FERSI Road Safety Research

FERSI Conference

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Removing barriers and enhancing public support

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Measuring the impact of driver behavior telematics in road safety

Armira Kontaxi

Transportation Engineer, PhD Candidate

Together with:
Apostolos Ziakopoulos, Christos Katrakazas, George Yannis

Department of Transportation Planning and Engineering,
National Technical University of Athens

Background

➢ The telematics industry is growing and changing rapidly due to the continuous advancements in Internet of Things (IoT), connectivity, and sensor hardware

➢ Data are recorded either by vehicle OBDs or smartphones sensors and transmitted to a control center

➢ The high penetration rate of smartphones and social networks provide new opportunities and features to monitor and analyze driver behaviour by adopting low-cost collection and processing methods

Objective

➢ Measuring the impact of driver behavior telematics in road safety using data from:

- Smartphone devices
- Naturalistic driving experiment

Experimental Design

➢ The naturalistic driving experiment consists of 2 phases differing in the **type of feedback provided** to drivers:

- Phase 1 - **no feedback to drivers** - only the trip list and the vehicle characterization were accessible - 12 weeks duration
- Phase 2 - **personalized feedback** in means of a trip list and a scorecard regarding driver behavior, namely speeding, harsh breaking, harsh acceleration, mobile phone use - 10 weeks duration

➢ A total of **26,619 trips** from a sample of 65 car drivers and 13 motorcyclist riders

The Telematics Application

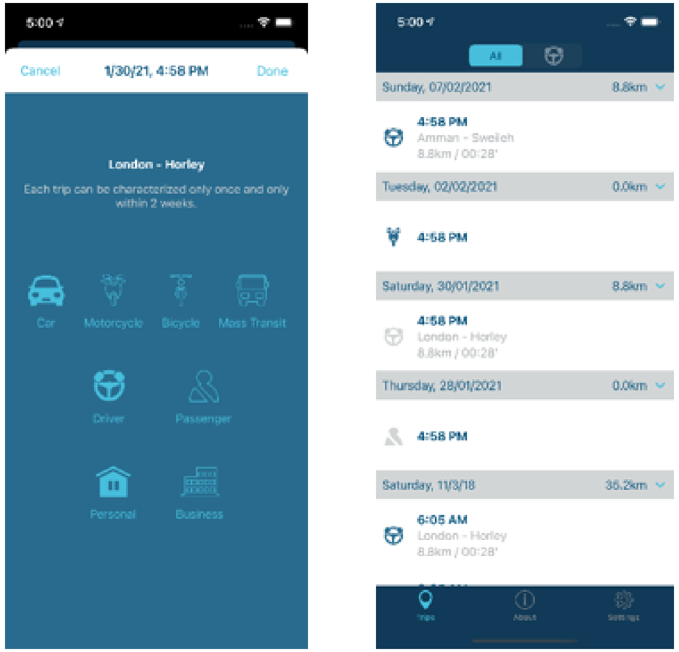
➢ Driving behavior characteristics

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

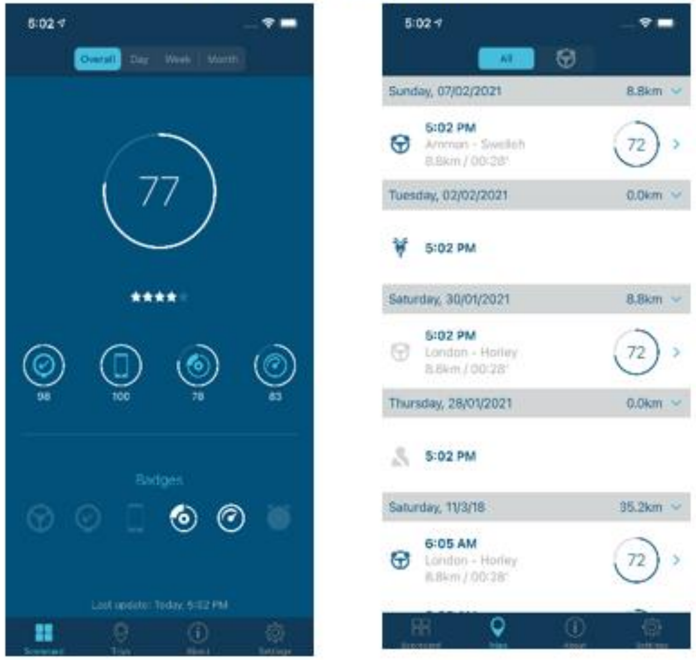
➢ Travel behavior characteristics

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

Phase 1 – No feedback

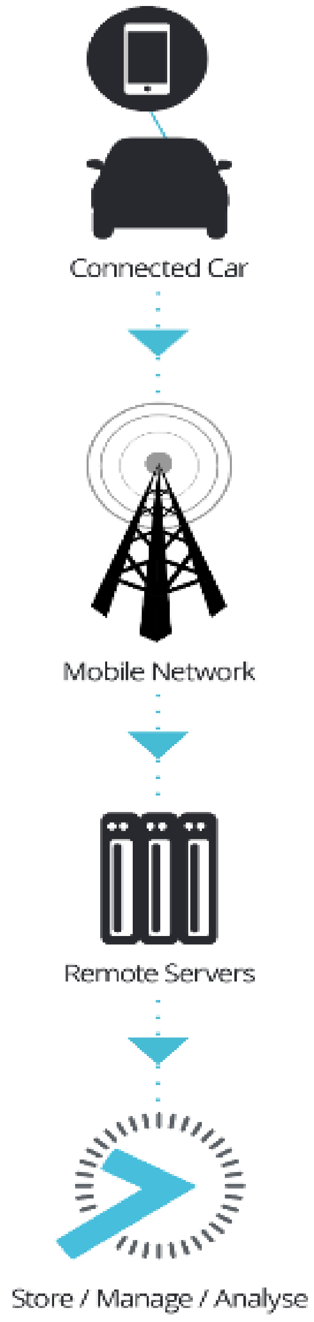


Phase 2 – Scorecard



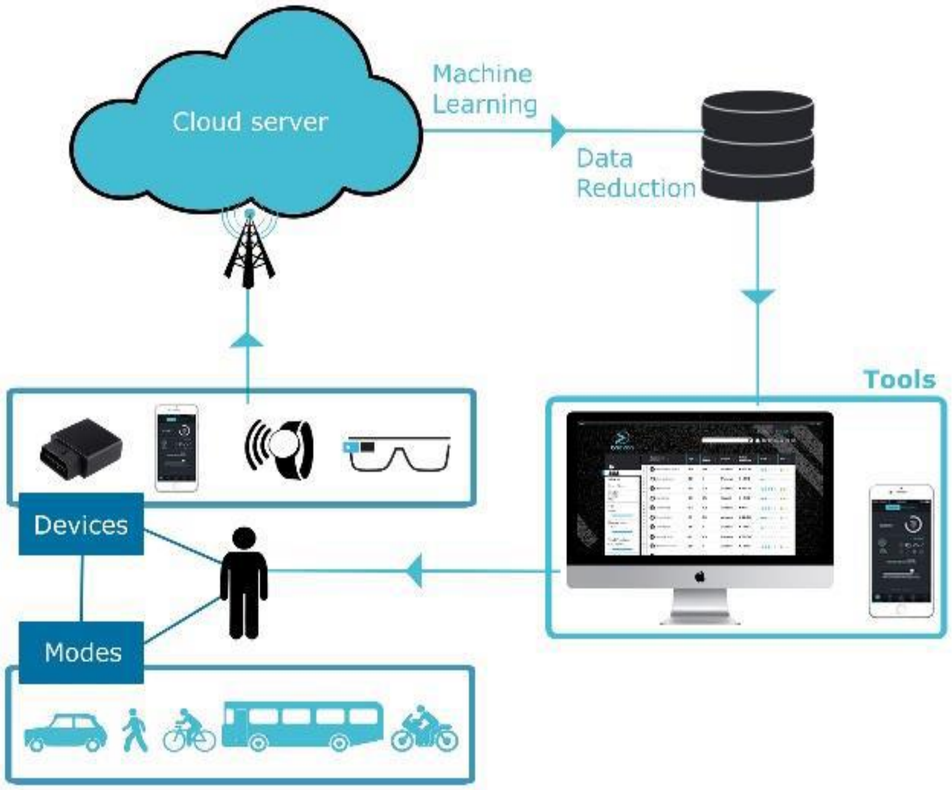
Smartphone data collection (1/2)

- A user-friendly smartphone app developed by OSeven Telematics to record user's driving behaviour (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



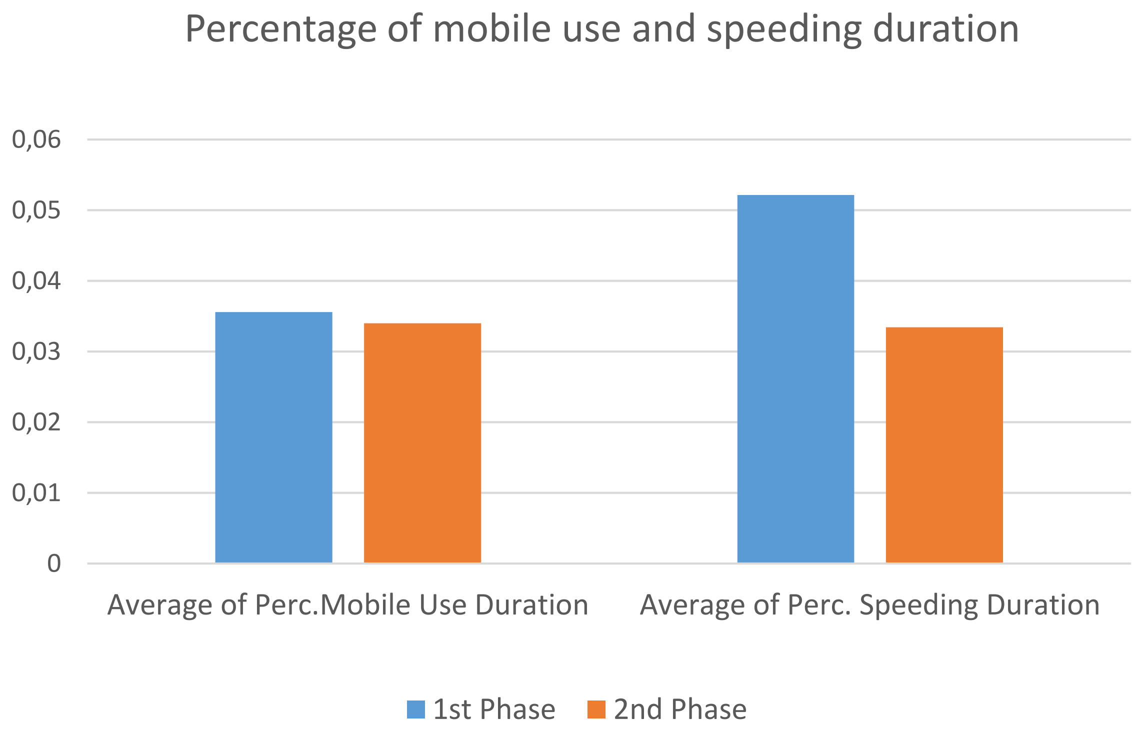
Smartphone data collection (2/2)

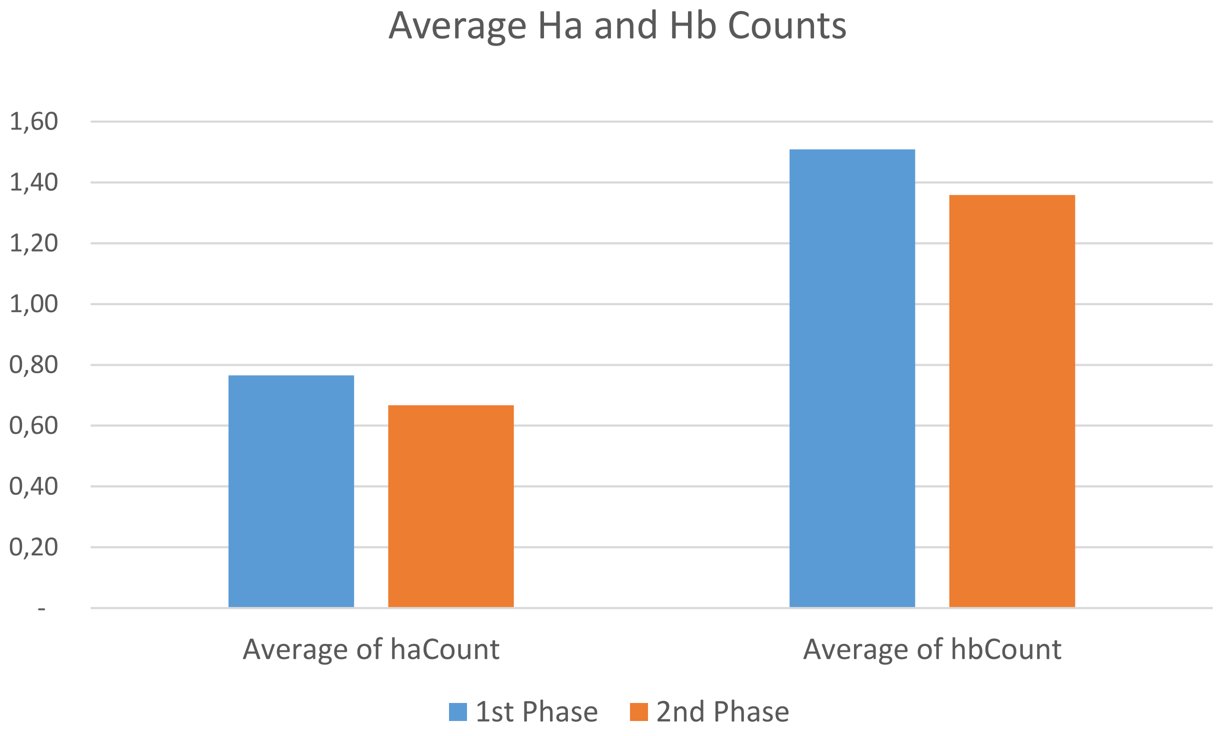
- Indicators are designed using:
  - machine learning algorithms
  - big data mining techniques
- The database analyzed was in .csv format
  - Drivers' trips are stored per row, the characteristics of which are stored in each column's variables
- State-of-the-art technologies and procedures in compliance 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

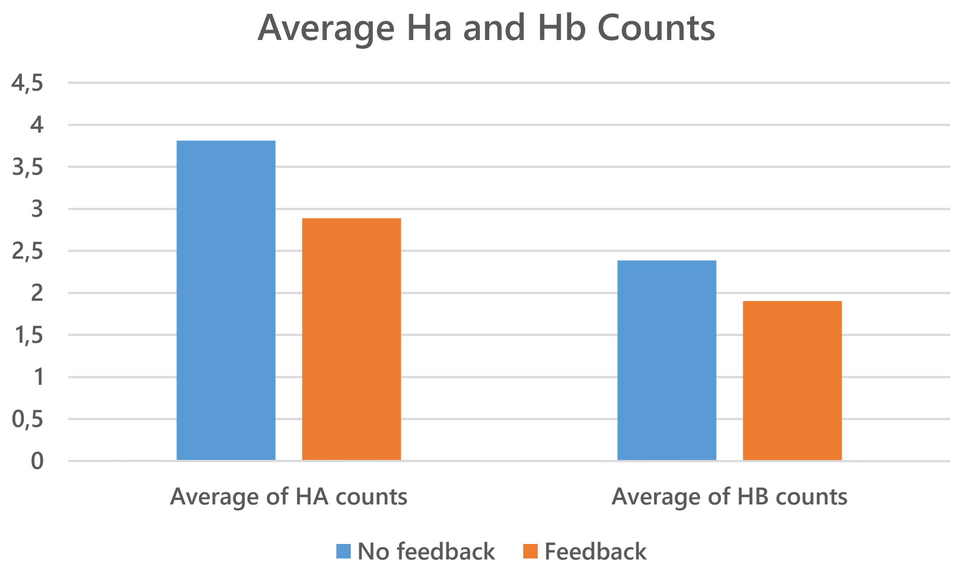


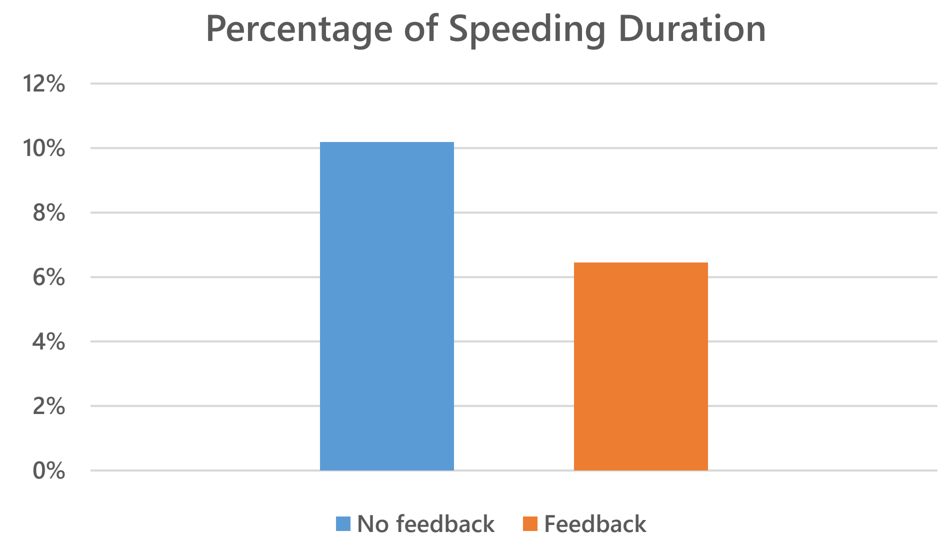


- The percentage of driving above the speed limits and driving while distracted by the mobile phone is reduced in the 2nd phase of the experiment

Descriptive statistics – motorcyclist riders

- Both types of harsh events (accelerations and brakings) are reduced when feedback is provided to riders





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

Methodology

- Analysis scope
  - Among the recorded risk factors, the **frequency of harsh events** per trip for the car drivers and the **percentage of speeding** per trip for motorcyclist riders are 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 – car drivers (1/2)

➤GLMMs for harsh acceleration counts

Parameter	GLMM for Phase 1					GLMM for Phase 2				
	Estimate	s.e.	p-value	Sig.	Relative Risk Ratio	Estimate	s.e.	p-value	Sig.	Relative Risk Ratio
Intercept	-0.927	0.091	0.000	***	0.395	-1.127	0.085	0.000	***	0.324
Maximum Speed	0.321	0.022	0.000	***	1.378	0.412	0.021	0.000	***	1.509
Percentage of Speeding Duration	0.074	0.013	0.000	***	1.076	0.035	0.012	0.003	**	1.035
Percentage of Mobile Use Duration	0.042	0.011	0.000	***	1.042	-	-	-	-	-
Log(Total Trip Duration)	0.848	0.051	0.000	***	2.334	0.729	0.050	0.000	***	2.073
Log(Total Trip Distance)	-0.231	0.050	0.000	***	0.793	-0.087	0.046	0.047	*	0.916

Results – car drivers (2/2)

➢GLMMs for harsh braking counts

Parameter	GLMM for Phase 1					GLMM for Phase 2				
	Estimate	s.e.	p-value	Sig.	Relative Risk Ratio	Estimate	s.e.	p-value	Sig.	Relative Risk Ratio
Intercept	-0.182	0.067	0.006	**	0.833	-0.313	0.075	0.000	***	0.731
Maximum Speed	0.327	0.016	0.000	***	1.387	0.331	0.015	0.000	***	1.395
Percentage of Speeding Duration	0.097	0.010	0.000	***	1.102	0.081	0.009	0.000	***	1.084
Log(Total Trip Duration)	0.885	0.045	0.000	***	2.423	0.723	0.038	0.000	***	2.061
Log(Total Trip Distance)	-0.298	0.036	0.000	*	0.742	-0.082	0.033	0.015	*	0.921

Results – motorcyclist riders

➢GLMMs for the percentage of travelled time above the speed limits

Trip Parameter	Overall model		Urban roads		Rural roads	
	B	p-value	B	p-value	B	p-value
Intercept	1.898	<0.001	1.810	<0.001	-	-
Rider Feedback	-0.145	<0.001	-0.031	0.005	-0.420	<0.001
Trip duration	0.194	0.042	0.001	<0.001	0.003	0.004
Harsh accelerations	0.248	<0.001	-	-	0.056	<0.001
Risky hours	0.018	<0.001	0.006	0.001	0.019	<0.001
Morning Rush	0.067	<0.001	0.093	<0.001	0.130	<0.001
Afternoon Rush	-0.286	<0.001	-0.303	<0.001	-0.436	<0.001
AIC	37114.1		54460.9		34576.3	

Findings– car drivers (1/2)

➢Impact of detailed trip parameters

- Maximum speed, the percentage of speeding duration and total trip duration positively correlated with both harsh event frequencies

- On the other hand, the exposure metric of total trip distance negatively correlated with both harsh event types

- The percentage of mobile use duration, significant only for harsh accelerations with a small positive correlation

Findings – car drivers (2/2)

➢ Impact of driver feedback

- Initial findings highlight speeding and mobile phone use reduction when personal feedback is provided to drivers
- Both types of harsh events (accelerations and brakings) are also reduced by providing drivers with feedback
- The present achievements open new venues for measuring the impact of driver behavior telematics on critical human risk factors

Findings – motorcyclist riders

- The present research contributes a preliminary example of the **quantitative documentation of the impact of personalized rider feedback** on speeding

- **Trip length** and riding during the **morning rush** and **night-time risky hours** are exposure metrics significantly associated with the odds of speeding while riding

- **Harsh accelerations** are also associated with the odds of someone exceeding the speed limits, outlining a pattern of an overall **unsafe riding behavior**

Conclusions

- Telematics have a **great potential for the improvement of driving behaviour** by:
  - **identifying unsafe behaviours** resulting from speeding, harsh events, distraction and thus creating the driver's safety "footprint"
  - **developing measures** by means of **novel technology applications**, allowing to inform, notify, motivate and train the drivers to reduce their errors and their accident risk

- Telematics benefits can be seen as a guide for the design of **more efficient and longer-lasting** driver safety behaviour measures

- Need for newer and more flexible **data management models** in terms of data sharing and protection

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