Comprehensive Study to Improve Bicycle Safety

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Presentation Outline

- Research Question
- Data and Methods
  - Data Processing
  - Validation of Explanatory Variables
- Model Estimation Results
- Key Findings
- Conclusions

Research Question

- Florida has the highest bicycle crashes in USA (6.8 fatalities per million population in 2013).
- On an average, 126 bicyclists are killed and 6,616 are injured each year
- Project Objective:
  - Hot spots identification
  - Crash causes and patterns analysis
  - Effective countermeasures selection

- The specific objective of this research work is to analyze significant contributing factors affecting injury severity levels in bicycle crashes by Logit Models (Multinomial and Mixed) Using SAS 9.4

Data

- 2011-2014 FDOT Crash Analysis Reporting (CAR) system databases:
  - Crash level data file
  - Non-motorist level data file
  - Vehicle, driver, and passenger level data file

- A total of 26,036 crashes with 503 fatal crashes and 22,146 injury crashes

- The records with incorrect information, such as bicyclists age 0 to 2 and crash severity code 0 (none) and 6 (non traffic fatality), were removed.

- Finally, a total of 23,583 bicycle-motor vehicle crashes were used for fitting the model.

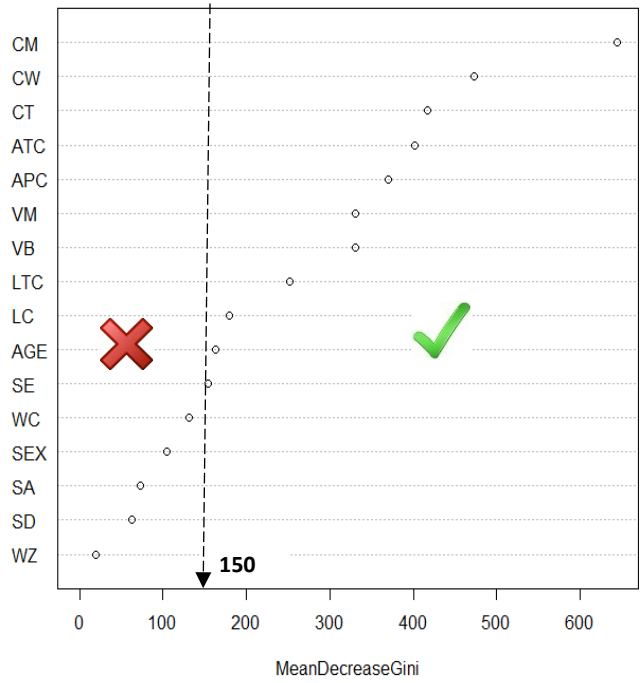
Model Variables

Categorical	Variables with Code
Response Variable	Injury Severity = fatal (Base Condition), injury (possible, non-incapacitating and incapacitating injury) and property damage only (PDO)
Temporal Factors	Month (CM), Day of Week (CW), Time of day (CT)
Environmental Factors	Lighting Condition (LT), Weather Condition (WC)
Bicyclist-Related Factors	Age (AGE), Gender (SEX), Impairment-Alcohol (SA), Impairment-Drug (SD), Safety Equipment (SE), Action Prior to Crash (APC), Action at Time of Crash (ATC), Location at Time of Crash (LTC)
Crash Location-Related Factors	Presence of Work Zone (WZ)
Vehicle-Related Factors	Vehicle Type (VB), Vehicle Maneuver Action (VM)

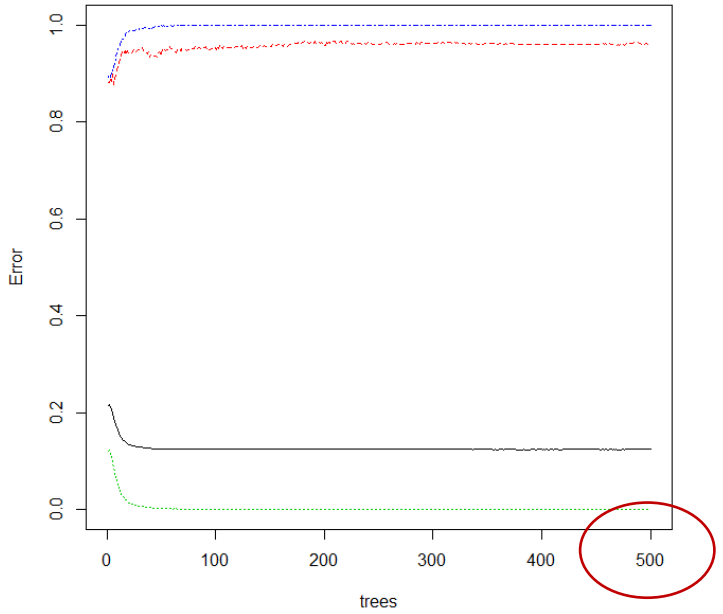
These categorical predictors were used as binary indicators ("one" if yes and "zero" if otherwise) to estimate significant model parameters.

Variable Importance

Random Forest Technique Using R



Predictor Variables Importance Plot



Error Plot for Choosing Appropriate Number of Decision Trees

The model is statistically significant with eleven significant variables (Lack of fit test using SAS 9.4)

Model Estimation Results

- Insignificant independent variables at 0.05 level of significance
- Adjusted R^2 is 0.1
- Chi-Square statistic is 1,378
- P-value (<.0001)
- The model output also includes:
  - Standard errors
  - Wald Chi-Square
  - Proportional odds ratio
  - 95% confidence intervals for the proportional odds ratios

Key Findings

Temporal factors:

- Bicycle crashes in Florida are nearly 2 times more likely to result in fatal when the crash occurs on Sunday
- Compared to fatal crashes, PDO crashes are 1.7 times more likely to occur during evening peak time

Environmental factors:

- Dark with unknown street light condition is 10 times more likely to result fatal crashes compared to PDO crashes

Key Findings (Continued)

Vehicle-Related factors:

- Medium/heavy trucks are most likely to result in fatal bicyclist crashes compared to injury and PDO crashes.
- Light truck, pickup, sport utility vehicle, passenger van have significant effect on bicyclists' injury severities.
- Leaving traffic lane is the most dangerous vehicle maneuver action. Fatal crashes significantly increase when vehicle turns left, right, and slowing down.
- Turning right is more likely to be a high-risk vehicular maneuver action compared to turning left.

Key Findings (Continued)

Bicyclist-Related Factors:

- Bicyclists over 65 years are 2 times more likely to result in fatal crashes compared to PDO crashes.
- Bicyclists are more likely to be involved in injury and PDO crashes than fatal crashes while they are cycling on sidewalk.
- Not visible bicyclists are 1.6 times more likely to be involved at time of fatal crashes than PDO crashes. Bicyclists' improper turn/merge has significant effect on PDO crashes.
- Bicyclist fatal crashes are 2 and 1.6 times more likely to occur on segment compared to injury and PDO crashes.

Conclusions

- The model estimation results recommend appropriate countermeasure incorporating 4 E's (Engineering, Education, Enforcement and Emergency Response) to mitigate severity of bicycle crashes
- Improved traffic management technique is needed on weekends and at evening peak time
- Proper lighting condition could reduce fatal crashes in the dark road
- Awareness through education campaign might help bicyclists to change their improper action while biking
- Limiting large vehicle might help to reduce bicycle crashes
- Better model could identify more appropriate contributing factors (Mixed Logit Model, Neural Network etc.)

Questions, Suggestions, and Discussion