



**ICTR** 2023



**11<sup>th</sup> INTERNATIONAL CONGRESS on TRANSPORTATION RESEARCH**  
**Clean and Accessible to All Multimodal Transport**  
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# Evaluation of safety interventions on risky driving behavior using data from a novel naturalistic driving experiment

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# The i-DREAMS project

## ➤ 13 Project partners:

- [National Technical University of Athens](#)

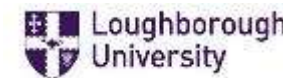
[Universiteit Hasselt](#), [Loughborough University](#), [Technische Universität München](#), [Kuratorium für Verkehrssicherheit](#), [Delft University of Technology](#), [University of Maribor](#), [OSeven Telematics](#), [DriveSimSolutions](#), [CardioID Technologies](#), [European Transport Safety Council](#), [POLIS Network](#), [Barraqueiro Transportes S.A.](#)

## ➤ Duration of the project:

- 48 months (May 2019 – April 2023)

## ➤ Framework Program:

- [Horizon 2020](#) - The EU Union Framework Programme for Research and Innovation - Mobility for Growth





# Introduction

- The primary cause of road crashes is attributed to **driving behavior** factors
- **Risky driving factors** include speeding, aggressive or impaired driving, distraction etc.
- **Naturalistic driving studies** have been extensively documented, as effective and accurate means of assessing driving behavior
- Automotive **telematics** and driver monitoring systems leverage technology for safety interventions and driver feedback



# Objectives

The assessment of the i-DREAMS safety interventions' impact on risky driving behavior, focusing on **speeding**

- The examination of the **correlation** between speeding events and the safety intervention Phases, as well as other risky driving factors
- The investigation of the **statistically significant difference** on speeding events among the safety intervention Phases





# Methodological Overview

- A **naturalistic driving experiment** was carried out involving 25 car drivers from Germany and a database consisting of 4,633 trips from February to September 2022 was analyzed
- A zero-inflated **negative binomial** (ZNB) model was developed for depicting the correlations between the speeding among the different safety intervention Phases and other risky driving factors like harsh acceleration, braking, steering, and fatigue
- A **Friedman test** was used to determine if there is a statistically significant difference on speeding events among the Phases



# i-DREAMS Experiment

- i-DREAMS aims to setup a framework for the definition, development and validation of a context-aware '**Safety Tolerance Zone (STZ)**' for driving
- The STZ includes **three different severity levels**: 'normal driving', 'danger' and 'avoidable crash' level
- The fundamental goal is to **keep the driver in the normal driving** level for as long as possible
- The experimental design of the on-road study consists of **4 Phases** during which real-time and post-trip interventions are provided to the drivers
- **Real-time interventions** trigger warnings of varying severity levels, depending on the detected event
- **Post-trip interventions** providing drivers with feedback through a smartphone app

## Phase 1 (Baseline)

- Intervention: No
- Duration: 4 weeks

## Phase 2

- Intervention: Real-time
- Duration: 4 weeks

## Phase 3

- Intervention: Real-time + Post-trip
- Duration: 4 weeks

## Phase 4

- Intervention: Real-time + Post-trip + Gamification
- Duration: 6 weeks



# Data Description

- The collected data concern a variety of factors about Safety Promoting Goals (SPGs) and Performance Objectives (PO):
  - **SPGs** encompass driving behaviors linked to safety outcomes
  - **POs** are specific actions or behavioral parameters necessary to achieve the SPGs
- For each PO, events were detected **categorized** as 'high' severity, 'medium' severity, and 'total' (medium + high) events
- The '**medium**' events correspond to the 'danger' STZ level where the risk of crash increases as internal /external events occur
- The '**high**' events correspond to the 'avoidable accident' STZ level where the crash risk is further increased if no preventative action taken by driver

SPG	PO (events/100 km)	Severity level	Median	STD
Speed Management	Speeding	Medium	6	22
		High	28	45
Vehicle Control	Acceleration	Medium	13	51
		High	0	17
	Deceleration	Medium	0	11
		High	0	4
	Steering	Medium	31	63
		High	0	13
Driver Fitness	Fatigue	Medium	0	1
		High	0	0
Distance (km)/trip		NA	7.94	29.94
Duration (sec)/trip		NA	758.50	1253



# ZNB Results

- The 'high' severity speeding events per 100 km are considered as a representative indicator of risky driving behavior
- Variables are considered statistically significant at the typical 95% level and 90% level, except of Phase 2 which seems to be insignificant
- The speeding events are decreasing significantly by providing a combination of real-time and post-trip interventions (Phase3) as well as by adding gamification features (Phase4) compared to no interventions (Phase1)
- A statistically significant correlation between the trip distance and risky driving behavior is depicted
- Longer trips and higher frequency of harsh events and fatigue events have a notable impact on increasing 'high' speeding events

Conditional model:	Estimate	Std. Error	z value	Pr(> z )	
(Intercept)	3.617	0.070	51.620	< 2e-16	***
Phase 2 (ref. level: Phase 1)	-0.005	0.030	-0.150	0.880	
Phase 3 (ref. level: Phase 1)	-0.072	0.031	-2.340	0.020	*
Phase 4 (ref. level: Phase1)	-0.053	0.029	-1.840	0.065	.
Trip Distance	-0.012	0.000	-26.530	< 2e-16	***
Total acceleration events /100 km	0.002	0.000	8.840	< 2e-16	***
Total deceleration events /100 km	0.005	0.001	6.060	0.000	***
Total steering events /100 km	0.003	0.000	15.260	< 2e-16	***
High fatigue events /100 km	2.017	0.422	4.770	0.000	***
Medium fatigue events /100 km	0.017	0.006	2.840	0.005	**

Zero-inflation model:	Estimate	Std. Error	z value	Pr(> z )	
(Intercept)	-1.475	0.038	-38.610	<2e-16	***
Log-likelihood of the model	-18,942.3				

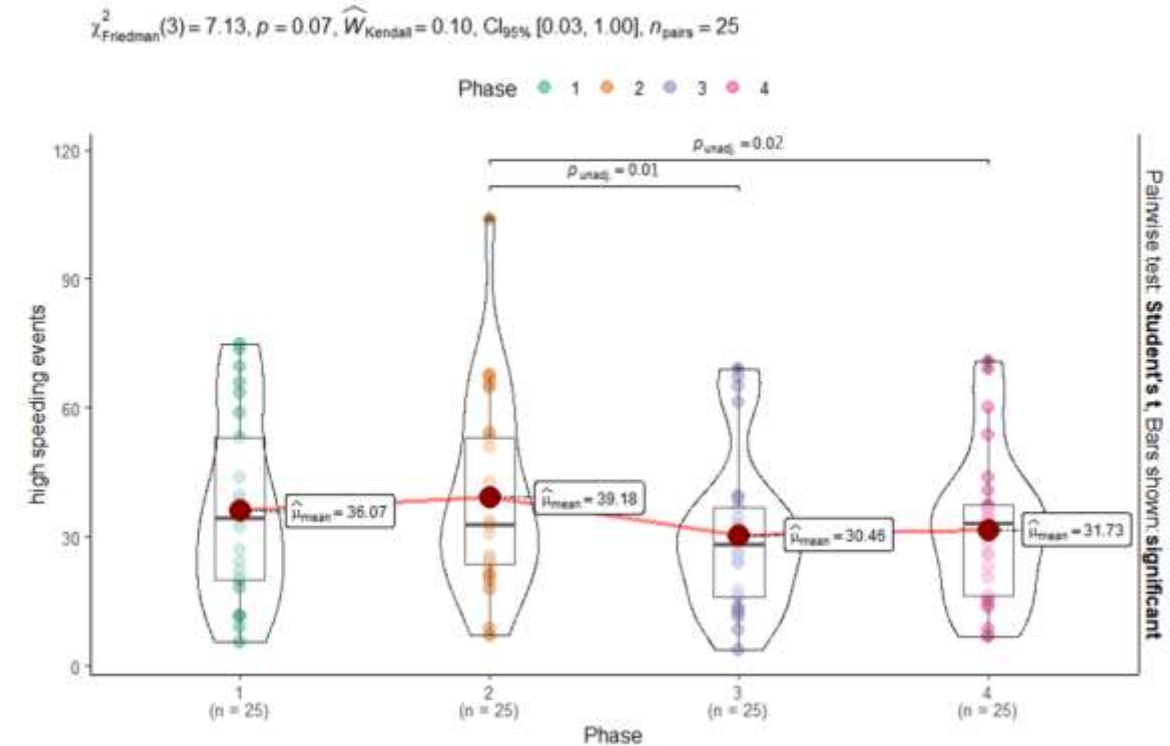
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# Friedman test Results

- A Friedman test is conducted as a **follow-up analysis** to explore further the differences in risky driving behavior among the 4 Phases
- A **post-hoc test** is conducted to further examine the specific pairwise differences between the Phases
- There is a **statistically significant difference** in the 'high' speeding events recorded during the i-DREAMS field trial in Germany
- There is a statistically significant decrease of high speeding events in **Phase 3 vs. Phase 2** ( $p = 0.01$ ) and in **Phase 4 vs. Phase 2** ( $p=0.02$ )



# Conclusions

- Real-time feedback using an adaptive ADAS system and post-trip feedback using a telematics mobile app, had **significant positive effects in addressing risky driving behavior**, particularly speeding events
- There is a positive impact of **combining real-time and post-trip** interventions, along with the incorporation of gamification features, in reducing speeding events
- The impact of providing **only real-time interventions** is positive but not statistically significant in improving safety
- **Longer trips and higher frequency** of harsh events and fatigue events have a notable impact on increasing speeding events
- Overall, these findings emphasize the **efficacy of specific intervention schemes** and highlight the importance of addressing multiple risk factors simultaneously to enhance driver behavior





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