest Level Injury | 5 | Fatal (Within 30 Days) Injury | 212 | 8.018% |
| | | 4 | Incapacitating Injury | 548 | 20.726% |
| | | 3 | Non-Incapacitating Injury | 684 | 25.870% |
| | | 2 | Possible Injury | 866 | 32.753% |
| | | 1 | No Injury | 334 | 12.632% |
| Dummy | Area | 1 | Urban | 2480 | 93.797% |
| | | 0 | Rural | 164 | 6.203% |
| | Alcohol/Drugs | 1 | Present | 136 | 5.144% |
| | | 0 | Not Present | 2508 | 94.856% |
| | Daytime | 1 | Yes | 1708 | 64.599% |
| | | 0 | No | 936 | 35.401% |
| | Dusk | 1 | Yes | 113 | 4.274% |
| | | 0 | No | 2531 | 95.726% |
| | Dawn | 1 | Yes | 33 | 1.248% |
| | | 0 | No | 2611 | 98.752% |
| | Dark-Lighted | 1 | Yes | 642 | 24.281% |
| | | 0 | No | 2002 | 75.719% |
| | Dark-Not Lighted | 1 | Yes | 144 | 5.446% |
| | | 0 | No | 2500 | 94.554% |
| | Dark-Unknown Lighting | 1 | Yes | 4 | 0.151% |
| | | 0 | No | 2640 | 99.849% |
| | Speeding | 1 | Yes | 119 | 4.501% |
| | | 0 | No | 2525 | 95.499% |
| | Aggressive Driving | 1 | Yes | 112 | 4.236% |
| | | 0 | No | 2532 | 95.764% |
| | Distracted Driving | 1 | Yes | 406 | 15.356% |
| | | 0 | No | 2238 | 84.644% |
| | Rear-End | 1 | Yes | 1054 | 39.864% |
| | | 0 | No | 1590 | 60.136% |
| | Head-On | 1 | Yes | 122 | 4.614% |
| | | 0 | No | 2522 | 95.386% |
| | Angle | 1 | Yes | 1005 | 38.011% |
| | | 0 | No | 1639 | 61.989% |
| | Sideswipe | 1 | Yes | 447 | 16.906% |
| | | 0 | No | 2197 | 83.094% |
| | Rear to Side | 1 | Yes | 12 | 0.454% |
| | | 0 | No | 2632 | 99.546% |
| | Rear to Rear | 1 | Yes | 4 | 0.151% |
| | | 0 | No | 2640 | 99.849% |
| | Clear Weather | 1 | Yes | 2294 | 86.762% |
| | | 0 | No | 350 | 13.238% |
| | Cloudy Weather | 1 | Yes | 262 | 9.909% |
| | | 0 | No | 2382 | 90.091% |
| | Rainy Weather | 1 | Yes | 77 | 2.912% |
| | | 0 | No | 2567 | 97.088% |
| | Fog, Smog, Smoke | 1 | Yes | 11 | 0.416% |
| | | 0 | No | 2633 | 99.584% |
| | Road Wet | 1 | Yes | 142 | 5.371% |
| | | 0 | No | 2502 | 94.629% |
| | Posted Speed >30 mph | 1 | Yes | 2502 | 94.629% |
| | | 0 | No | 142 | 5.371% |
| Continuous | AADT | | Annual Average Daily Traffic (in Thousands) | 1300 ~ 269000 | |
| | Posted Speed | | Posted Speed Limit (in mph) | 25 ~ 70 | |

## Future Work

- Develop SPFs for pre-COVID-19 years (2018, 2019).
- Combine 2020 (existing) data and 2021 data for during COVID-19 condition.
- Develop SPFs for during COVID-19 condition (2020, 2021).
- Collect data for post-COVID-19 condition (2022, 2023).
- Develop SPFs for post-COVID-19 condition (2022, 2023).
- Compare SPFs from pre-, during, and post COVID-19 years.

## Preliminary Model Results

Tables 2 and 3 list the model results obtained from SPSS and the Goodness of Fit of the results, respectively. All selected variables are significant at a 95% confidence level.

### Table 2: Significant Variables for Motorcycle Crash Injury Level

| Parameter | Coefficients | Std. Error | 95% Wald Confidence Interval | | Hypothesis Test | | |
|---|---|---|---|---|---|---|---|
| | | | Lower | Upper | Wald Chi-Square | df | Sig. |
| Constant | 5.080 | .1655 | 4.756 | 5.405 | 941.724 | 1 | 0.000 |
| Functional Class | .558 | .0860 | .389 | .726 | 42.046 | 1 | .000 |
| Posted Speed >30mph | -.557 | .0916 | -.737 | -.377 | 36.959 | 1 | .000 |
| Alcohol/Drugs Involved | -1.026 | .0946 | -1.212 | -.841 | 117.610 | 1 | 0.000 |
| Daylight | .100 | .0438 | .014 | .185 | 5.180 | 1 | .023 |
| Clear Weather | .166 | .0611 | .046 | .285 | 7.355 | 1 | .007 |
| Head-On Collision | -.420 | .1003 | -.616 | -.223 | 17.499 | 1 | .000 |
| Angle Collision | -.503 | .0431 | -.587 | -.418 | 136.061 | 1 | 0.000 |
| Speeding | -.700 | .1001 | -.897 | -.504 | 48.950 | 1 | .000 |

### Table 3: Goodness of Fit of SPSS Model

| Goodness of Fit | | | |
|---|---|---|---|
| Likelihood Ratio Chi-Square | df | | Sig. |
| 427.572 | 8 | | 0.000 |
| | Value | df | Value/df |
| Deviance | 2959.142 | 2635 | 1.123 |
| Scaled Deviance | 2644.000 | 2635 | |
| Pearson Chi-Square | 2959.142 | 2635 | 1.123 |
| Scaled Pearson Chi-Square | 2644.000 | 2635 | |
| Log Likelihood[b] | -3900.539 | | |
| Akaike's Information Criterion (AIC) | 7821.079 | | |
| Finite Sample Corrected AIC (AICC) | 7821.162 | | |
| Bayesian Information Criterion (BIC) | 7879.879 | | |
| Consistent AIC (CAIC) | 7889.879 | | |