

Risk Analysis of Flammable Liquids on U.S. Highways

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INTRODUCTION

Background

- Flammable liquids are used by vehicles as fuel
- Cargo tank trucks are used to move these flammable liquids across the U.S.

Issues

- Many of these trucks can be involved in fatal crashes that can lead to an array of consequences
- In North Richland Hills, TX, one person died and another was hospitalized after a fiery crash between a cargo tank truck and a garbage truck on December 22, 2021 (WFAA-TV)
- In Fremont, CA, a cargo tank truck overturned after a crash, leading to 7,900 gallons of gasoline being spilled, on December 24, 2021 (KPIX-TV)
- Both accidents led to the roads being closed for multiple hours

Objective of research

- Perform a risk analysis to inform carriers about times, weather conditions, and road types to avoid in order to minimize the risk of a fatal crash

LITERATURE REVIEW AND DATA ANALYSIS

Transitory Trouble: Inter and Intrastate Hazardous Materials Flow in South Carolina

- Roughly 90% of Class 3 hazardous material highway traffic is used for fuel oil and gasoline

Present Practices of Highway Transportation of Hazardous Materials

- Reviewed responsibilities of different agencies related to highway transportation of hazardous materials
- Provided default values of truck accident rates

An Expeditious Risk Assessment of the Highway Transportation of Flammable Liquids in Bulk (Glickman)

- Compared the risk of the NYC Fire Department cargo tank design to the MC307 cargo tank design

Federal Motor Carrier Safety Administration (FMCSA)

- Crash statistics
- Registration statistics
- Example of registration statistics

Calculating the risk

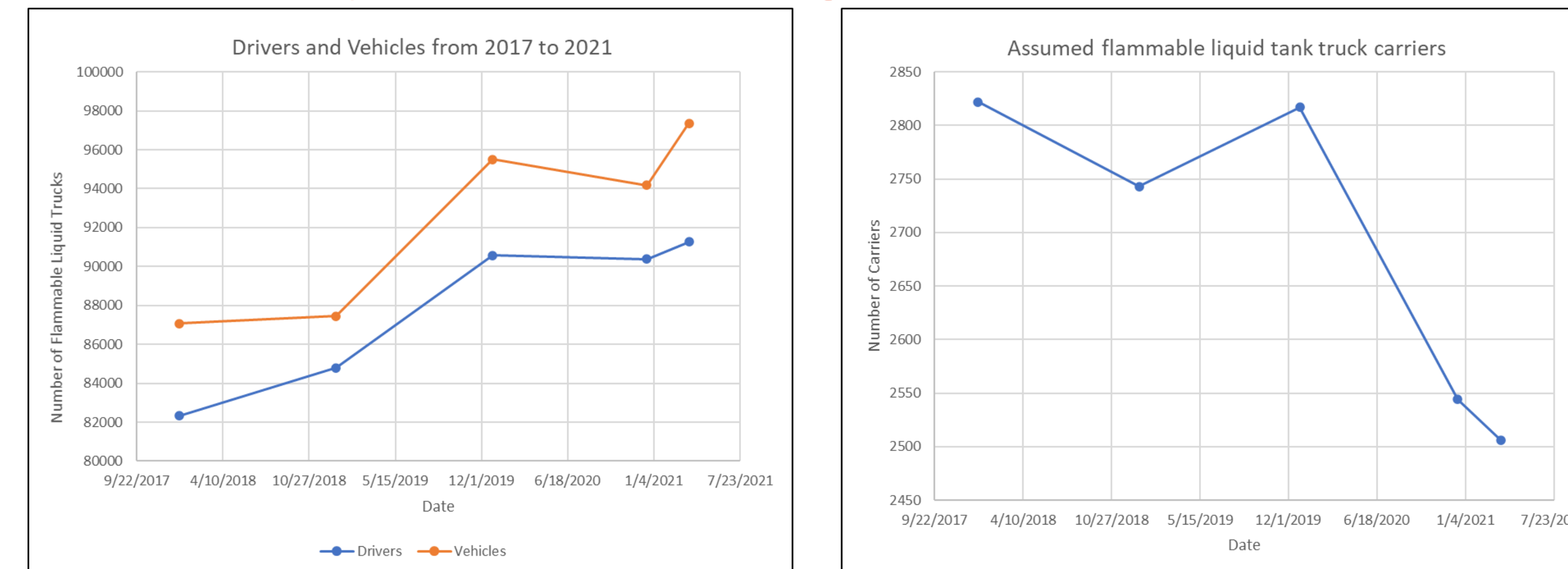
$$P(F) = P(A \cap R) * P(F|(A \cap R))$$

- $P(F)$ is the probability of a vehicle being involved in a fatal crash per flammable liquid truck
- $P(A \cap R)$ is the number of vehicles being involved in a crash with a flammable liquid release
- $P(F|(A \cap R))$ is the probability of a vehicle being involved in a fatal crash given that a crash with a release has occurred

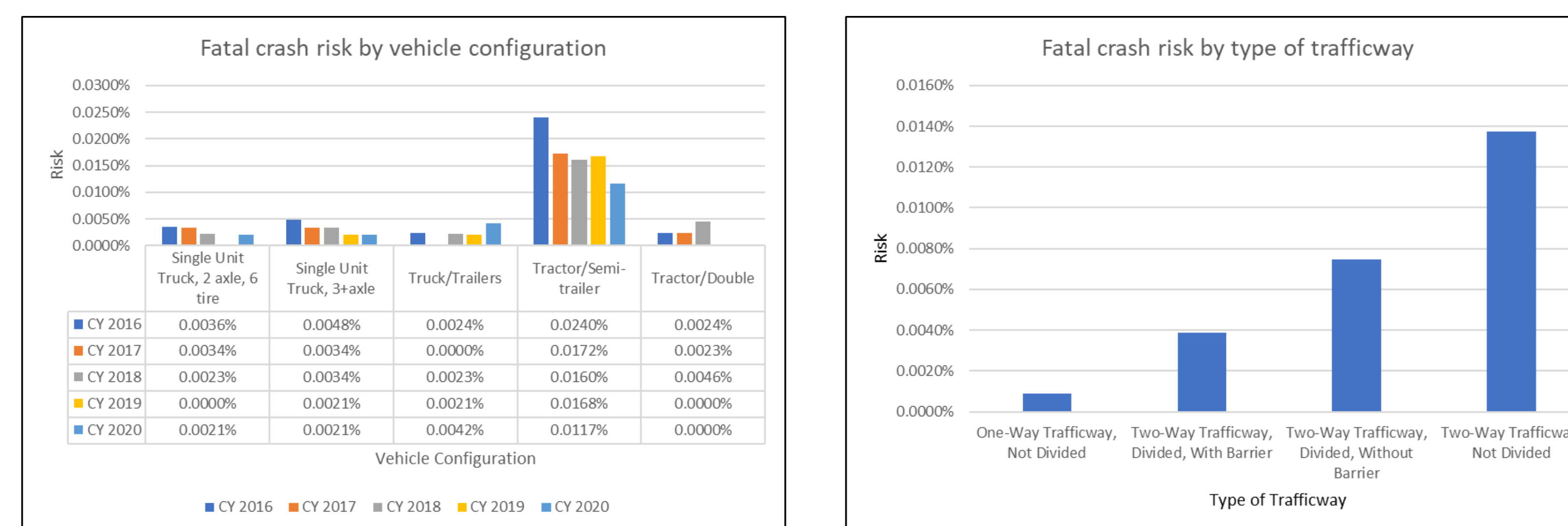


RESULTS

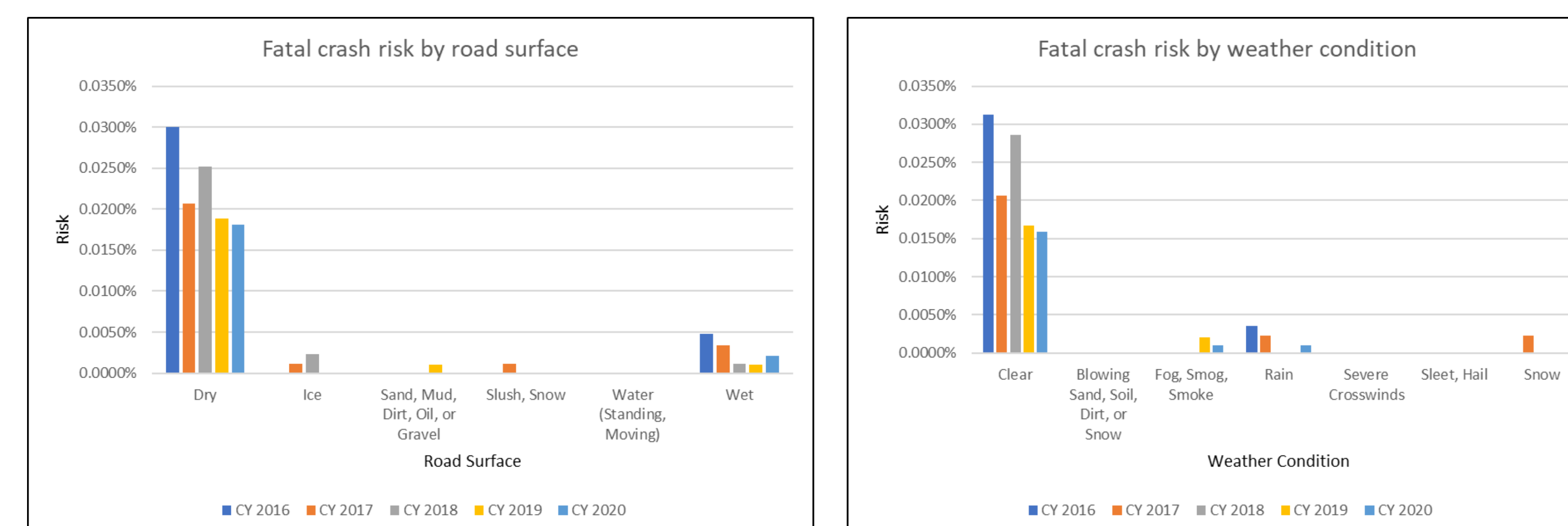
Yearly Trends in the Registration Statistics



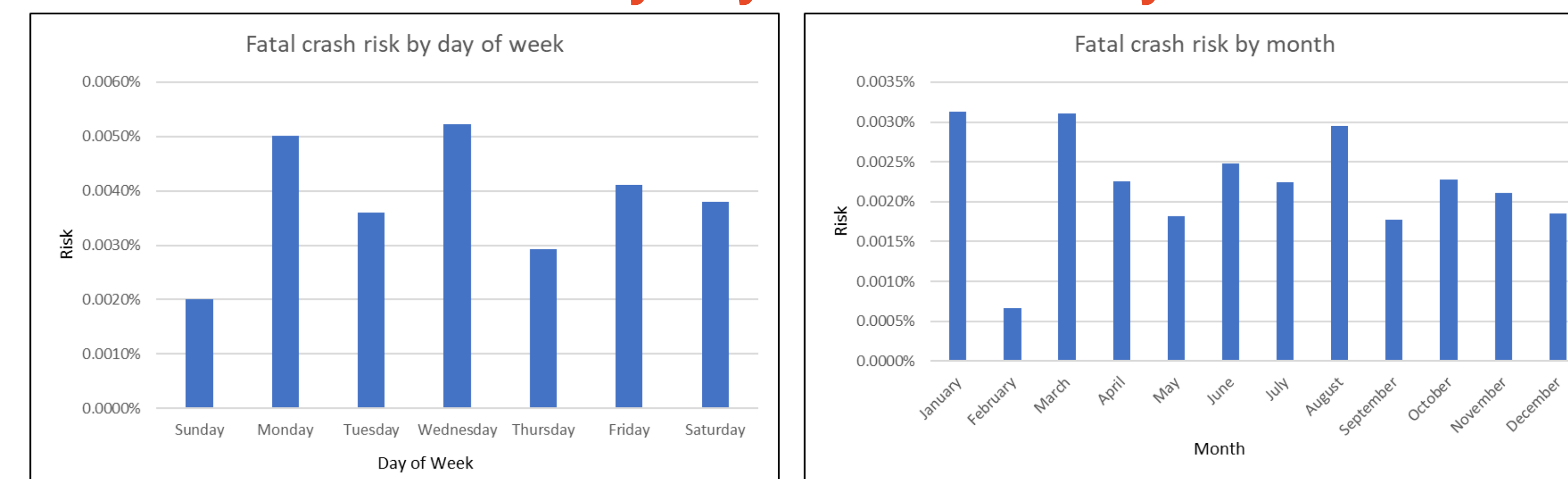
Fatal crash risk by vehicle configuration and road design



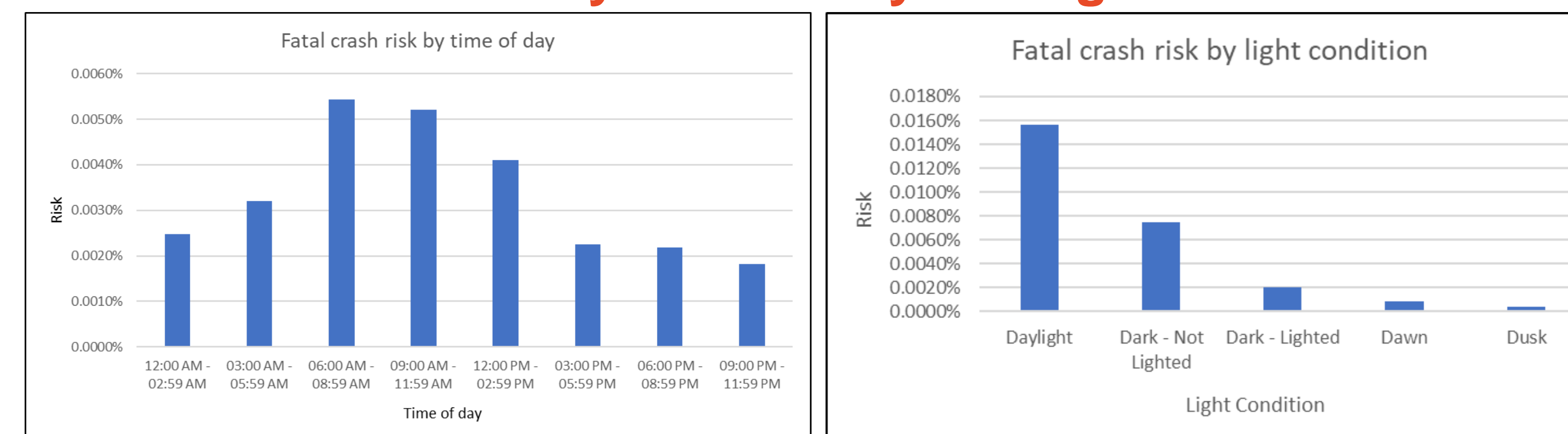
Fatal crash risk by weather-related conditions



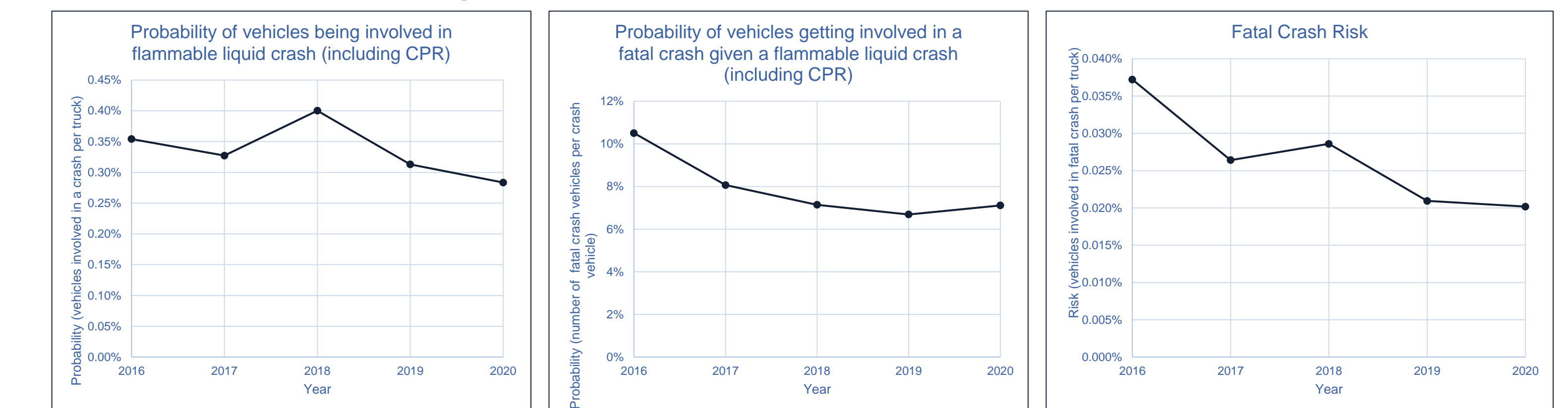
Fatal crash risk by day of week and by month



Fatal crash risk by time of day and light condition



Risk Analysis over time from 2016 to 2020



DISCUSSION

Comparing current results to Glickman results

- Glickman results of fatalities per year per truck
 - Average case on a typical route for MC307 tank truck: 5.81×10^{-4}
- Average fatalities per year calculated using the average fatal crash risk results and assuming there are 1.5 people per truck: 4.00×10^{-4}

Conclusion

- With a continuous demand for flammable liquids, in the future, one can expect that cargo tank trucks will continue to be on U.S. Highways
- Fatal crash risk of flammable liquid trucks has generally decreased

Recommendations

- Two-way divided trafficway with barriers should be used to prevent severe incidents and other consequences like spills
- Nights and days with fog, smog, and smoke should be avoided since low visibility could lead to more fatal crashes
- An alternative would be to transport flammable liquids by rail so as to further reduce risks during on-peak hours on U.S. highways when passenger vehicle travel is high

Future Work

- Include speed limits in flammable liquid truck data to understand the effects speed has on fatal crashes
- Using Machine Learning methods to develop risk models
- Investigating how telematics and other technologies can reduce risk
- Extend on Data Analytics and Business Intelligence (BI)

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