ECTRI TG Safety Meeting
30 November 2020

Assessing the impact of personalized feedback on driving and riding behavior through a smartphone application

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Introduction

- ➢ Accurate **monitoring of driver behavior** has scientific and technical requirements

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

The BeSmart project

➢Project partners:

- National Technical University of Athens, Department of Transportation Planning and Engineering www.nrso.ntua.gr
- OSeven Telematics www.oseven.io

➢Duration of the project:

- 36 months (July 2018 – July 2021)

➢Operational Program:

- "Competitiveness, Entrepreneurship and Innovation" (EPAnEK) of the National Strategic Reference Framework (NSRF)

The BeSmart Objectives

- The objectives of the project:
  - 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

- Identification of **the critical driving parameters that affect speeding** behavior using data from:
  - Smartphone devices
  - Naturalistic driving experiment

- Investigation of **the impact of driver feedback** on driving behavior as expressed by the exceedance of speed limits

The BeSmart driving experiment

- The experiment consists of 6 different phases differing in the type of feedback provided to drivers

- The present study refers to the first two phases (car drivers – PTW riders):
  - Phase 1 - no feedback to drivers - 12 weeks duration
  - Phase 2 - personalized feedback in means of a trip list and a scorecard regarding drivers' behavior - 10 weeks duration

- A total of 26,619 trips from a sample of 147 car drivers and 3,853 trips from 20 motorcyclists

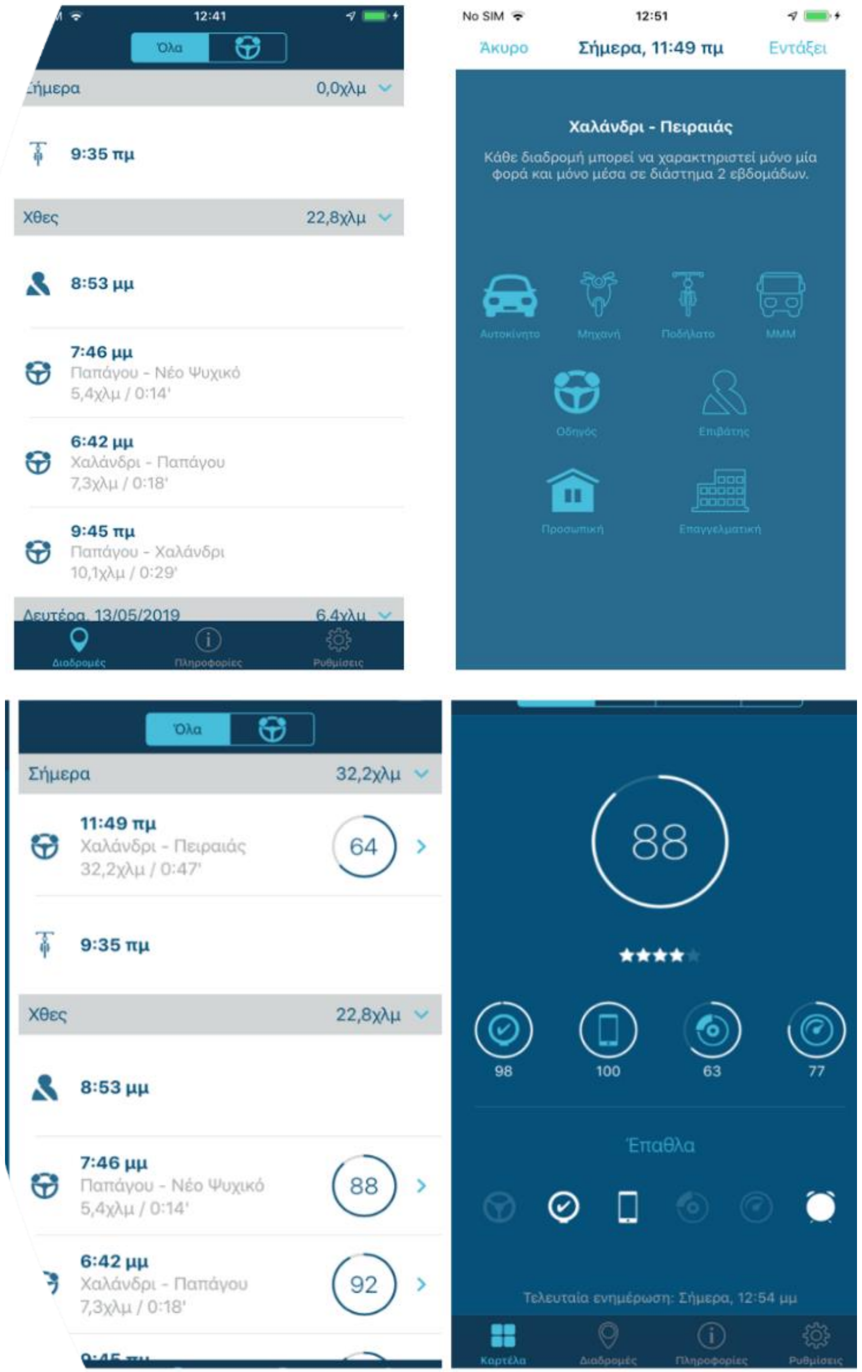
The BeSmart Application

➢ Driving behavior characteristics

- Speeding
- Harsh braking/ acceleration/ cornering
- Mobile phone use (car drivers' application)

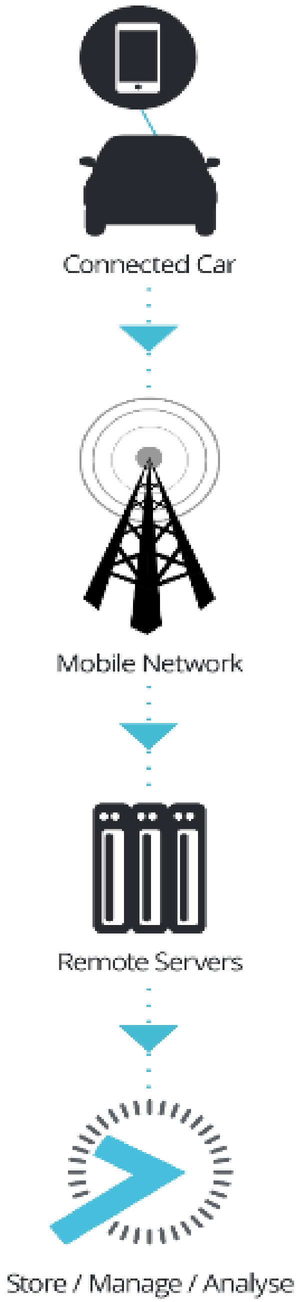
➢ Travel behavior characteristics

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



Smartphone data collection (1/2)

- A mobile application to **record user's driving behavior** (automatic start / stop)
- 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**



Smartphone data collection (2/2)

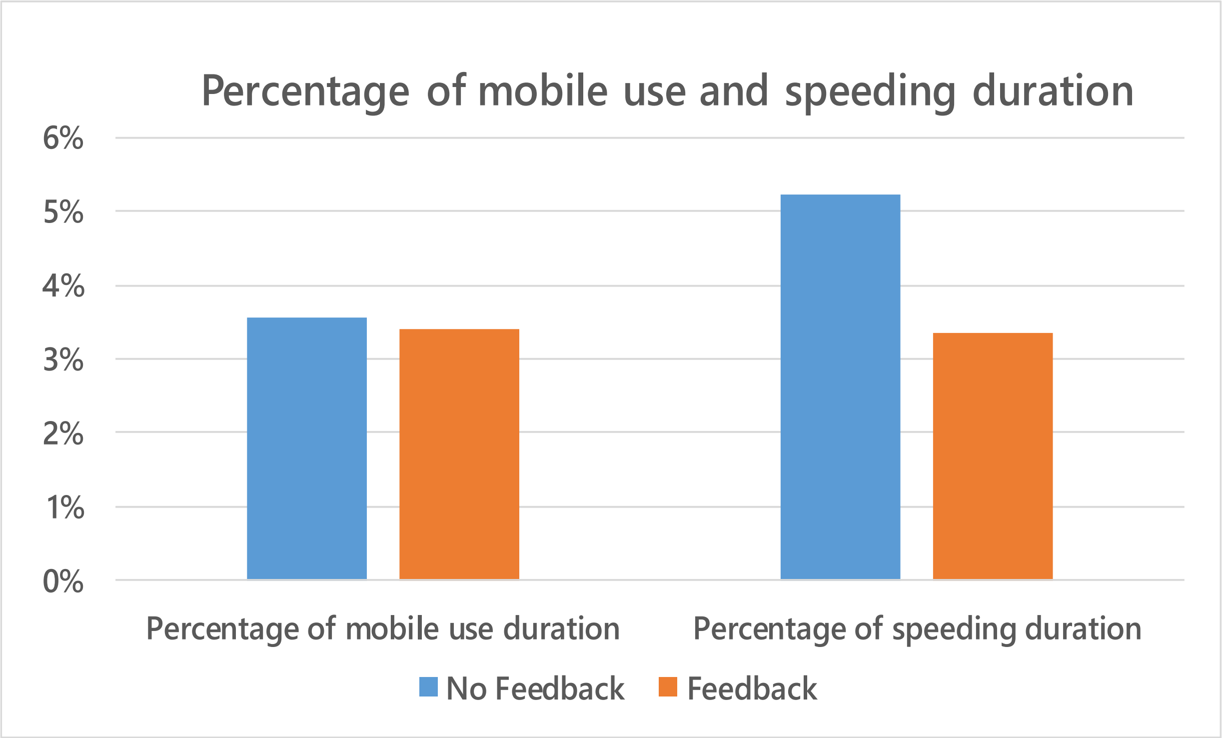
- **Indicators are designed using**:
  - machine learning algorithms
  - big data mining techniques

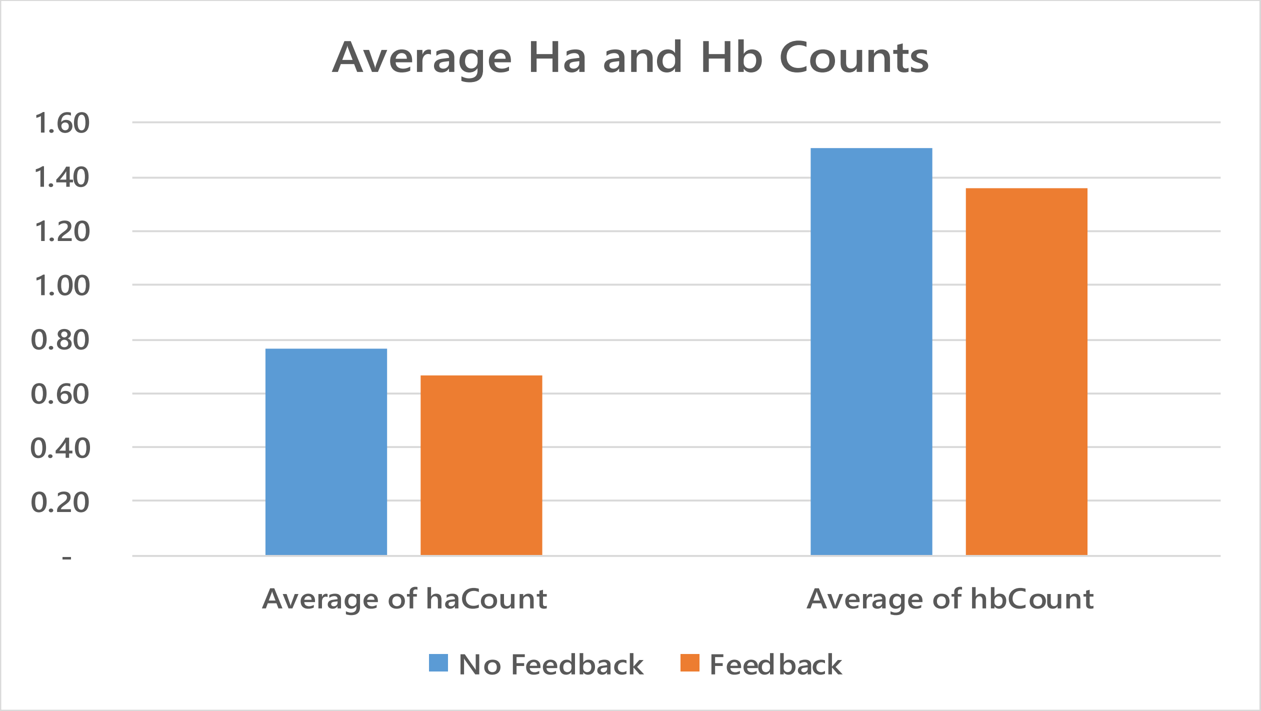
- The **database analyzed** was in .csv format
  - Drivers' trips are stored per row, the characteristics of which are stored in each column's variables

- State-of-the-art technologies and procedures in compliance with standing Greek and European **personal data protection laws (GDPR)**

Descriptive statistics – car drivers

- Both types of harsh events (accelerations and brakings) are **reduced in the 2nd phase** of the experiment

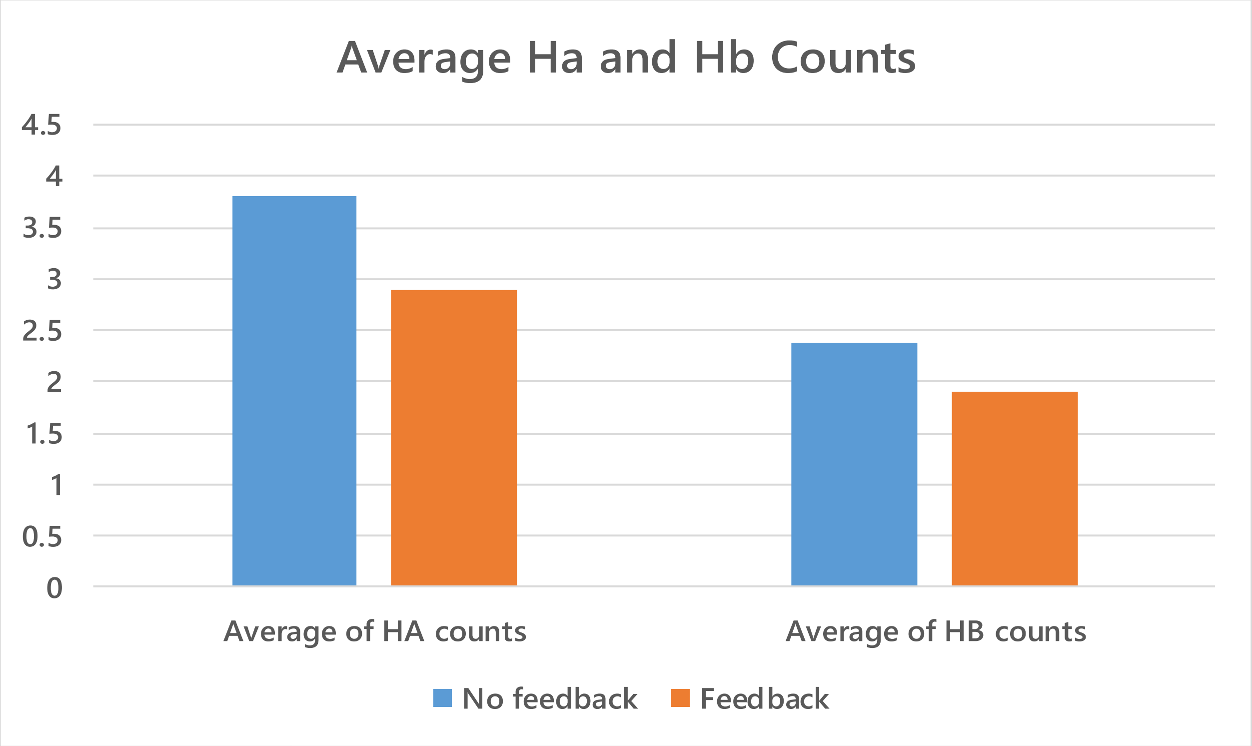


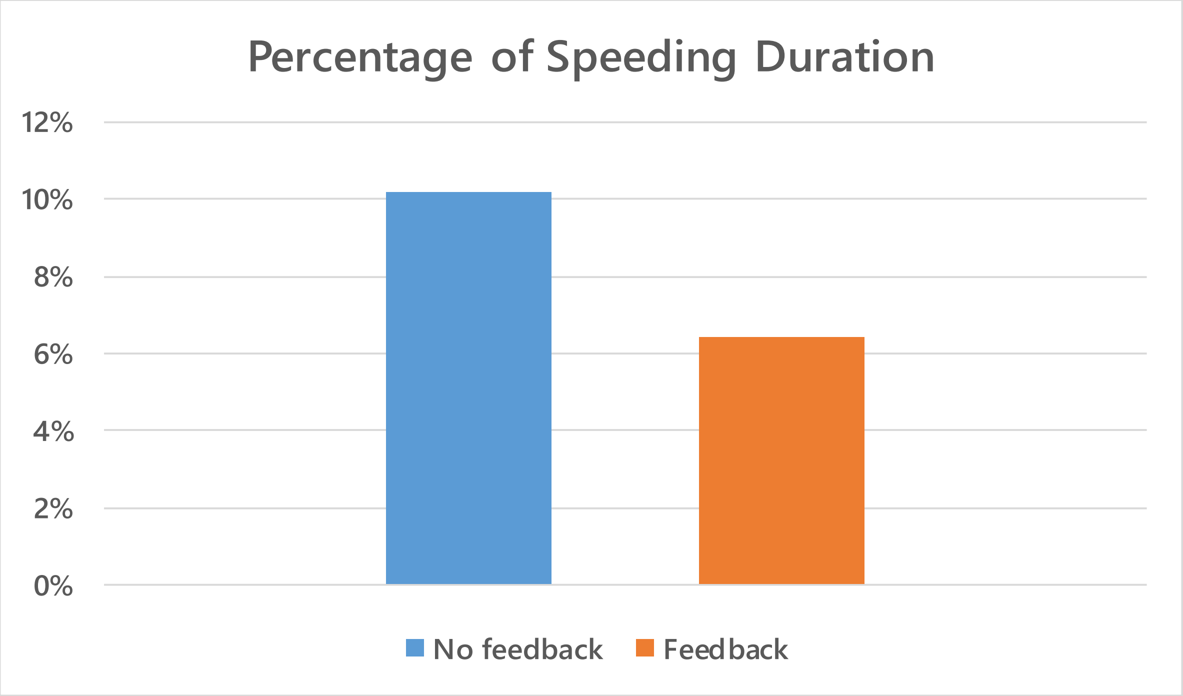


- The percentage of driving above the speed limits and driving while distracted by the mobile phone is **reduced in the 2nd phase** of the experiment

Descriptive statistics – PTW riders

- Both types of harsh events (accelerations and brakings) are **reduced in the 2nd phase** of the experiment





- The percentage of driving above the speed limits is **reduced in the 2nd phase** of the experiment

Theoretical Background

➢ Selection of statistical method:

- Need for fraction prediction – **percentage of speeding time**
- Generalized Linear Models (GLM) - **Poisson Regression**
- Introduce random effects to capture different driving behaviors and extend GLMs as **Generalized Linear Mixed-Effects Models** (GLMMs), given by the following formula:

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

Results (1/2) – car drivers

GLMMs for the percentage of driving time above the speed limit

Trip Parameter	Estimate	s.e.	p-value	Sig.	Rel. Risk Ratio
Intercept	1.702	0.0614	<0.001	***	5.485
Exp. phase (0=no feedback, 1=feedback)	-0.392	0.006	<0.001	***	0.675
Total trip duration (s)	0.204	0.036	<0.001	***	1.226
Number of harsh accel. per trip (count)	0.161	0.002	<0.001	***	1.175
Trip distance during risky hours [22:00-05:00]	0.029	0.001	<0.001	***	1.029
Morning peak hour [06:00-10:00] (0=yes, 1=no)	0.027	0.008	<0.001	***	1.027
Afternoon peak hour [16:00-20:00] (0=yes, 1=no)	-0.236	0.007	<0.001	***	0.790

Results (2/2) – PTW riders

GLMMs for the percentage of driving time above the speed limit

Trip Parameter	Estimate	s.e.	p-value	Sig.	Rel. Risk Ratio
Intercept	1.898	0.276	<0.001	***	6.672
Exp. phase (0=no feedback, 1=feedback)	-0.145	0.013	<0.001	***	0.865
Total trip duration (s)	0.194	0.095	0.042	*	1.214
Number of harsh accel. per trip (count)	0.248	0.005	<0.001	***	1.281
Trip distance during risky hours [22:00-05:00]	0.018	0.003	<0.001	***	1.018
Morning peak hour [06:00-10:00] (0=yes, 1=no)	0.067	0.015	<0.001	***	1.069
Afternoon peak hour [16:00-20:00] (0=yes, 1=no)	-0.286	0.015	<0.001	***	0.751

Conclusions (1/2)

- Both **car drivers and PTW riders indicate similar behavior** while exceeding the speed limits
- **Trip length** and driving during the **morning rush and night-time risky hours** are exposure metrics positively correlated with the odds of speeding
- **Harsh accelerations** are also associated with the odds of someone exceeding the speed limits, outlining a pattern of an overall unsafe driving behavior

Conclusions (2/2)

- The present results capture and quantify the **positive effects of driver feedback** on one of the most important human risk factors; speeding

- The ultimate objective when providing feedback to drivers is to:
  - Trigger their **learning and self-assessment process**, thus enabling them to gradually improve their performance
  - Monitor the **shift of driving behaviour** as the application provides feedback

Future research

- Investigating the impact of **different types of personalized feedback** communicated through the project application:
  - Incentives within a social gamification scheme, with personalized target setting,
  - Benchmarking and comparison with peers
- Examinations of the **impact of feedback over time**, the influence of its evolution on drivers and its consistency
- Microscopic data analysis of the collected database through **machine learning techniques**

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