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Examining the impact of driver distraction on speeding through the exploitation of smartphone sensor data

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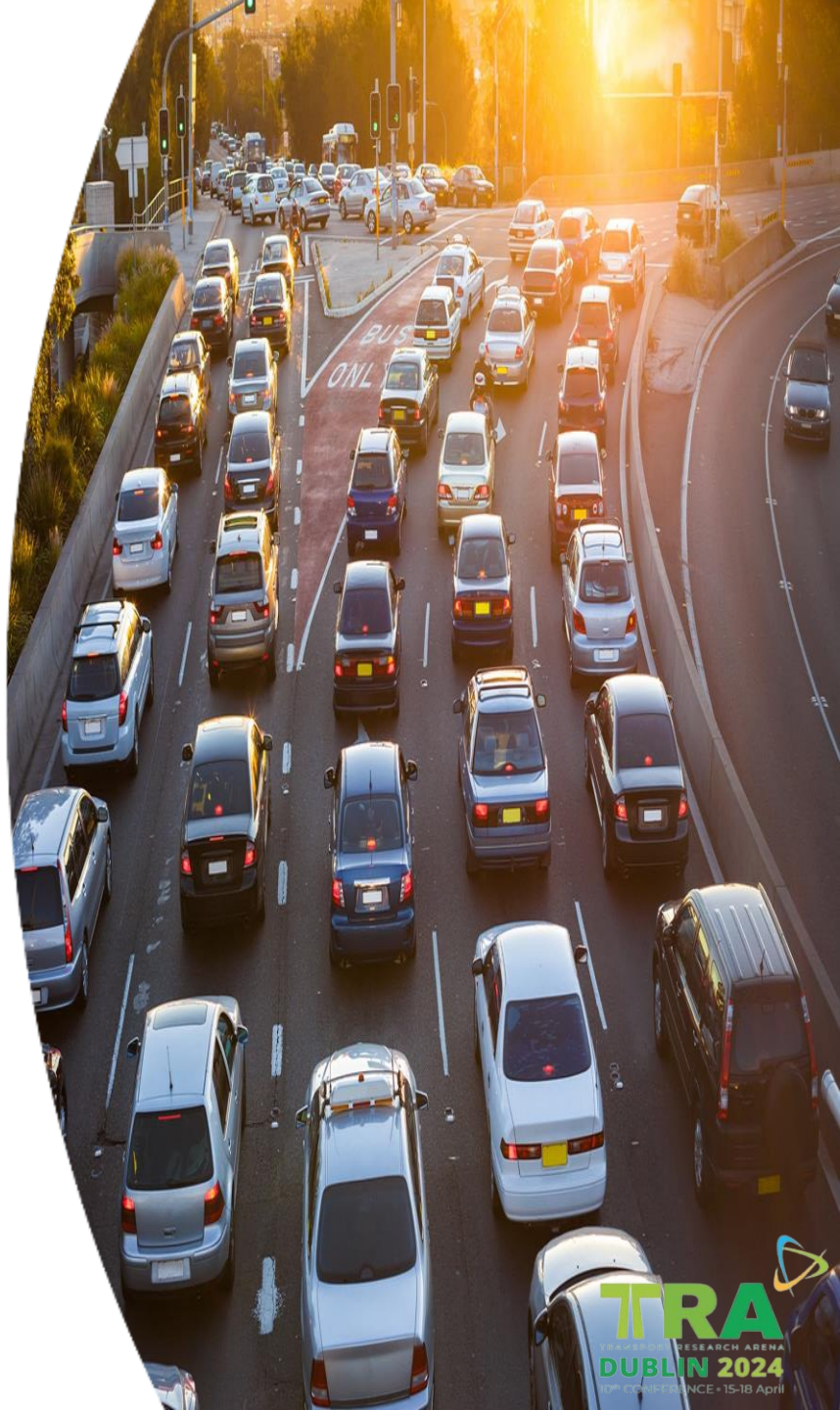
Introduction

- Embracing new technological applications, such as smartphones, has become a contemporary approach for drivers seeking information and navigation.
- However, the surge in their unwarranted utilization has heightened the risk of road accidents stemming from driver distraction.
- Driver distraction significantly increases the risk of motor vehicle accidents, contributing to approximately 25% of all traffic collision fatalities.
- In recent years, new technologies and safety systems have been integrated into the interior of vehicles (e.g. collision prevention systems, distance sensors, airbags).



Objectives

- Investigating how driver distraction affects speeding using smartphone sensor data.
- Examining the correlation between driver distraction and speeding tendencies
- Experiment for a period of six months.
- Development of four statistical lognormal regression models predicting speeding rate: one overall model and one by road type (i.e. highway, rural, urban).

Smartphone data collection (1/2)

- A mobile application to record user's driving behavior (automatic start / stop), Oseven.
- The application has developed a comprehensive system to capture, collect, store, evaluate and present driving behavior data using mobile phone applications and advanced Machine Learning algorithms.
- Data are transmitted from the mobile App to the central database.
- Data are stored in a sophisticated database where they are managed and processed.

Smartphone data collection (2/2)

- First, an experiment was conducted in real-world driving conditions using large-scale data collected through a mobile phone application.
- In the experiment participated 100 drivers aged 18-65.
- Before the start of the experiment, the participants filled out a specially designed questionnaire which included three different sections:
  a. driving experience – transportation
  b. vehicle
  c. driving behavior

Detect Driving

Collect Sensors Data

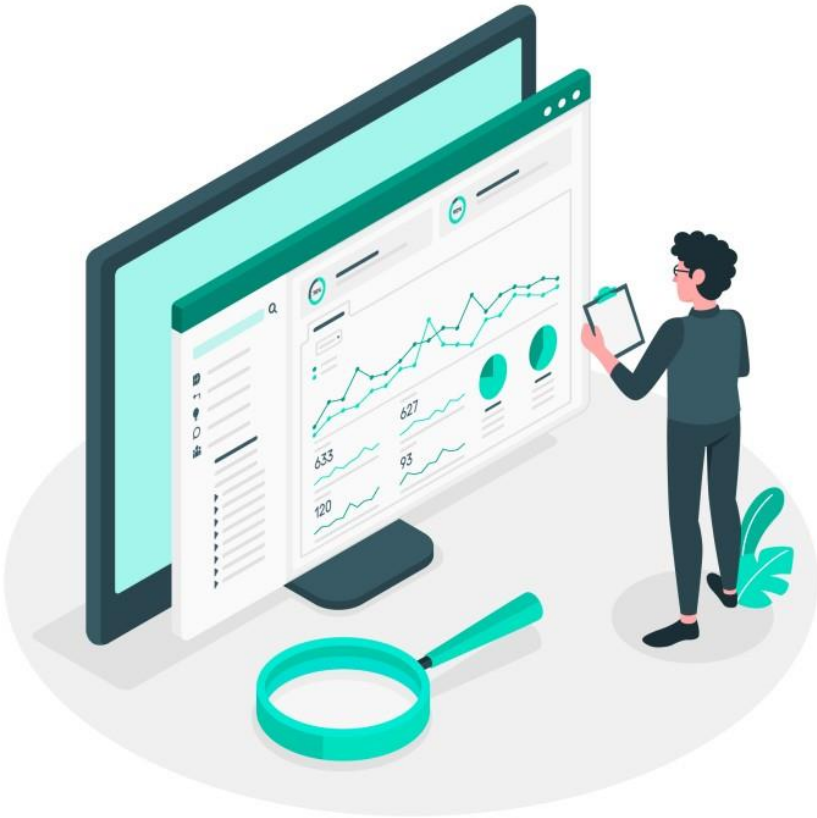
Data Processing

Scores & Analytics

Methodology

- When a variable Y is linearly depended on more than one variables X (X1, X2, X3,….,Xκ), multiple linear regression is used. The mathematical relationship that describes this equation is as follows:

$$\log(y_i) = b_0 + b_1 \times x_{1_i} + b_2 \times x_{2_i} + \cdots + b_n \times x_{n_i} + e_i$$



- Mathematical models:

1. All road type together (highway, rural, urban)
2. Each different road type

Results (1/3)

- Final multiple lognormal regression models.

Independent Variables	Model 1 (Overall)			Model 2 (Highway)			Model 3 (Rural)			Model 4 (Urban)		
	b_i	t	e_i	b_i	t	e_i	b_i	t	e_i	b_i	t	e_i
Constant	1,493	57,351		1,690	30,019		1,654	54,509		3,033	187,263	
Mobile phone use	1,007	100,984	0,847	0,763	26,025	0,242	0,546	31,813	0,164	-1,039	-118,139	-0,231
Harsh accelerations	0,014	4,496	0,245	0,039	4,909	0,050	0,059	13,743	0,306	0,027	6,97	0,400
Avg. deceleration	-0,066	-5,439	-0,574	-0,097	-8,005	-0,064	-0,043	-4,906	-0,145	-0,027	-4,131	-0,294
Distance travelled	0,003	10,03	1,004	-0,003	-15,439	0,201	0,001	3,294	0,361	0,005	25,942	1,074
Risky hours driving	0,007	4,478	0,654	0,009	4,393	0,428	0,007	4,675	0,245	0,005	4,023	0,407
Gender	-0,58	-58,866	-0,116	-0,733	-25,412	-0,156	-0,471	-28,683	-0,105	-0,614	-79,272	-0,078
Age	-0,123	-24,775	-0,048	-0,051	-8,918	-0,017	-0,181	-26,857	-0,044	-0,291	-70,157	-0,039
R2		0,491			0,728			0,569			0,562	

Results (2/3)

- Comparison of the lognormal regression mathematical models applied for speeding.

Independent Variables	Model 1 (Overall)	Model 2 (Highway)	Model 3 (Rural)	Model 4 (Urban)
Mobile phone use	17,650	14,188	3,686	5,995
Harsh accelerations	5,106	2,956	6,876	10,366
Avg. deceleration	11,954	3,747	3,253	7,616
Distance travelled	20,906	11,801	8,106	27,811
Risky hours driving	13,626	25,125	5,515	10,552
Gender	2,412	9,136	2,350	2,024
Age	1,000	1,000	1,000	1,000

Results (3/3)

- Mobile phone use while driving positively correlates with exceeding speed limits on highways, rural areas, and overall.
- Distracted drivers exhibit less focus on driving tasks on highways and rural areas, resulting in higher levels of speeding.
- In urban areas, speeding shows a negative correlation with distraction from mobile phone use.
- Increased distance traveled, number of harsh accelerations, and driving during risky hours are associated with higher percentages of speeding.
- Male drivers display less attention to speed limits compared to females, while older and more experienced drivers tend to follow more closely to speed limits.
- In the overall model, the variable "distance traveled" had the greatest impact among all independent variables on speeding.

Conclusions

- Driver distraction and mobile phone use while driving significantly impact speeding behavior, leading to reduced perception of surroundings and decreased speeding rates, particularly in urban areas.
- Distance traveled emerges as the most influential factor across all models predicting speeding, with longer distances associated with aggressive driving styles and higher rates of speeding.
- Driving during risky hours is linked to increased speeding incidents across all road types, suggesting a connection between low traffic volumes during these hours and heightened nervous/aggressive driving behaviors.
- Gender and age are significant factors influencing speeding behavior, with male and younger drivers displaying higher rates of speeding and riskier driving behavior compared to female and older drivers, respectively.
- The above findings reinforce the need for education and awareness measures regarding safe driving and limiting mobile phone use while driving.

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