RSS 2022
8th Road Safety & Simulation International Conference
Road Safety and Digitalization
08-10 June, 2022 • Athens, Greece

Discovering the influence of feedback on driver behavior through a multiphase experiment

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Introduction

- Accurate monitoring of driver behaviour is progressively established in the transportation field
- 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
- Naturalistic driving experiments by means of mobile phone allow researchers to examine the effect of various risk factors on driving performance, identify aggressive and dangerous driving profiles and provide driver feedback

The BeSmart project

- 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

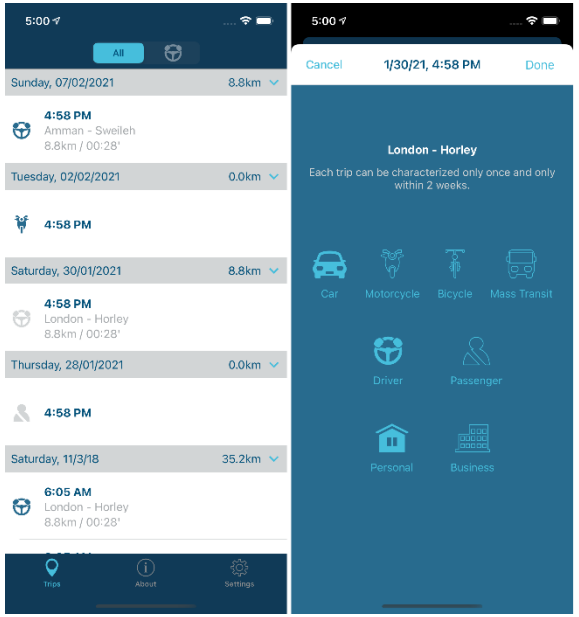
- The objective of the current research is to exploit large-scale trip data from smartphone sensors in order to identify the impacts of driver feedback on various key performance indicators, namely speeding, harsh braking and harsh acceleration events

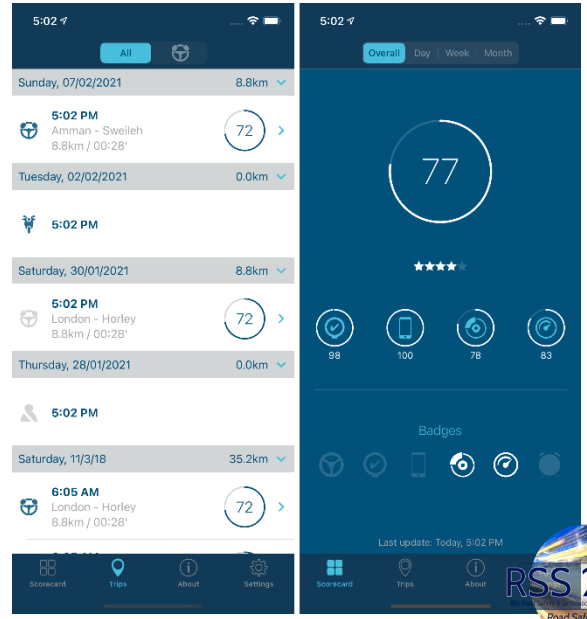
The BeSmart Application

- 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
- Driving behavior indicators are designed using:
  - machine learning algorithms
  - big data mining techniques
- State-of-the-art technologies and procedures in compliance with standing Greek and European personal data protection laws (GDPR)

The BeSmart driving experiment

- **The experiment consists of 6 different phases** differing in the type of feedback provided to drivers
  - Phase 1 - trip list and characterization accessible to the application user
  - Phase 2 - Scorecard enabling scoring per trip
  - Phase 3 - Maps and Highlights providing further information per trip.
  - Phase 4 - Comparisons between drivers
  - Phase 5 - Competitions with prizes for safe driving
  - Phase 6 – back to Phase 1 - all additional feedback removed from the drivers





Descriptive Statistics

- Overall, during the 12-months experiment 106,776 trips were recorded from a sample of 200 drivers (male 46%, female 54%)

Experiment Phases	Percentage of mobile use	Harsh accelerations per 100km	Harsh brakings per 100km	Speed above the speed limits	Percentage of speeding time
Phase1	3.85%	6.42	15.78	3.89km/h	5.32%
Phase 2	2.84%	6.26	13.74	3.19 km/h	3.12%
Phase 3	2.08%	6.26	13.94	2.31 km/h	2.60%
Phase 4	2.28%	6.96	12.54	2.34 km/h	2.45%
Phase 5	2.19%	6.24	12.14	1.85 km/h	2.13%
Phase 6	2.48%	8.26	16.34	2.60 km/h	3.34%

Statistical Analysis

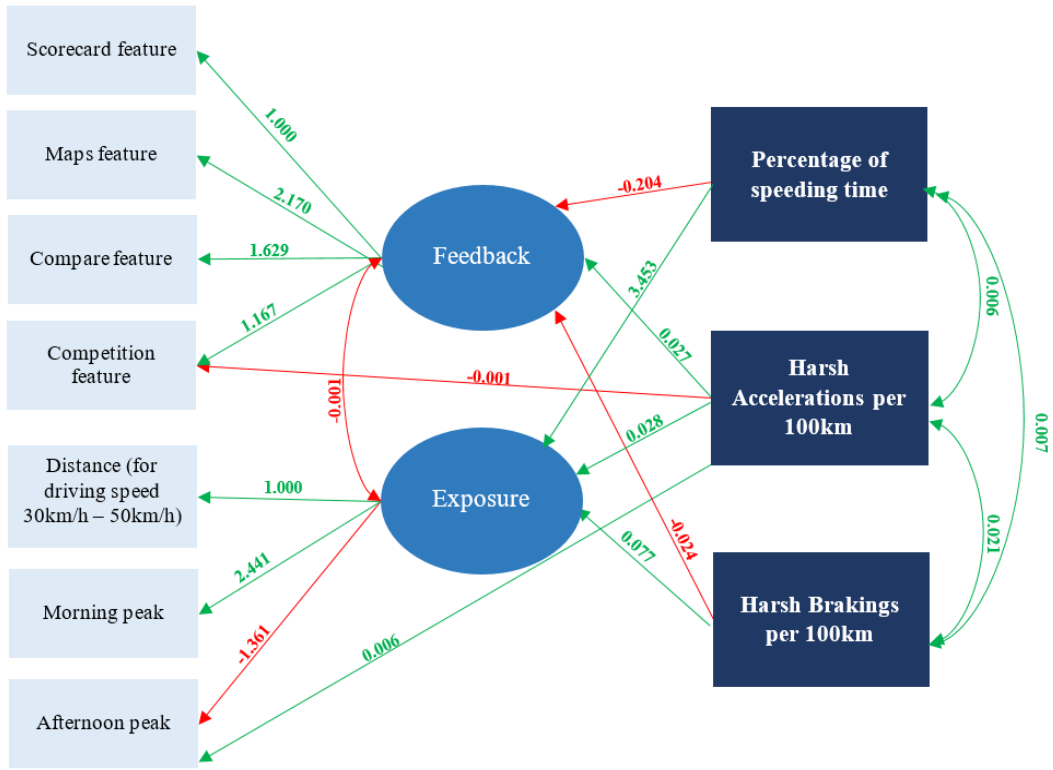
- Structural Equation Models (SEM)

- Ultimately, the proposed SEM structure retained two latent unobserved variables:
  - Feedback, expressing the influence of the different features of the smartphone app during the different phases of the experiment
  - Exposure, expressing the influence of the exposure metrics, namely Distance (for driving speed 30km/h – 50km/h), Morning peak and Afternoon peak

Results

SEM model of Percentage of speeding time, Harsh Brakings per 100km & Harsh Accelerations per 100km

SEM Components		Parameters	Estimate	S.E.	z-value	P(>|z|)
Latent Variables	Feedback	Scorecard feature	1.000	–	–	–
		Maps feature	2.076	0.014	148.640	0.000
		Compare feature	1.646	0.010	157.864	0.000
		Competition feature	1.215	0.029	41.754	0.000
		Challenges feature	2.053	0.038	54.447	0.000
	Exposure	Distance_(for driving speed 30km/h – 50km/h)	1.000	–	–	–
		Morning peak	2.473	0.350	7.072	0.000
		Afternoon peak	-1.360	0.129	-10.579	0.000
Regressions	Percentage of speeding time	Intercept	0.409	0.003	138.941	0.000
		Exposure	0.326	0.043	7.627	0.000
		Feedback	-0.214	0.014	-15.655	0.000
	Harsh Accelerations per 100km	Intercept	0.099	0.001	95.037	0.000
		Exposure	0.028	0.010	2.769	0.006
		Feedback	0.026	0.004	6.493	0.000
		Competition feature	-0.001	0.000	-2.748	0.000
		Afternoon peak	0.006	0.002	3.095	0.002
	Harsh Brakings per 100km	Intercept	0.184	0.001	158.258	0.000
		Exposure	0.077	0.014	5.542	0.000
		Feedback	-0.027	0.005	-4.976	0.000
Covariances	Percentage of speeding time	Harsh Brakings per 100km	0.007	0.001	7.686	0.000
	Harsh Accelerations per 100km	Percentage of speeding time	0.006	0.001	9.526	0.000
	Harsh Brakings per 100km	Harsh Accelerations per 100km	0.021	0.000	75.739	0.000
	Feedback	Exposure	-0.001	0.000	-5.558	0.000
Goodness-of-fit measures		CFI	0.940			
		TLI	0.944			
		RMSEA	0.049			0.845
		SRMR	0.025			



Conclusions (1/2)

- From the execution of the BeSmart experiment, it becomes evident that driving behavior can be evaluated and communicated to drivers

- The influence of feedback appears to increase across the various experimental phases, though it appears that there are some platooning effects for drivers towards the end of the experiment

Conclusions (2/2)

- The ultimate goal of providing feedback to drivers is to activate the process of learning and self-assessment of drivers and to enable them to gradually improve their performance and monitor their progress

- This process may include establishing detailed cause-and-effect relationships between aggressive driving and risk, information on improving road safety

Future Challenges

- Integration of a multitude of IoT technologies, development of advanced know-how
- Development of new smartphone applications, for all road users and all transport modes
- Properly matching telematics metrics with crash risk
- Exploitation of know-how for the safe integration and monitoring of automated vehicles
- Enhancement of innovation capacity and creation of new market opportunities for driver behaviour telematics

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