10th INTERNATIONAL CONGRESS
ON TRANSPORTATION
RESEARCH

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Investigation of speeding and aggressive behavior of professional drivers on highways through an innovative smartphone application

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Background

- The Internet of Things (IoT) constantly offers new opportunities and features to monitor and analyse driver behavior through:
  - Widespread use of smartphones and social media
  - Effective data collection and handling
  - Big Data Analysis

- Naturalistic driving experiments via smartphones allow for:
  - Investigation of the impact of risk factors on driver behavior
  - Identification of aggressive and dangerous driving profiles
  - Provision of driver feedback

The BeSmart project

BESMART

- **Project partners**:
  - National Technical University of Athens, Department of Transportation Planning and Engineering www.nrso.ntua.gr
  - OSeven Private Company www.oseven.io
- **Duration of the project**:
  - 42 months (July 2018 – January 2022)
- **Operational Program**:
  - "Competitiveness, Entrepreneurship and Innovation" (EPAnEK) of the National Strategic Reference Framework (NSRF)

European Union
European Regional Development Fund

ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΥΠΟΥΡΓΕΙΟ ΠΑΙΔΕΙΑΣ ΕΡΕΥΝΑΣ & ΘΡΗΣΚΕΥΜΑΤΩΝ

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ΕΙΔΙΚΗ ΥΠΗΡΕΣΙΑ ΔΙΑΧΕΙΡΙΣΗΣ ΕΠΑνΕΚ

EPAnEK 2014-2020
OPERATIONAL PROGRAMME
COMPETITIVENESS • ENTREPRENEURSHIP • INNOVATION

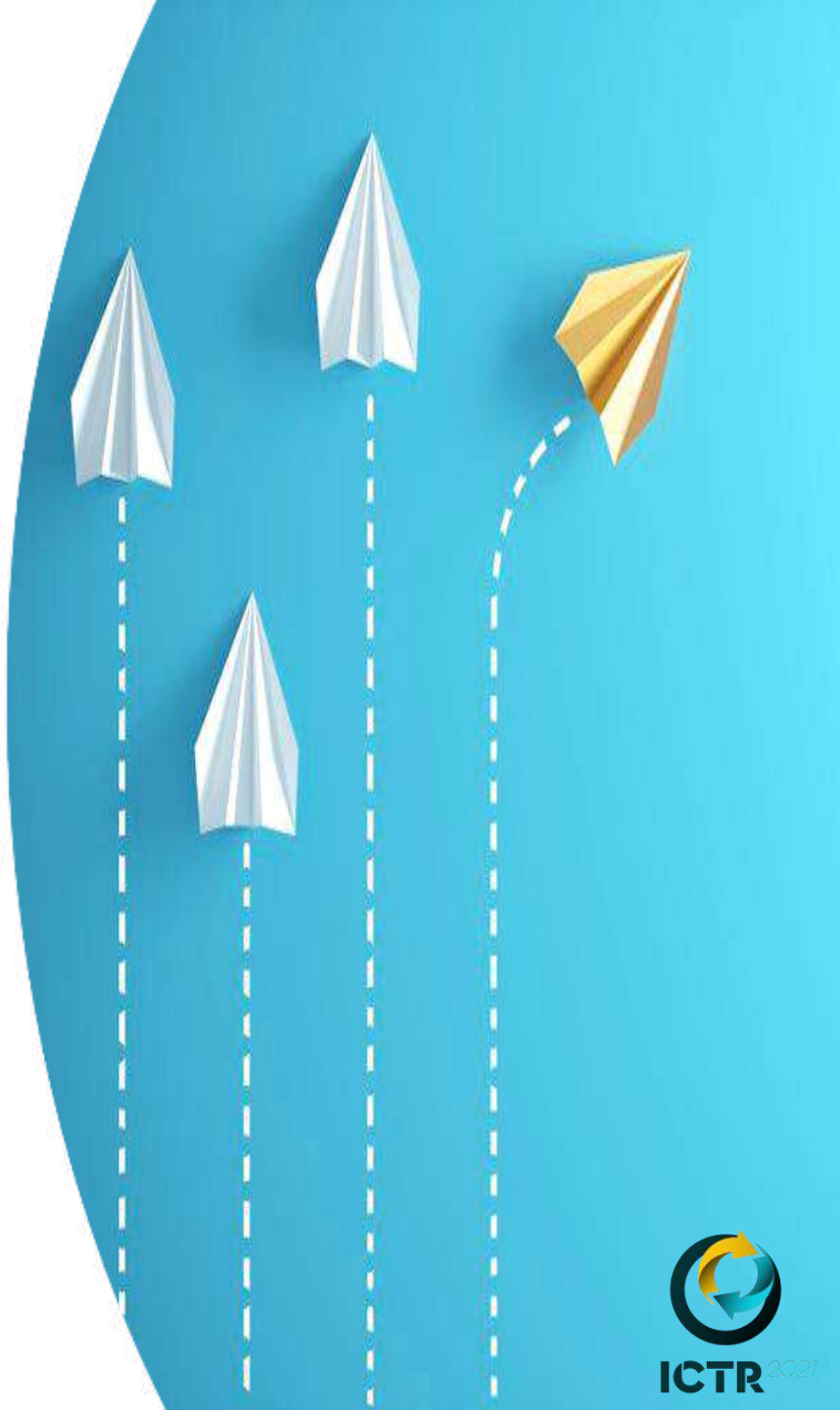
The BeSmart Objectives

- Development of an innovative and seamless Internet of Things application
- Assessment and improvement of behavior and safety of all drivers (car drivers, powered two-wheelers, cyclists, professional drivers) along multi-modal trips
- Organization and exploitation of a naturalistic driving experiment of 200 drivers for 12 months

Research Scope

- Which are the critical driving parameters that affect speeding and aggressive behavior of professional drivers on highways using data from:
  - Smartphone devices
  - Naturalistic driving experiment

- Can incentives in a social gamification scheme through a smartphone application improve driving behavior?



The BeSmart driving experiment

- The experiment consists of different phases differing in the type of feedback provided to drivers
- The present study refers to Phases A and B:
  - Phase A - personalized feedback; namely a trip list and a scorecard regarding their driving behavior are provided to drivers
  - Phase B - 30-day competition with prizes for safe driving
- A total of 5,345 trips from a sample of 19 professional drivers were recorded

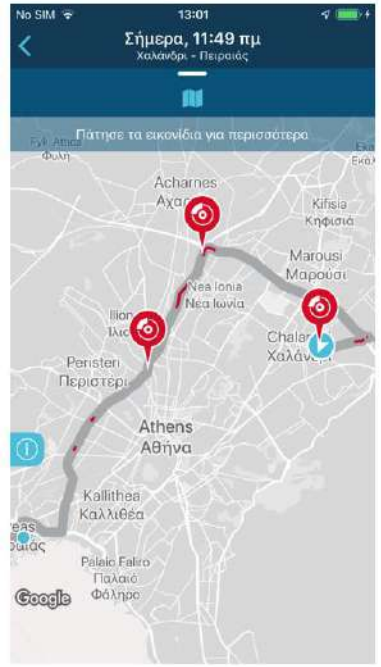
The BeSmart Application

Driving behavior characteristics

- Speeding
- Harsh braking
- Harsh acceleration
- Harsh cornering
- Mobile phone use

Travel behavior characteristics

- Total distance
- Road network type
- Risky hours driving
- Vehicle type



Smartphone data collection

- A variety of APIs is used to read mobile phone sensor data
- Data is transmitted from the mobile App to the central database
- Data are stored in a sophisticated database where they are managed and processed
- Indicators are designed using machine learning algorithms and big data mining techniques
- State-of-the-art technologies and procedures in compliance with personal data protection laws (GDPR)

Methodology

Analysis scope

- Among the recorded risk factors, the frequency of harsh events and speeding is chosen to be investigated in the present study

Selection of statistical method

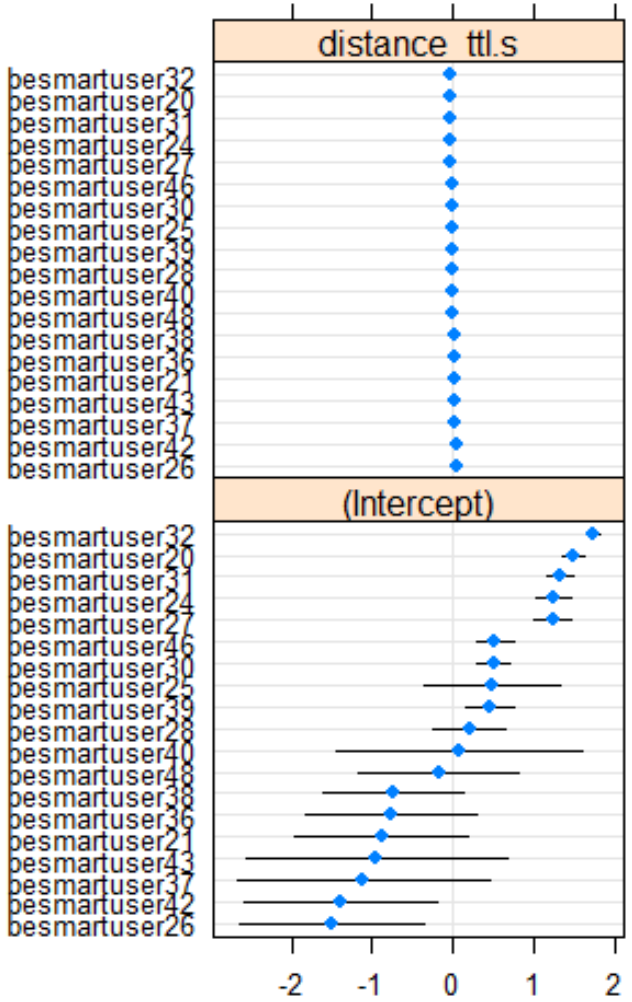
- Need for event prediction - data counting (data modeling)
- Generalized Linear Mixed-Effects Models (GLMMs) to capture different driving behaviors, given by the following formula:

$$log(\lambda_i) = \beta_{0i} + \beta_{ji}x_{ji} + \beta_{n-1}x_{n-1} + \varepsilon$$

Results (1/3)

GLMMs for the percentage of travelled time above the speed limits per trip

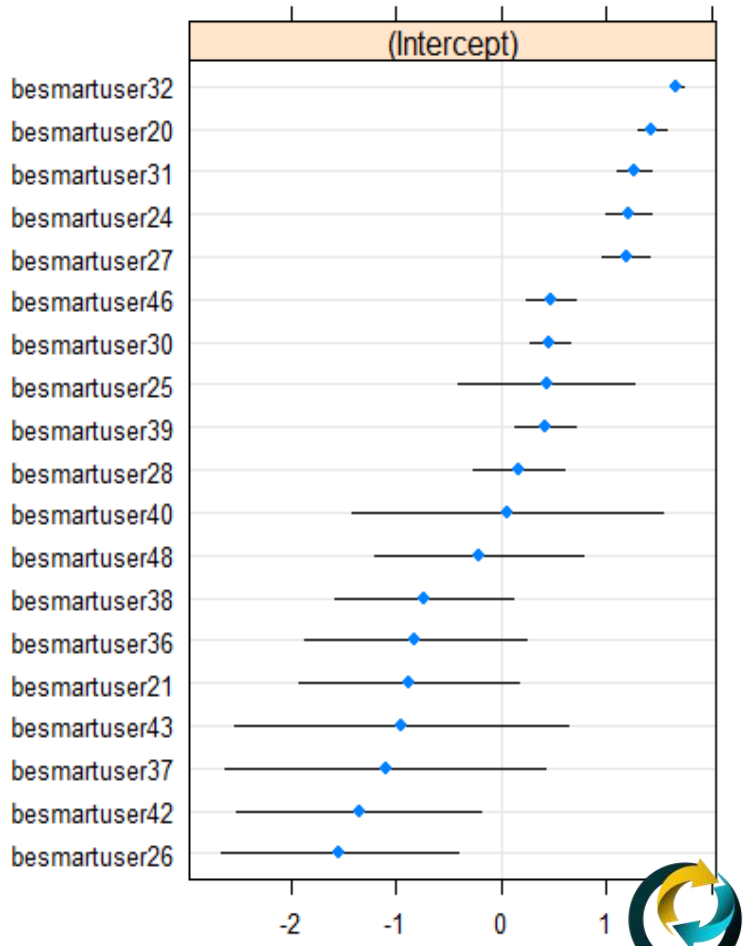
Trip characteristic	Estimate	s.e.	p-value	Sig.	Rel. Risk Ratio
Intercept	-12.581	1.736	0.000	***	-
Competition	-1.492	0.339	0.000	***	0.225
Trip Duration	- 6.148	0.421	0.000	***	0.002
Harsh Acceleration	0.422	0.027	0.000	***	1.525



Results (2/3)

GLMMs for the frequencies of harsh acceleration events per trip

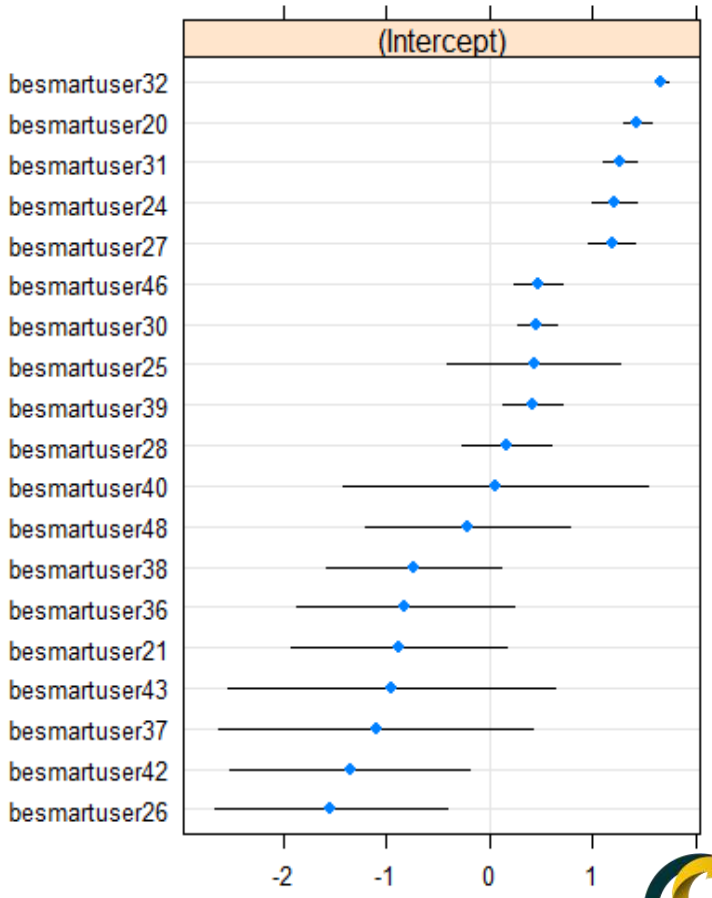
Trip characteristic	Estimate	s.e.	p-value	Sig.	Rel. Risk Ratio
Intercept	-3.531	0.341	0.000	***	-
Competition	-1.054	0.219	0.000	***	0.348
Trip Duration	0.444	0.026	0.000	***	1.558
Weekend	-0.414	0.175	0.000	*	0.661



Results (3/3)

GLMMs for the frequencies of harsh braking events per trip

Trip characteristic	Estimate	s.e.	p-value	Sig.	Rel. Risk Ratio
Intercept	-2.384	-8.161	0.000	***	-
Competition	-0.907	-7.738	0.000	***	0.404
Trip Duration	0.447	45.106	0.000	***	1.564
Weekend	-0.290	-3.432	0.001	***	0.748



Conclusions (1/2)

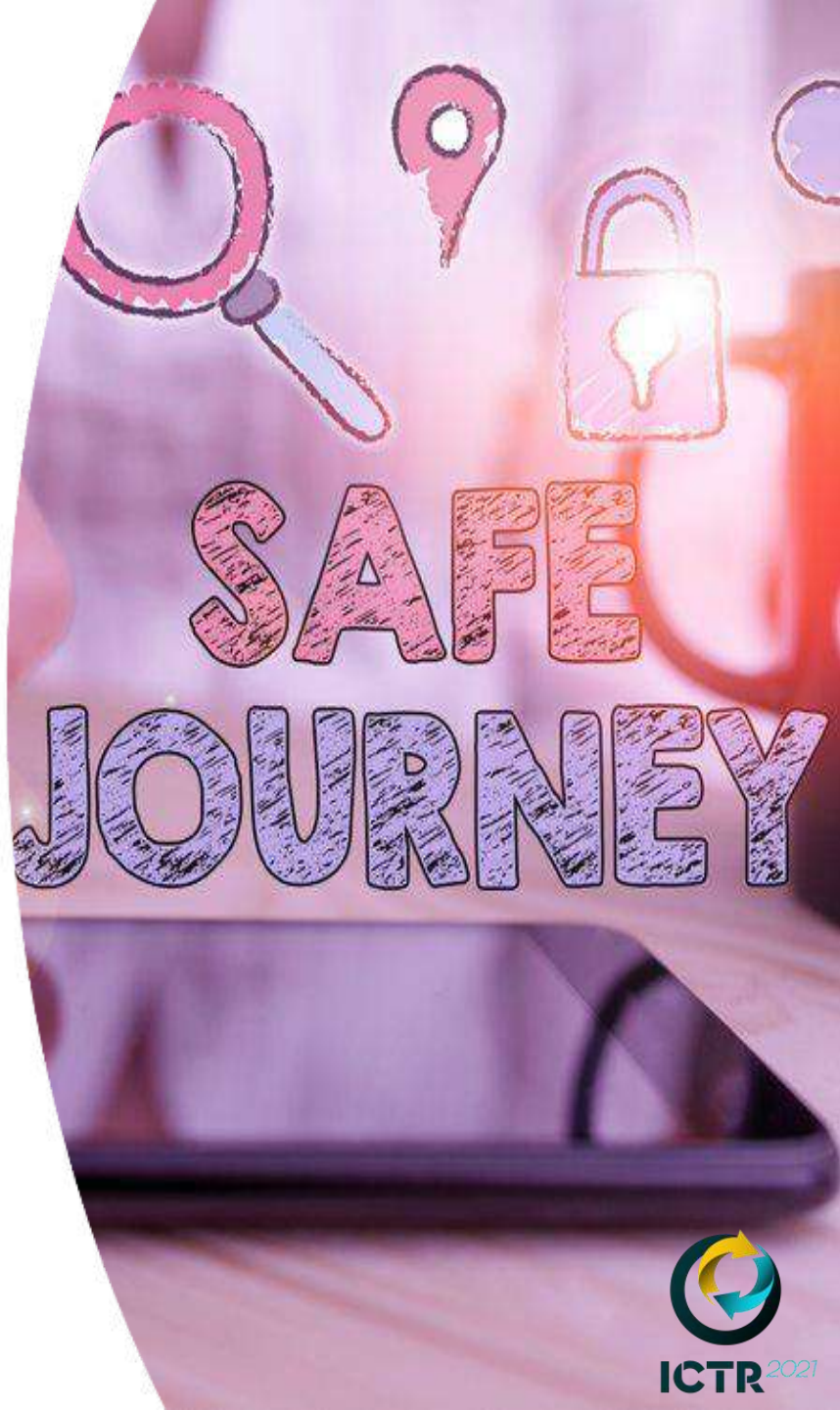
Impact of detailed trip parameters

- Trip duration has a different impact on speeding (negative correlation) compared to harsh events (positive correlation)
- Driving during the weekends seems to reduce the frequency of harsh events; both accelerations and brakings
- Harsh accelerations are associated with the odds of someone exceeding the speed limits, outlining a pattern of an overall unsafe driving behavior

Conclusions (2/2)

Impact of incentives and motivations

- The present research quantifies the positive impact of the 30-day competition on all the three examined human risk factors
- Rewarding safe driving behavior and providing drivers with motivations and incentives within a social gamification scheme has successful results
- State-of-the-art interventions can include approaches for driver training and support through driver behavior monitoring and feedback tools



Future research

- Analysis of different driving behavior parameters identified by the road safety literature as risk factors (e.g. mobile phone distraction)
- Analyses per gender, age, history of accidents, self–assessment, driving experience and more demographic characteristics
- Comparative analysis of drivers using different vehicle types

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