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COLLEGE OF ENGINEERING | School of Civil and Construction Engineering

THE IMPACTS OF CELL PHONE COVERAGE AREAS ON DISTRACTED DRIVING, TRAFFIC CRASHES, FATALITIES, AND INJURIES

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Introduction

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Study Introduction- The Growing Risks of Distracted Driving and Cellphone Usage

- **Introduction:**
- The rise of smartphones and social media (Instagram, Meta, TikTok) has accelerated cellphone usage in vehicles, with over 300 million users in the U.S., expected to reach 360 million by 2040.
- Despite their benefits (e.g., maps, traffic alerts), smartphones are significant driving distractions.

- **Key Statistics:**
  - In 2019, 9% of fatal crashes, 15% of injury crashes, and 15% of all reported crashes were linked to distractions (NHTSA, 2021).
  - Drivers aged 15-20 were the most likely to be distracted in fatal crashes.
  - In Oregon (2016-2020), over 15,000 distracted driving crashes resulted in 186 deaths and 24,000 injuries (ODOT, 2023).

Research objectives

- Investigate the relationship between distracted driving, crash severity, and geographical factors, particularly the role of cellphone coverage.
- **Methodology:**
  - Mixed logit modeling framework used crash data from ODOT (2017-2020).
  - The model incorporates random factors affecting driver distraction and unobserved individual characteristics.
- **Impact and Solutions:**
  - Insights can guide safety measures like pullouts, signage, enforcement, and awareness campaigns.
  - Findings provide valuable insights for safety interventions, aiding transportation, law enforcement, and public health stakeholders in combating distracted driving.

Literature Review on Distracted Driving and Injury Severity, part #1

- **Injury Severity Studies**
  - Researchers use advanced statistical models like the mixed logit to understand injury severity in distracted driving crashes (Alnawmasi & Mannering, 2022; Fatmi et al., 2019).
  - **Key Findings:**
    - Environmental factors (e.g., rain, road alignment) affect injury severity (Fatmi et al., 2019).
    - Cellphone use increases injury risk, while cognitive distractions reduce severity (Razi-Ardakani et al., 2019).
    - Other factors: vehicle type (Islam, 2023), daylight and right shoulder width (Alnawmasi & Mannering, 2022), and urban location (Wu et al., 2022).

Literature Review on Distracted Driving and Injury Severity, part #1

- **Non-Injury Severity Studies**
  - Distracted driving negatively impacts traffic flow by affecting lane positioning, speed, and risky lane changes (Stavrinos et al., 2013; Cooper et al., 2009).
  - Reduced speeds and larger gaps between vehicles lower traffic efficiency (Xiao et al., 2016).
  - Distractions at intersections increase time intervals between vehicles, reducing intersection capacity (Sherif et al., 2023).

Data and Visualizations

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Empirical Setting

- **Data Source:**
  - ODOT crash data (2017-2020) focusing on distracted driving events, including cellphone use and other electronic distractions.
  - 2,690 observations with variables like driver action, crash type, roadway, environmental, and vehicle characteristics.
- **Injury Severity:**
  - Data categorized into 3 injury types based on KABCO scale:
    - Severe (K+A): 1.19%
    - Minor (B+C): 35.69%
    - No Injury (O): 63.12%

Which of the following is NOT a common form of distracted driving?

Using a cell phone to text

0%

Eating while driving

0%

Listening to the radio at a moderate volume

0%

Using a navigation system

0%

Hands-free devices completely eliminate the risks associated with cell phone use while driving

True

0%

False

0%

Don't Know

0%

Spatial Distribution of Distracted Driving Crashes

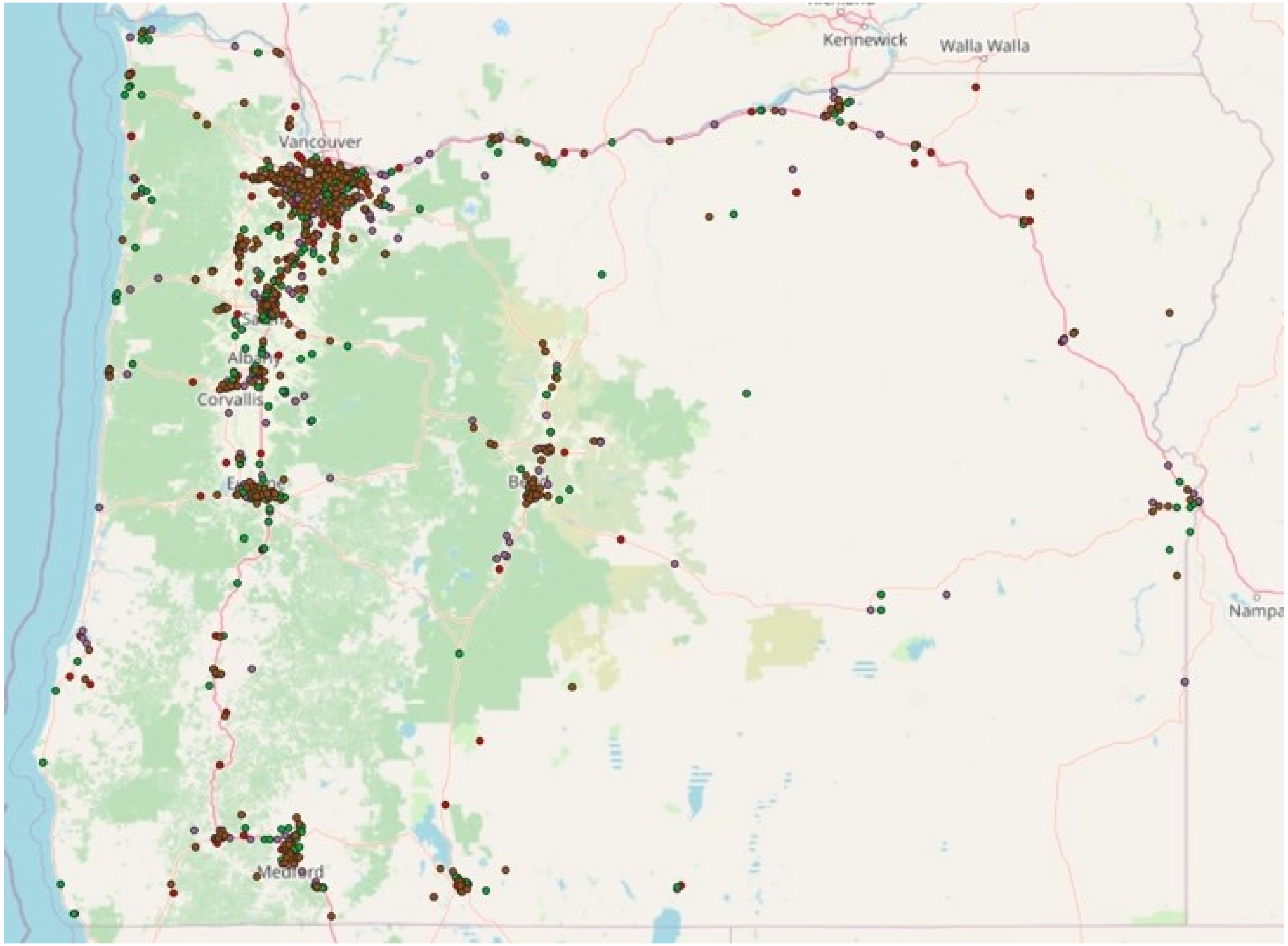


Figure 1 - Spatial Distribution of Distracted Driving Crashes in Oregon (2017-2020): A GIS visualization highlighting the geolocations of reported incidents over the four-year study period.

Heatmaps

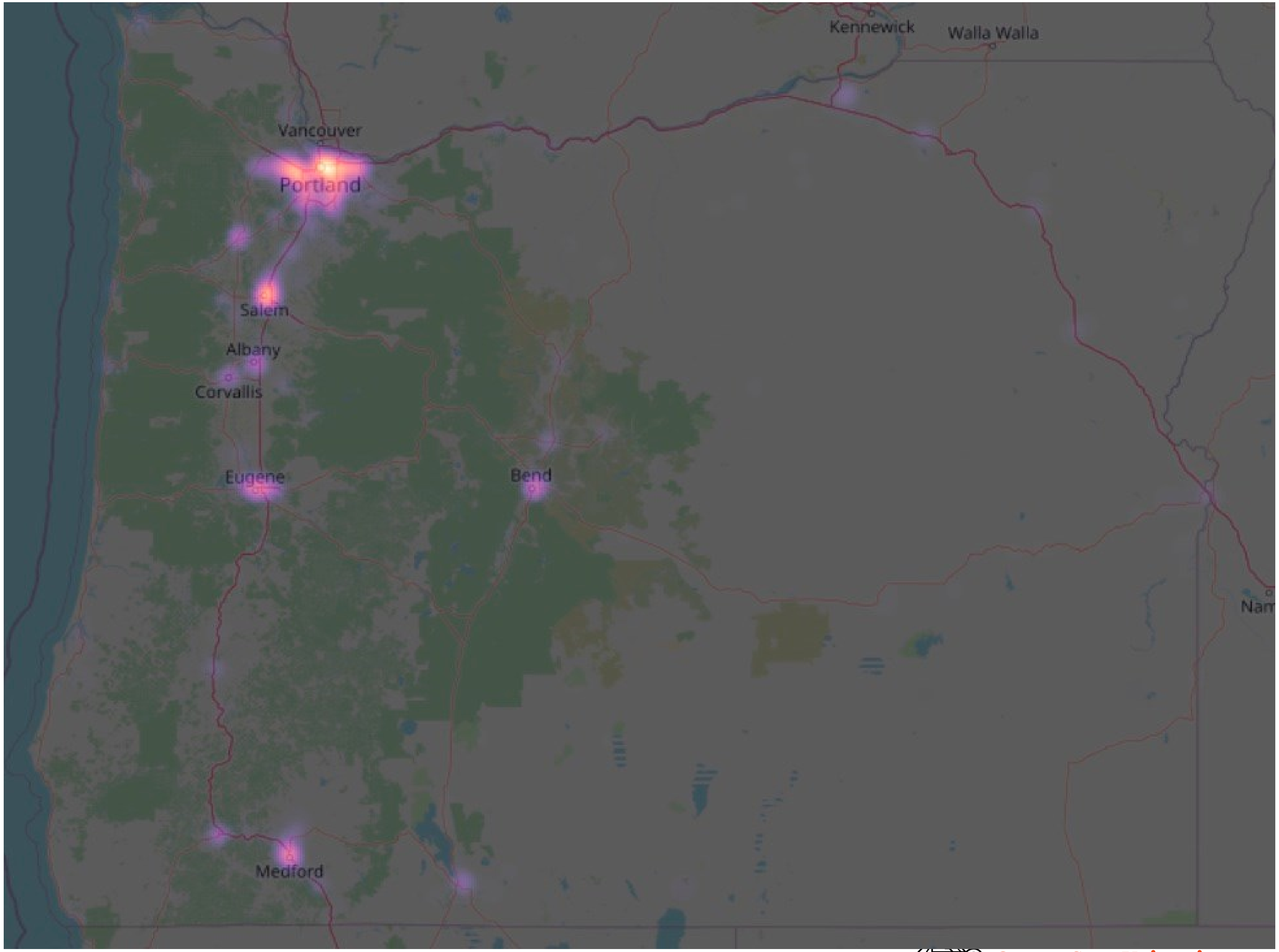


Figure 2 - Heatmap of Oregon: Delineating Concentrations of Distracted Driving Crashes with Dominant Clusters in Major Urban Centers like Portland, Salem, Eugene, Medford, and Bend

Heatmaps

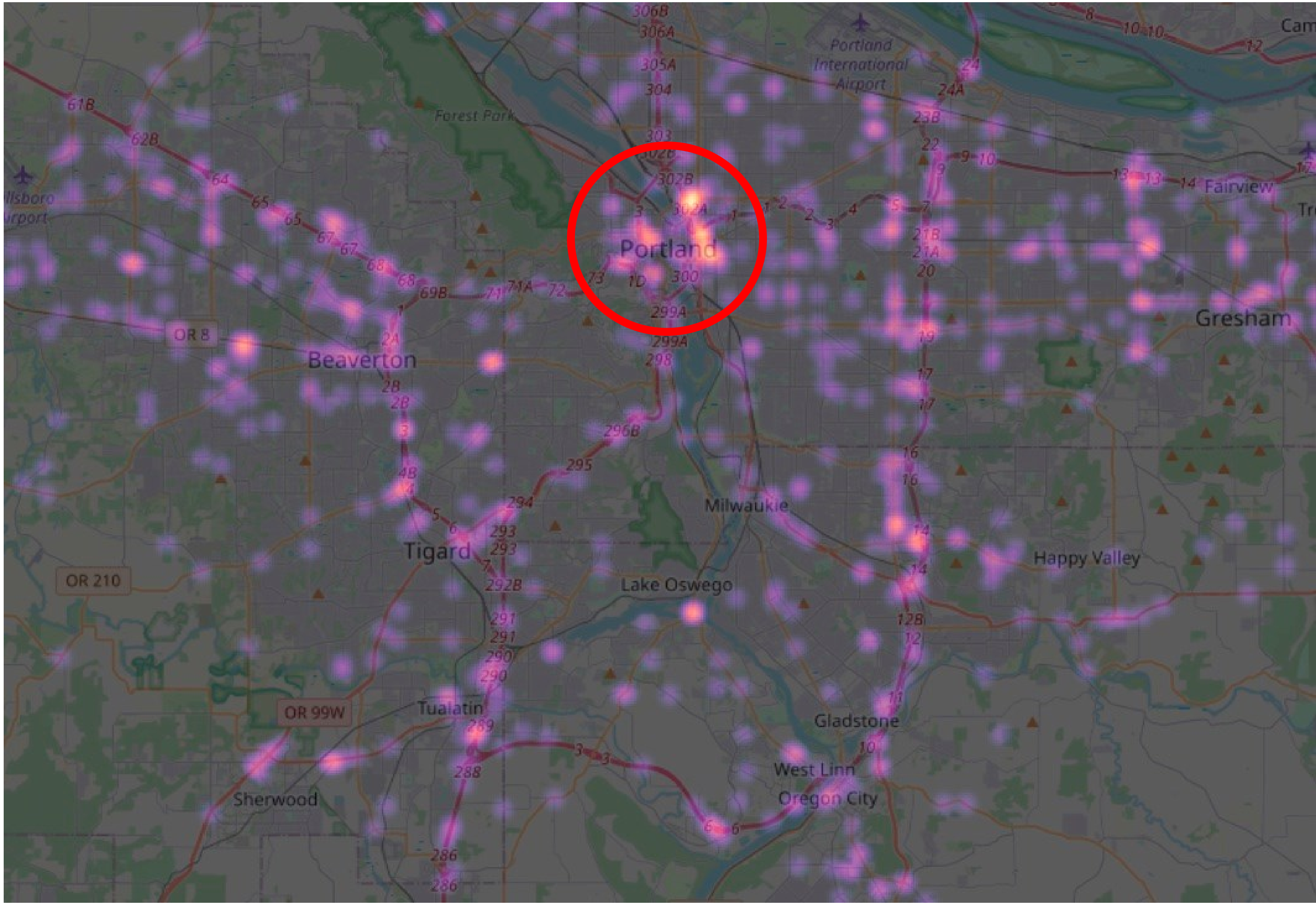


Figure 3 - Heatmap of the Portland Area: Highlighting Concentrations of Distracted Driving Crashes with Intense Clusters in Downtown

Heatmaps

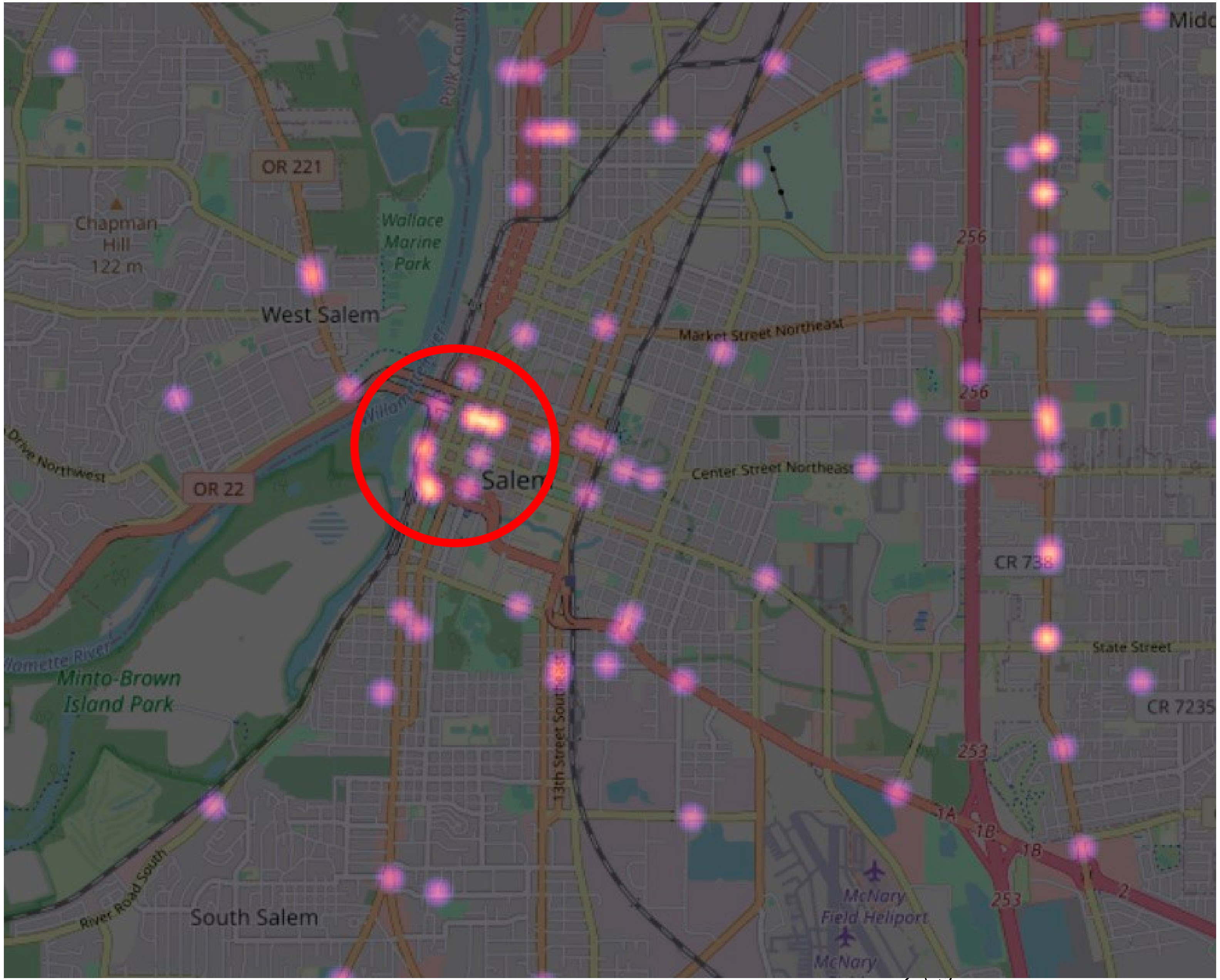
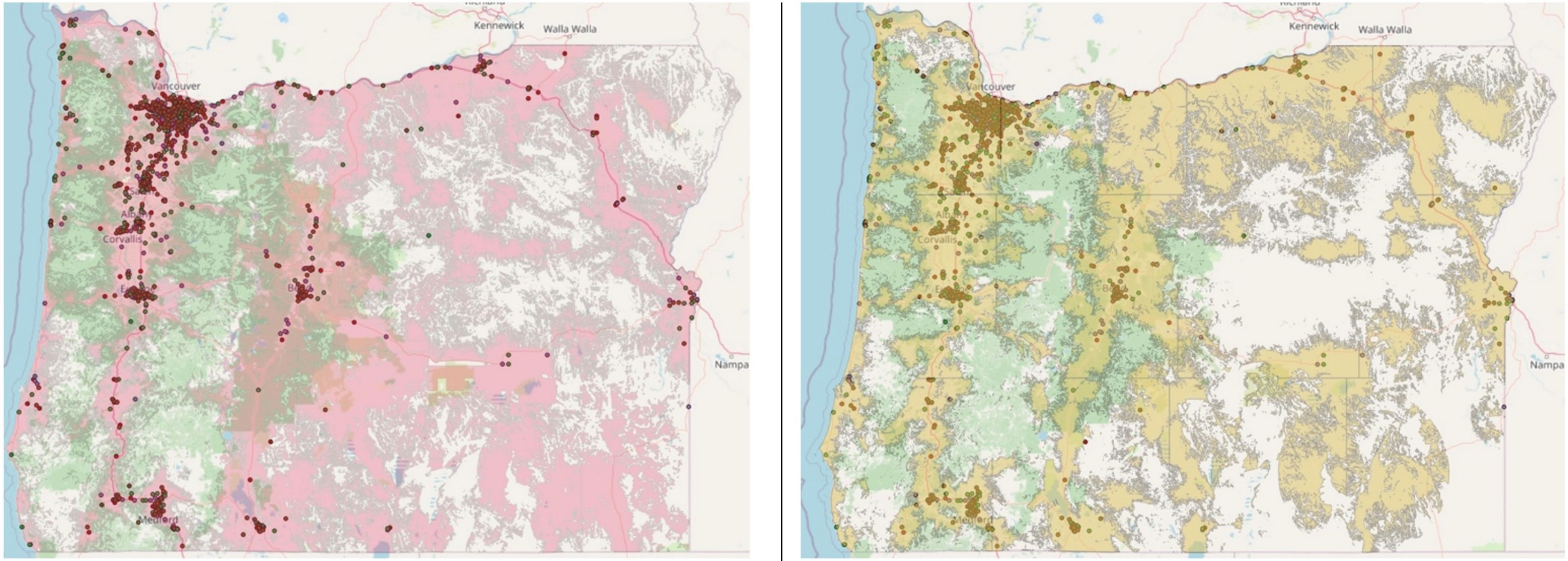


Figure 4 - Heatmap of Salem Downtown: Highlighting Concentrations of Distracted Driving Crashes, with Intense Clusters Downtown

Cell Coverage Maps Superimposed onto the Recorded Crash Sites



(a) (b)

Figure 5 - (a) Verizon Mobile Cell Coverage Map Superimposed onto the Recorded Crash Sites from the Study Period (2017-2020); (b) AT&T Mobile Coverage Map Superimposed onto the Recorded Crash Sites from the Study Period (2017-2020).

Comparing Yearly Totals of All Crashes vs. Distracted-Related Crashes

Table 2.1 Table Comparing Yearly Totals of All Crashes vs. Distracted-Related Crashes (2017-2020): Analyzing the Percentage Contribution of Distractions

Year	All Crashes	Total Distracted Related Crashes	% Of Total	Normalized Distracted Crashes
2017	57716	381	0.66%	0.39
2018	50092	421	0.84%	1.00
2019	50117	388	0.77%	0.54
2020	38124	311	0.82%	0.00

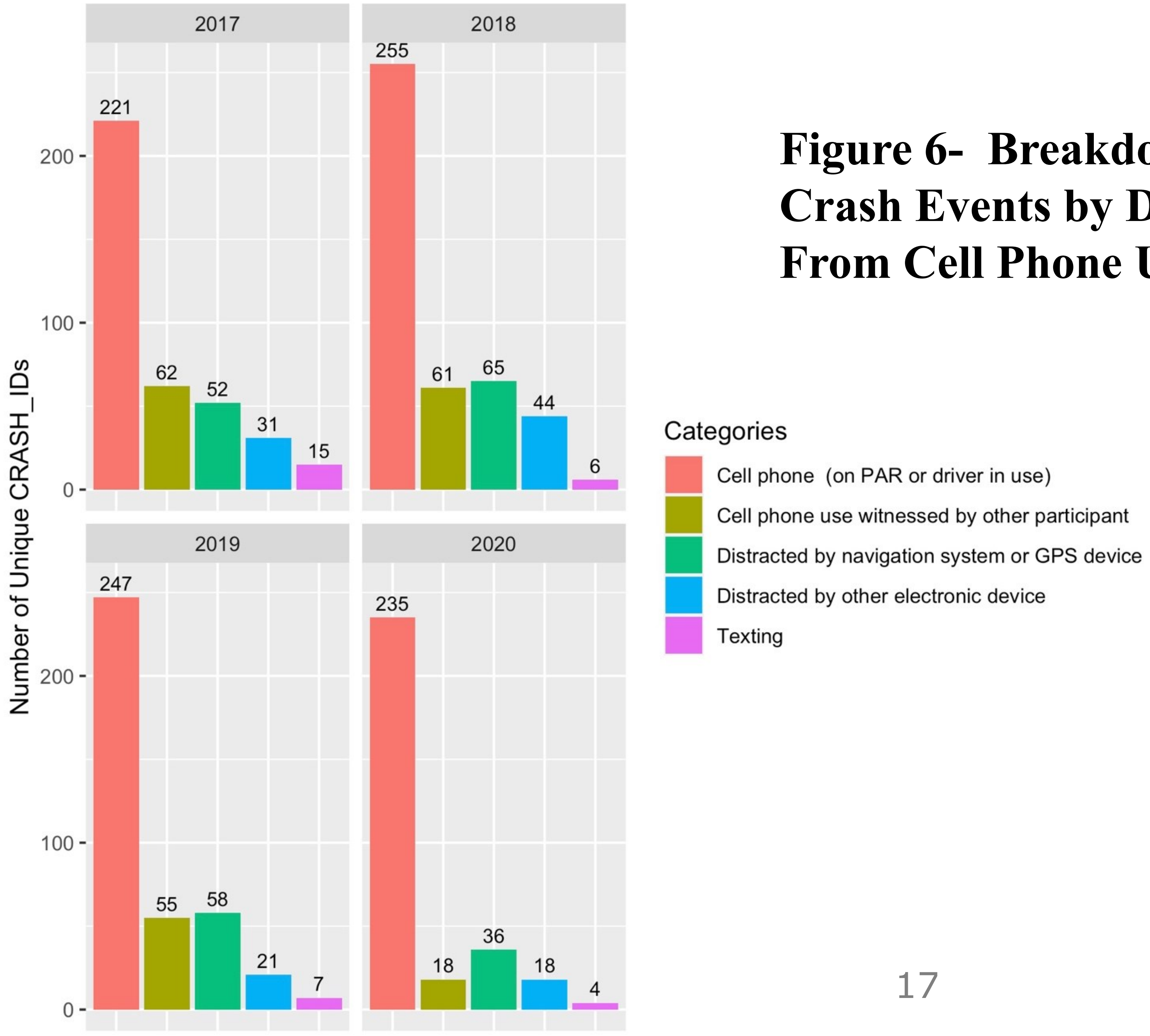


Figure 6- Breakdown per Year of Crash Events by Distraction Source: From Cell Phone Use to Texting

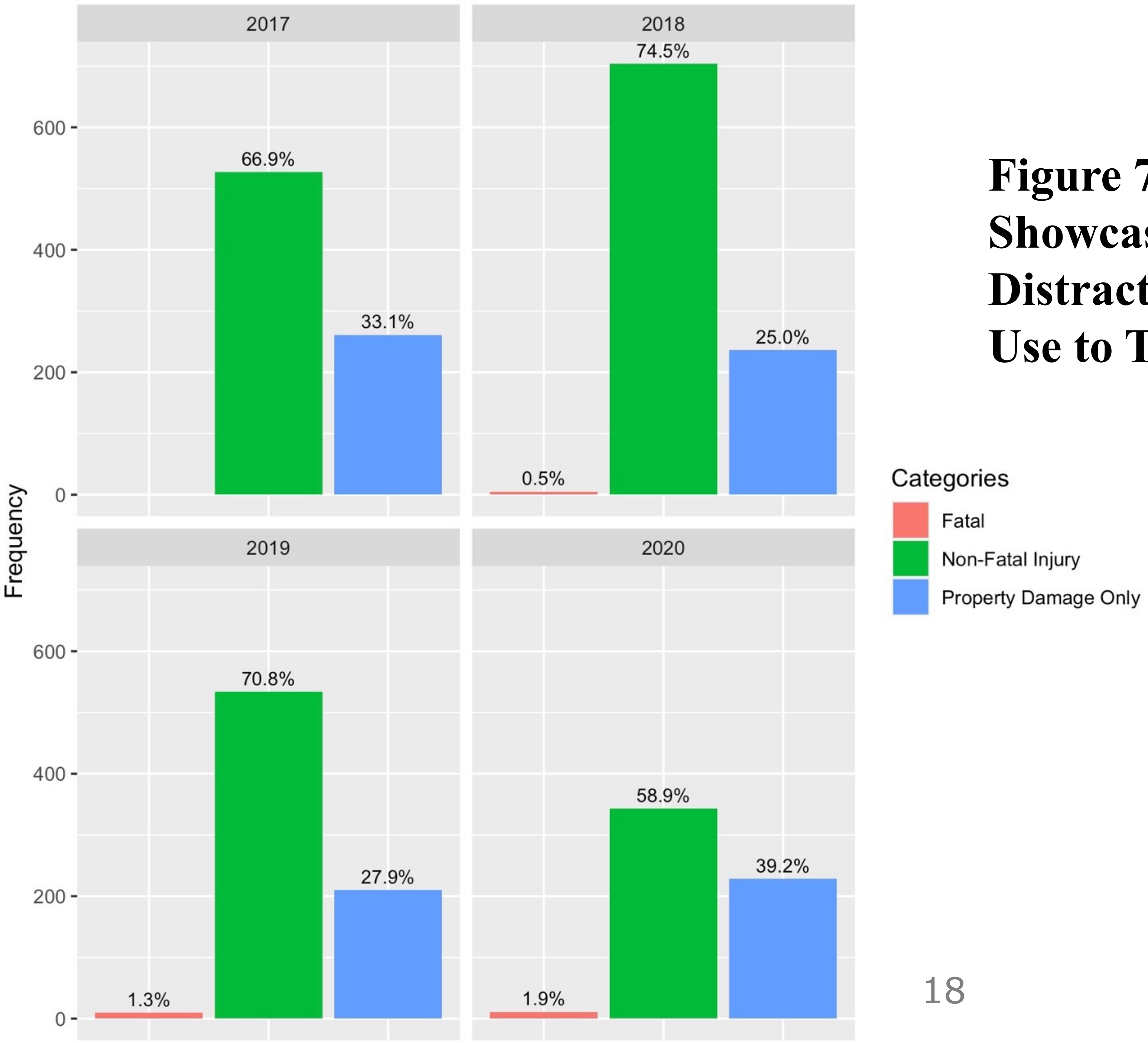


Figure 7- Histograms per Year Showcasing Injury Severity Across All Distraction Sources: From Cell Phone Use to Texting

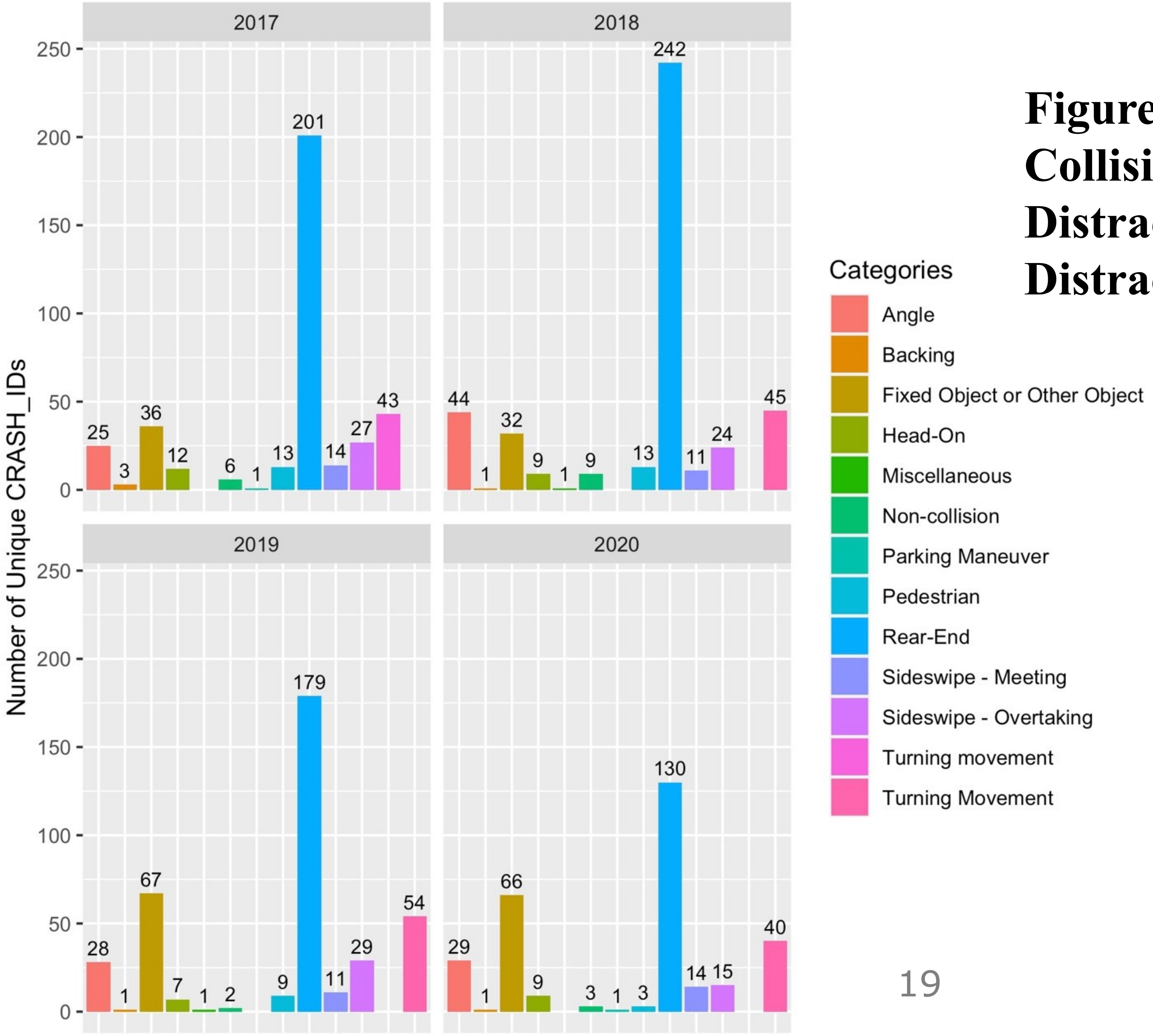


Figure 8 - Yearly Histograms of Collision Types Resulting from Distractions: Analyzing Impacts of Distraction-Induced Crashes

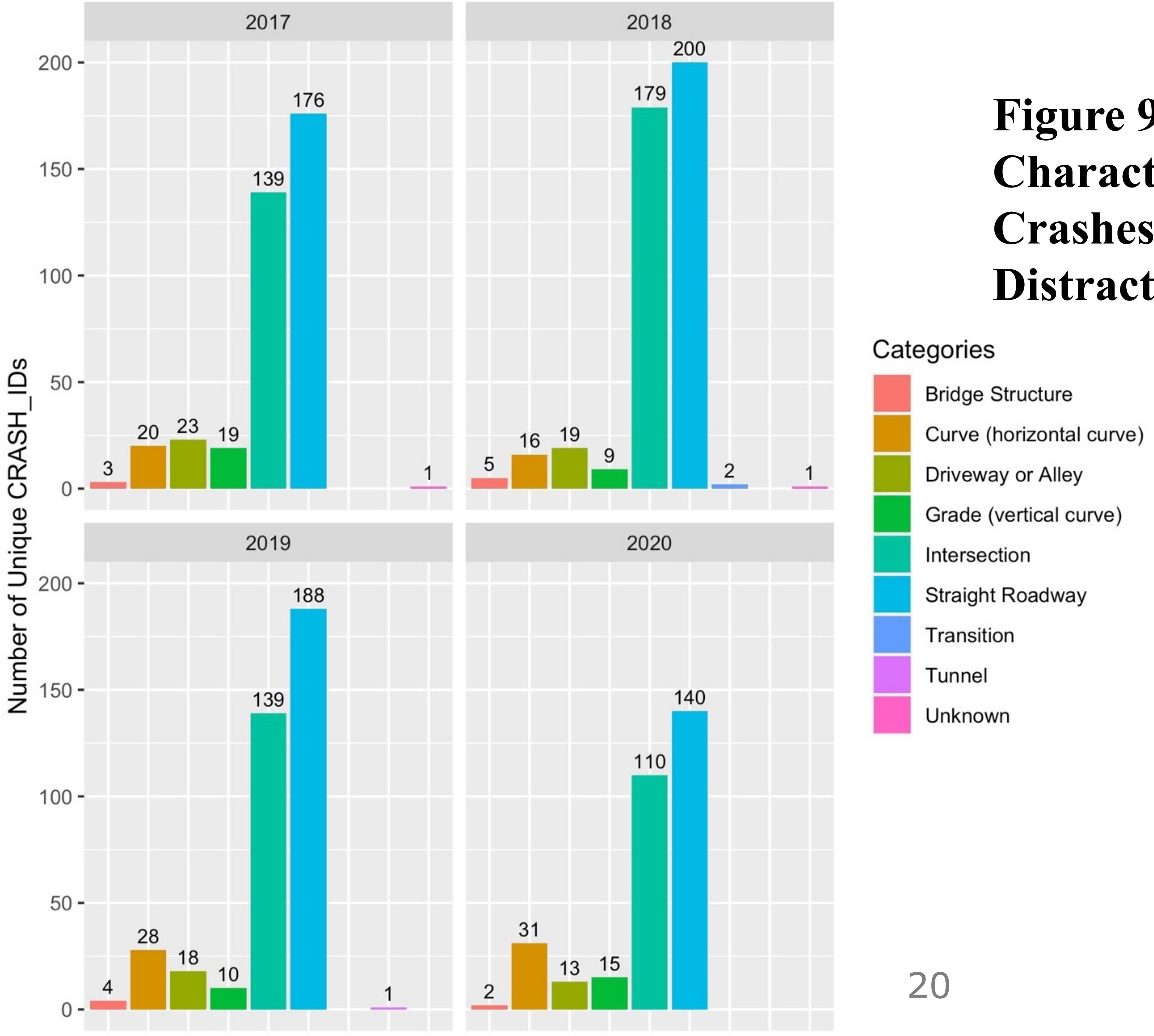


Figure 9 - Yearly Histograms of Roadway Characteristics in Distraction-Related Crashes: Analyzing Environments of Distraction-Induced Crashes

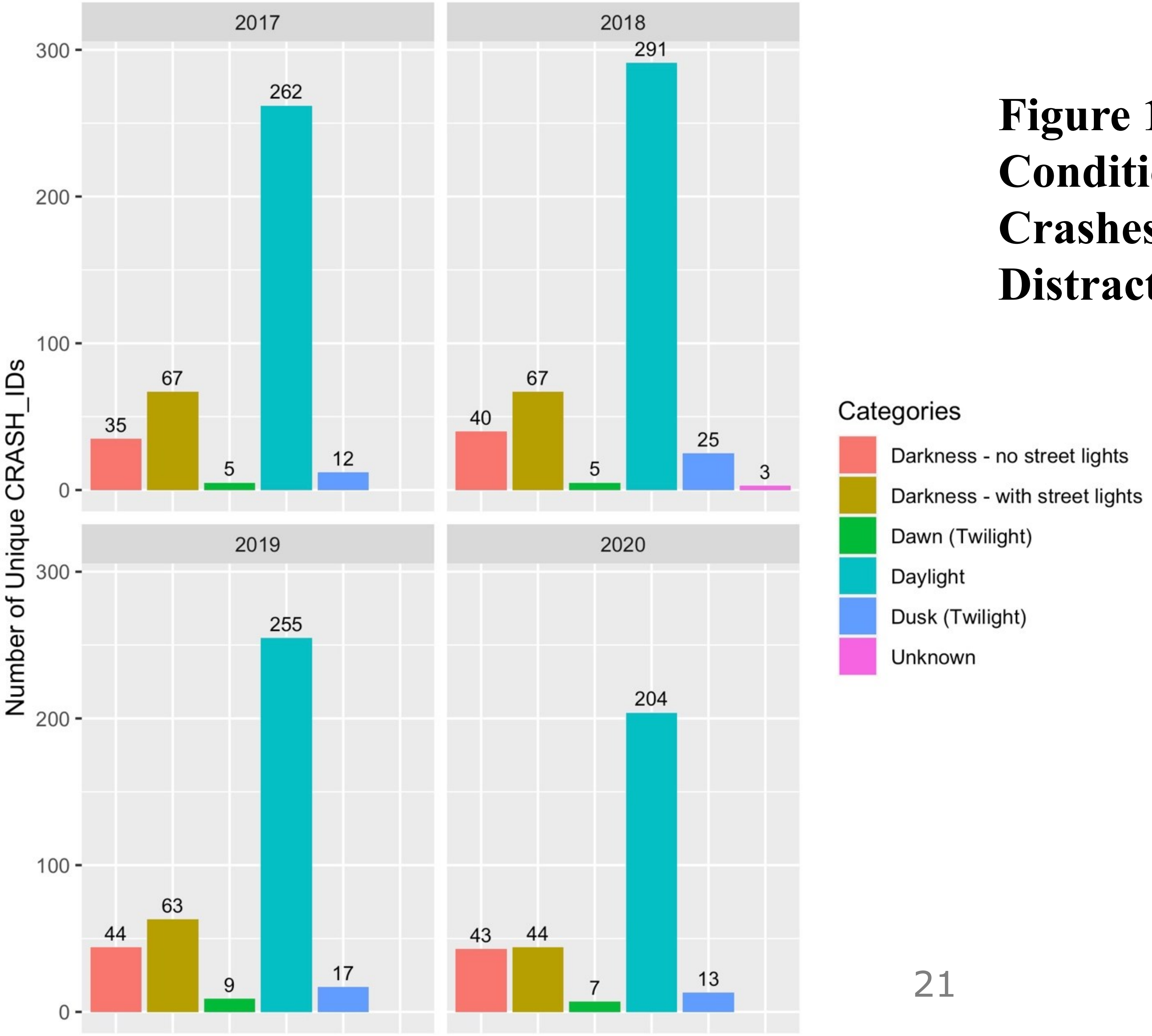


Figure 10 - Yearly Histograms of Lighting Conditions in Distraction-Related Crashes: Shedding Light on Times of Distraction-Induced Crashes

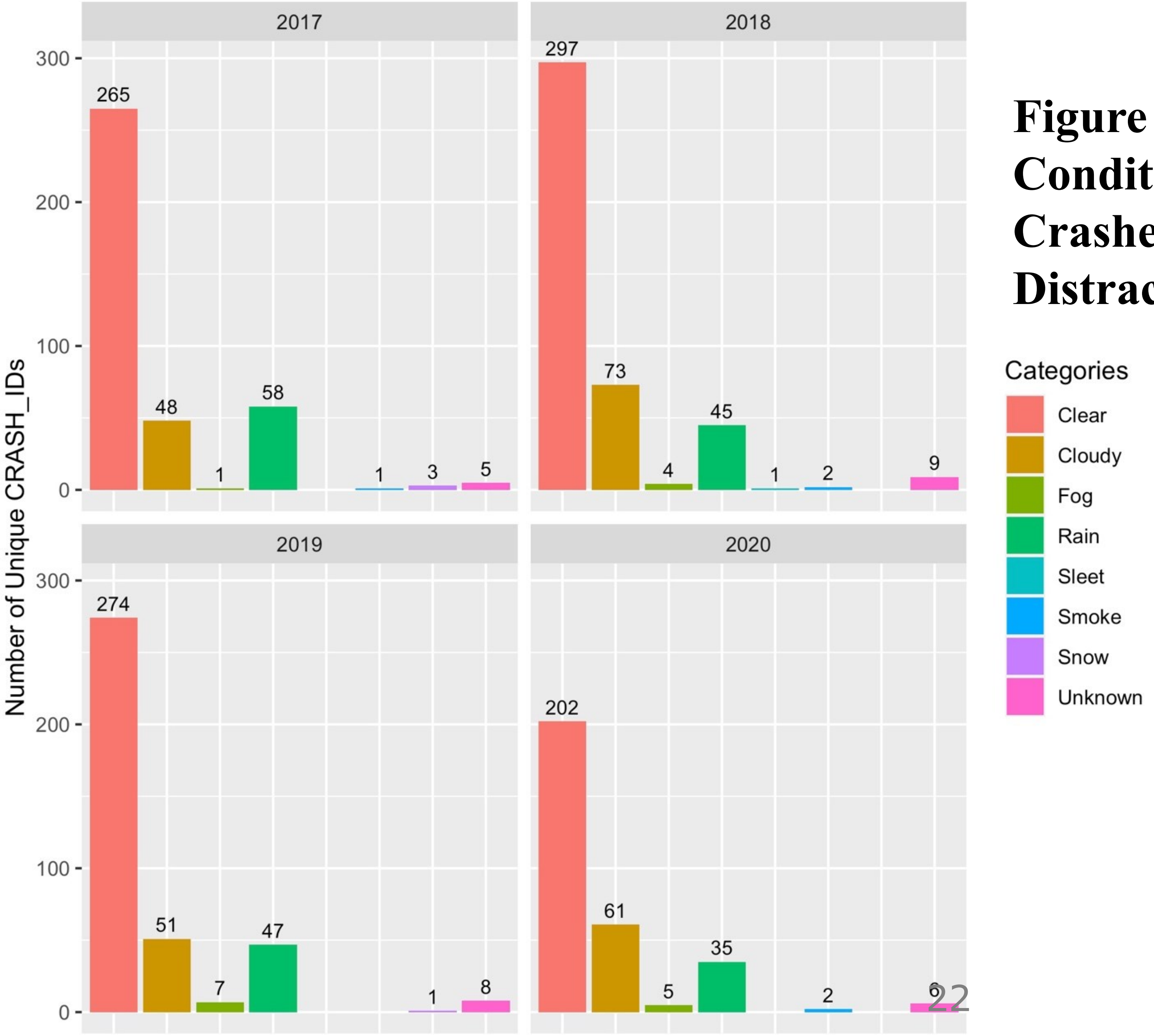


Figure 11 - Yearly Histograms of Weather Conditions in Distraction-Related Crashes: Unveiling the Climate of Distraction-Induced Crashes

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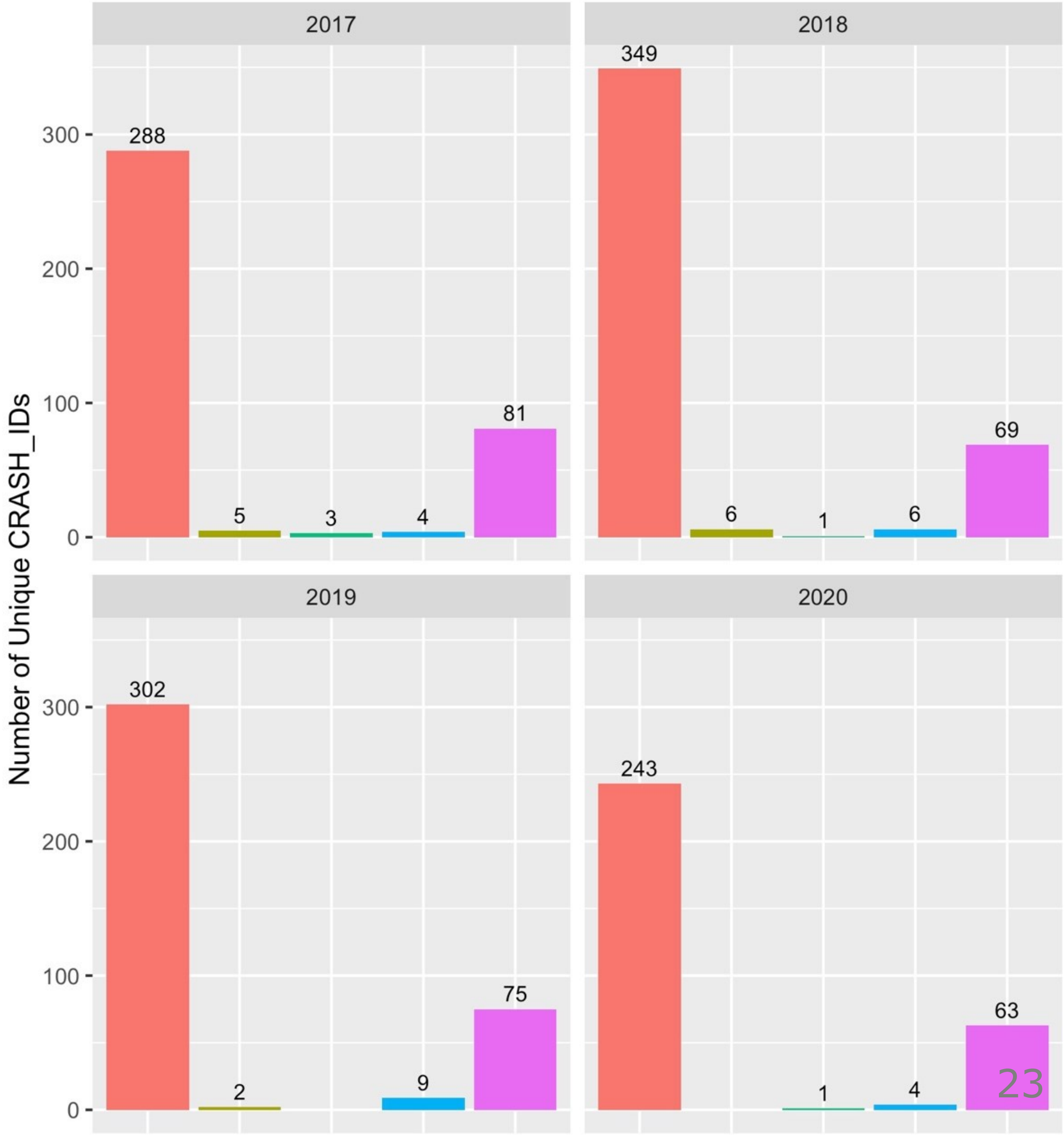


Figure 12 - Yearly Histograms of Roadway Conditions: Distribution of Distraction-Related Crashes on Dry, Ice, Snow, and Wet Surfaces

Descriptive Statistics of Variables found to be significant contributors

Table 3.2: Descriptive Statistics of Significant Variables by Injury Severity Category

Variable	Mean	Std Deviation
Mixed Logit Model		
Airbag (1 if the airbag deployed, 0 otherwise)	0.134572	0.341288
Collision Type (1 if rear-end, 0 otherwise)	0.562082	0.496162
High Speed (1 if was greater than 55 MPH, 0 otherwise)	0.178439	0.382905
Airbag (1 if the airbag deployed, 0 otherwise)	0.134572	0.341288
Collision Type (1 if fixed-object, 0 otherwise)	0.086245	0.280743
Safety Equipment (1 if seatbelt use, 0 otherwise)	0.549814	0.497543
Low Speed (1 if speed greater than 20 MPH but Less than 40 MPH, 0 otherwise)	0.302602	0.459413
Gender (1 if female, 0 otherwise)	0.30223	0.459253
Driver Proximity to Residence (1 if within 25 Miles, 0 otherwise)	0.521933	0.49955
Age (1 if driver age is less than 25 years old)	0.526766	0.499314

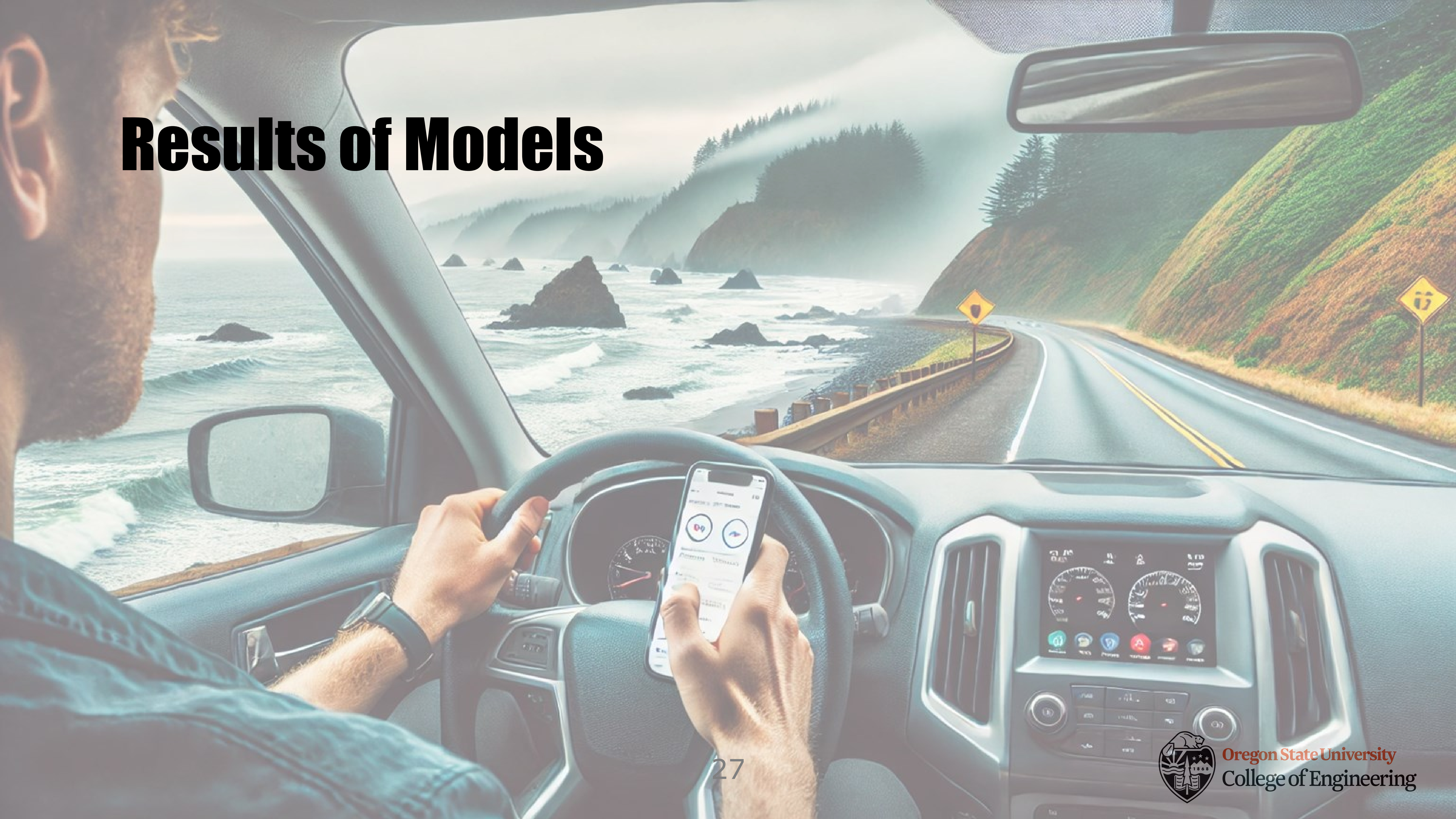
In your opinion, which age group is most likely to engage in distracted driving due to cell phone use?

- Teenagers (16-19) — 0%
- Young adults (20-29) — 0%
- Middle-aged adults (30-49) — 0%
- Older adults (50+) — 0%

Which technology do you think is most effective in minimizing driving distractions?

Advanced driver-assistance systems (ADAS)	0%
Mobile phone blockers	0%
Voice-activated controls	0%
None are significantly effective	0%

Results of Models



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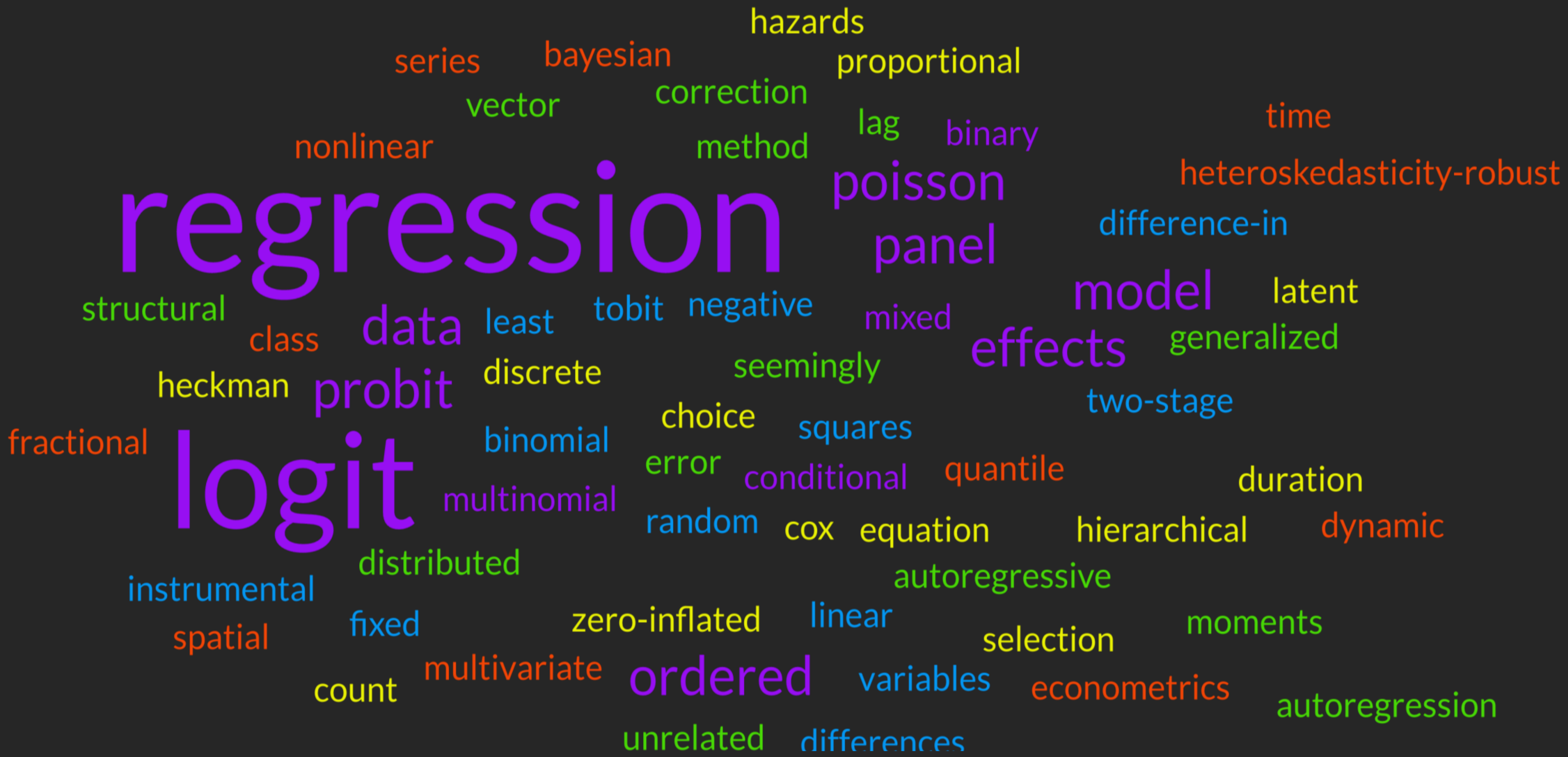
hazards
series
bayesian
proportional
correction
vector
time
lag
binary
nonlinear
method
heteroskedasticity-robust
regression
poisson
difference-in
panel
model
latent
structural
data
least
tobit
negative
mixed
effects
generalized
class
discrete
seemingly
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probit
two-stage
choice
fractional
logit
binomial
squares
error
conditional
quantile
duration
multinomial
random
cox
equation
hierarchical
dynamic
distributed
autoregressive
instrumental
fixed
zero-inflated
linear
moments
spatial
selection
multivariate
ordered
variables
econometrics
count
autoregression
unrelated
differences

Econometric Model: Mixed Logit Model Overview

- **Flexible Statistical Model:** Accounts for variations across individuals or events (unobserved heterogeneity).
- **Captures Random Effects:** Allows certain factors (like airbag deployment) to have different impacts on different drivers.
- **Probabilistic Outcomes:** Estimates the likelihood of each injury severity category (severe, minor, or no injury).
- **Overcomes Bias:** Corrects for hidden factors that could distort results.
- **Widely Used:** Applied in transportation and injury severity studies for more accurate predictions.

Results of Econometric Model

- **Modeling Approach in Crash Data Analysis**
  - **Unobserved Heterogeneity**:
    - Missing details like driver characteristics or subtle environmental factors can introduce variations in the data.
    - These hidden factors can bias model outcomes if not addressed.
  - **Mixed Logit Model**:
    - Used to handle unobserved heterogeneity and improve accuracy.
  - The model views injury severity as discrete choices, estimating the probability of each outcome.
- **Key Benefit:**
  - Highlights significant factors influencing the likelihood of specific injury severities.
  - Widely applied in recent injury severity studies for better insights.

Results of Econometric Model

- **Significant Variables:**
  - 10 significant variables across injury severity categories (Severe, Minor, No Injury).
  - **Airbag Deployment**: Significant in 'No Injury' and 'Minor Injury' categories.
  - **Driver Proximity to Residence (within 25 miles)**: Significant in 'No Injury' category.

Results of Econometric Model, Cont'd

Random Parameters:

- **Airbag Deployment (Minor Injury):** Mean = 1.91106, Std Dev = 1.94798.
  - 16.33% of cases: Reduced likelihood of minor injuries.
  - 83.67% of cases: Increased likelihood of minor injuries.
- **Driver Proximity to Residence (No Injury):** Mean = -2.12281, Std Dev = 3.01796.
  - 24.09%: Increased likelihood of no injury.
  - 75.91%: Increased likelihood of injury when closer to home.

Results of Econometric Model, Cont'd

- **Heterogeneity in Means:**
  - Age (35-45): Decreases likelihood of minor injury when airbags deploy.
  - Male Drivers: More likely to experience no injuries when crashes occur near home.
- **Heterogeneity in Variance:**
  - Rear-End Collisions: Increases variability in no-injury crashes near residence, potentially linked to driver behavior near home.

Results of Econometric Model, Cont'd

- **Crash Characteristics:**
  - **Rear-End Collisions**: Decrease in severe injuries, but higher likelihood of minor/no injuries.
  - **Fixed Object Collisions**: Increase in minor injuries, but lower probability of severe/no injuries.
  - **Airbag Deployment**: Increases severe injuries but slightly decreases minor/no injuries.
- **Driver Characteristics:**
  - **Female Drivers**: More likely to sustain severe/minor injuries but less likely to be involved in no-injury crashes.
  - **Drivers < 25 Years**: Higher likelihood of no injury, lower risk of severe/minor injuries, possibly due to physical resilience..

Results of Econometric Model, Cont'd

- **Accident-Specific Characteristics**:
  - **Speed > 55 MPH**: Increases probability of severe injuries.
  - **Proximity to Residence**: Increases odds of minor/severe injuries.

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Summary

- Analyzed 2,690 distracted driving crashes; 1.19% severe, 35.69% minor injuries, 63.12% property damage.
- Hot Spot Analysis linked crashes to cell coverage areas.
- Mixed Logit Model used to address unobserved factors like driver condition
- Airbag Deployment increases severe injury risk by 0.99%.
- Seatbelt Use significantly reduces injury severity.
- Younger Drivers (<25) more likely to sustain less severe injuries.

Thanks!

Assessing the Impact of Cellular Coverage Areas on Distracted Driving, Crashes, and Injuries

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ABSTRACT

This study combines econometric and geospatial methods to analyze the impact of cellular coverage on distracted driving incidents, crashes, and injuries in Oregon from 2017 to 2020, focusing on cell phone-related crashes. Despite reduced travel in 2020, these crashes remained high. Geospatial tools identified urban hotspots like Portland and Salem. We used the mixed logit model to evaluate factors like driver demographics, vehicle characteristics, and environmental conditions, shedding light on the economic aspects of injury severity. Results highlight the crucial role of seatbelt use in reducing injury severity. The study underlines the need for comprehensive strategies to combat distracted driving in Oregon for better road safety and to lower economic costs associated with such incidents.

1. INTRODUCTION

Technological advancements in communication, coupled with the growing popularity of social media platforms like Instagram, Meta (formerly Facebook), and TikTok, have accelerated the use of cell phones in motor vehicles. As of now, the United States boasts over 300 million smartphone users, a figure projected to reach 360 million by 2040 (Statista, 2023). While

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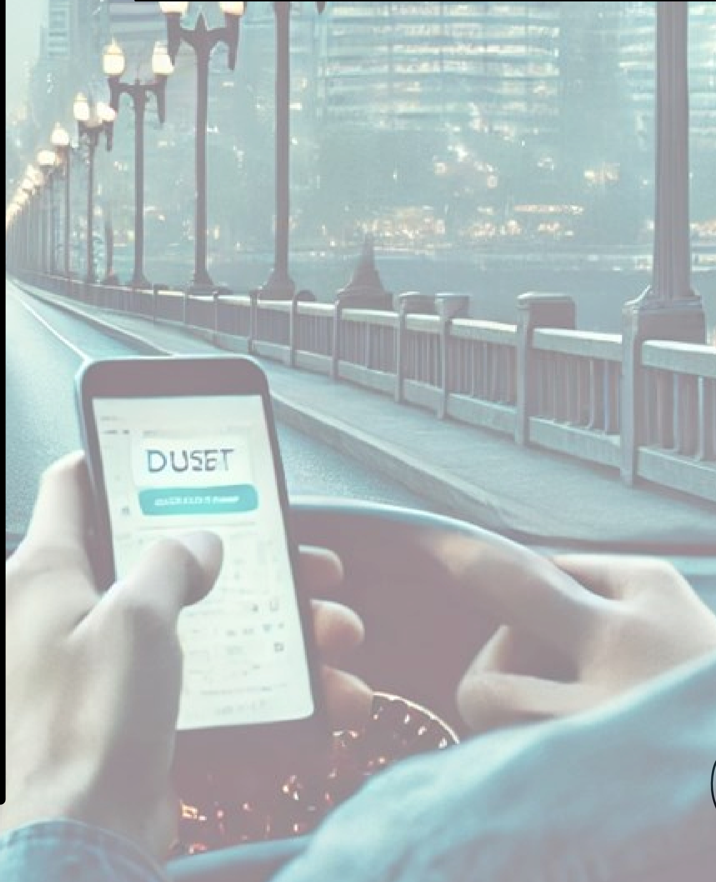
Kelly Kapri,
Distracted Driving Program Manager



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