Monitoring and Improving Driving Behavior of Motorcyclists Through an Innovative Smartphone Application

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Background

- The Internet of Things (IoT) constantly offers new opportunities and features to monitor and analyze 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

- 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

- Which are the critical driving parameters that affect speeding behavior of motorcyclists using data from:
  - Smartphone devices
  - Naturalistic driving experiment
- Can personalized feedback through a smartphone application improve motorcyclist behavior?

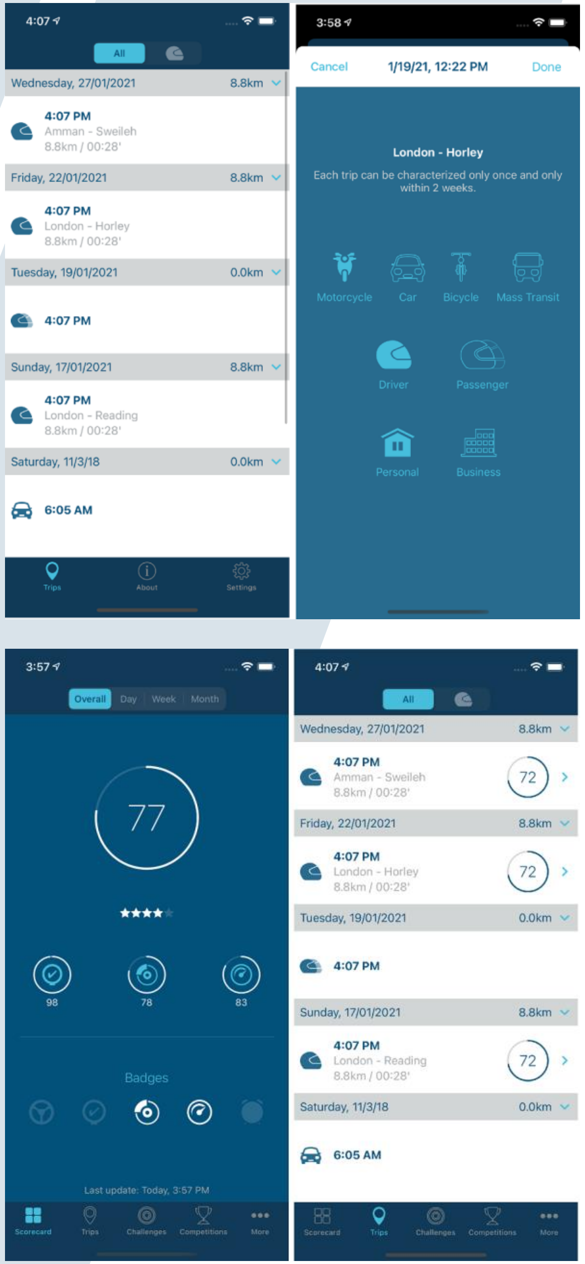
The BeSmart Application

- 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)

Experimental Design

- 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:
  - Phase 1 - no feedback to riders - 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 riders' behavior, namely speeding, harsh breaking, harsh acceleration - 10 weeks duration



Rider Panel

- Participant panel description regarding riding and vehicle data (N=13)

Riding parameter	Distribution of participants			
Riding experience (number of years)	<5	5-10	11-20	>20
	7.7%	30.8%	53.8%	7.7%
Driven distance per year (km)	<5000	5001-10000	10001-15000	>15000
	15.4%	7.7%	61.5%	15.4%
Motorcycle engine size (cc)	<251	251-500	501-1000	>1000
	46.1%	7.7%	23.1%	23.1%

Descriptive Statistics

- Descriptive statistics of the per trip values of the variables and the respective standard errors (in parenthesis)

Variable	Road type					
	Urban		Rural		Highway	
	Baseline	Feedback	Baseline	Feedback	Baseline	Feedback
Average speed [km/h]	35.82 (0.30)	33.66 (0.29)	50.08 (0.66)	38.28 (0.48)	97.01 (0.58)	77.62 (0.66)
Speeding percentage [%]	13.41 (0.41)	9.84 (0.33)	10.33 (0.62)	3.07 (0.34)	5.60 (0.96)	5.35 (0.90)
Harsh accelerations [count]	2.54 (0.08)	1.70 (0.06)	2.02 (0.09)	1.38 (0.06)	0.81 (0.11)	0.22 (0.04)
Harsh brakings [count]	1.59 (0.05)	1.14 (0.04)	1.27 (0.07)	0.81 (0.04)	0.45 (0.08)	0.16 (0.03)

Methodology

- Analysis scope
  - Among the recorded risk factors, the percentage of 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

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

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	

Conclusions

- The present research contributes a preliminary example of the quantitative documentation of the impact of personalized rider feedback on one of the most important human risk factors; 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

Impact

- The present results capture and quantify the positive effects of rider feedback, thus providing needed impetus for larger-scale applications as well as relevant policy interventions

- State-of-the-art interventions can include approaches for driver or rider training and support through innovative rider behavior monitoring and feedback tools for different types of riders, such as cyclists or motorcyclists

Future research

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

Any questions?

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