International Transport Forum | irtad Road Safety Data

7th IRTAD Conference

BETTER ROAD SAFETY DATA
FOR BETTER SAFETY OUTCOMES

Lyon, 27-28 September 2022

Driver behaviour KPIs through smartphone telematics

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Background

- Accurate monitoring of driver behaviour has scientific and technical requirements

- The Internet of Things (IoT) constantly offers new opportunities and features to monitor and analyse driver behaviour through:

  - Affordable On-board Diagnostics (OBD)
  - Widespread use of smartphones and social media
  - Effective data collection and handling
  - Big Data Analysis

Joint efforts in 3 Research Projects

BESMART

Multi-modal driver behaviour and safety support system on the basis of smartphone applications

www.besmart-project.gr

smartmaps

Smart city mapping for safer and eco driver behaviour through smartphone sensor big data

www.smart-maps.gr

iDREAMS

Safety tolerance zone calculation and interventions for driver-vehicle-environment interactions under challenging conditions

www.idreamsproject.eu

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**:
  - 42 months (July 2018 – February 2022)
- **Operational Program**:
  - "Competitiveness, Entrepreneurship and Innovation" (EPAnEK) of the National Strategic Reference Framework (NSRF)

BESMART

European Union
European Regional Development Fund

ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΥΠΟΥΡΓΕΙΟ ΠΑΙΔΕΙΑΣ ΕΡΕΥΝΑΣ & ΘΡΗΣΚΕΥΜΑΤΩΝ

ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
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EPAnEK 2014-2020
OPERATIONAL PROGRAMME
COMPETITIVENESS • ENTREPRENEURSHIP • INNOVATION

The SmartMaps project

- **Project partners**:
  - **National Technical University of Athens**, Department of Transportation Planning and Engineering
    www.nrso.ntua.gr
  - **OSeven Telematics**
    www.oseven.io
  - **Global Link**
    www.globallink.gr

- **Duration of the project:**
  - 30 months (June 2021 – December 2023)

- **Operational Program:**
  - "Competitiveness, Entrepreneurship and Innovation" (EPAnEK) of the National Strategic Reference Framework (NSRF) – 2nd iteration

The i-Dreams project

- 13 Project partners:
  - National Technical University of Athens
    Universiteit Hasselt, Loughborough University, Technische Universität München, Kuratorium für Verkehrssicherheit, Delft University of Technology, University of Maribor, OSeven Telematics, DriveSimSolutions, CardioID Technologies, European Transport Safety Council, POLIS Network, Barraqueiro Transportes S.A.

- Duration of the project:
  - 46 months (May 2019 – February 2023)

- Framework Program:
  - Horizon 2020 - The EU Union Framework Programme for Research and Innovation – Mobility for Growth

The BeSmart Objectives

- Development of an innovative and seamless Internet of Things application
- Assessment and improvement of behaviour 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

- Acquire and monitor driver behaviour KPIs:
  - driving speed
  - speeding violations
  - distraction through usage of mobile phone while driving
  - harsh driving event frequencies (harsh accelerations and decelerations)

- Investigate the impact of driver feedback on driving behavior and safety as expressed by the driver behaviour KPIs

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:
  - 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

The BeSmart Application

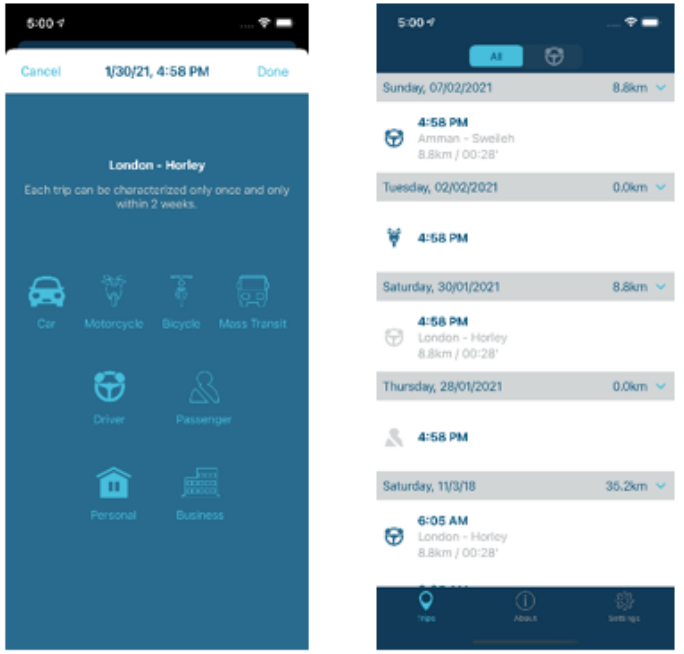
➢Driving behaviour characteristics

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

➢Travel behaviour 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)

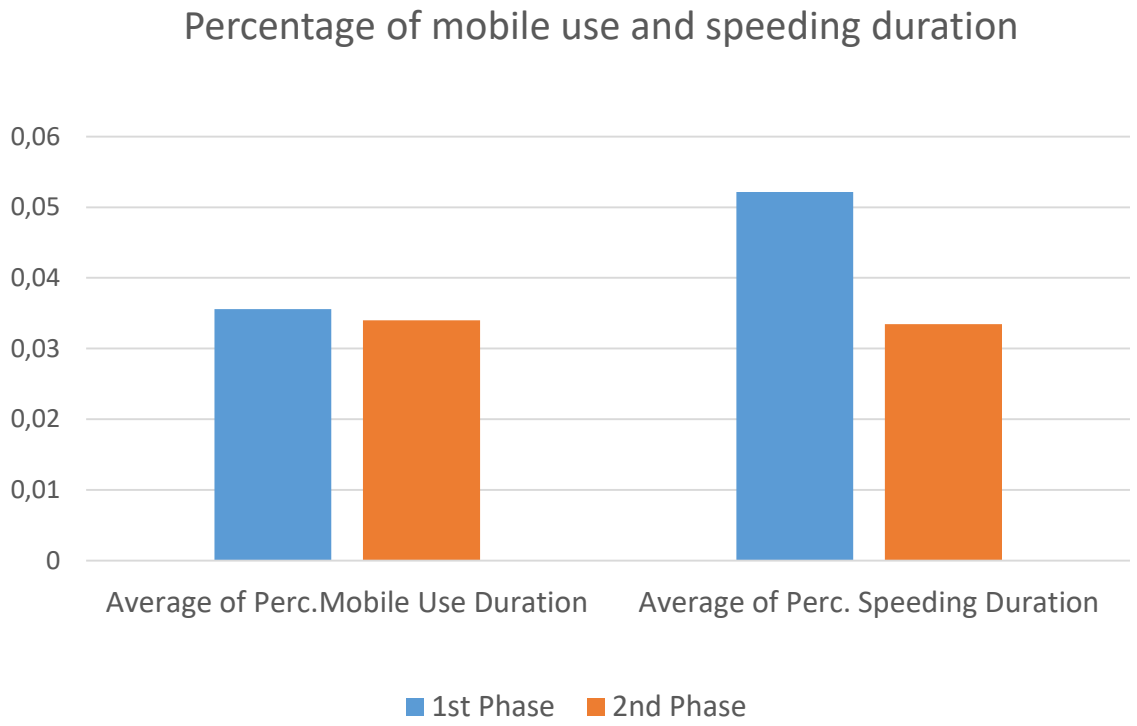
- The BeSmart mobile application to record user's driving behaviour (automatic start / stop)
- A variety of APIs is used to read mobile phone sensor data
- Data is transmitted from the mobile App to the central database
- Data are stored in a sophisticated database where they are managed and processed

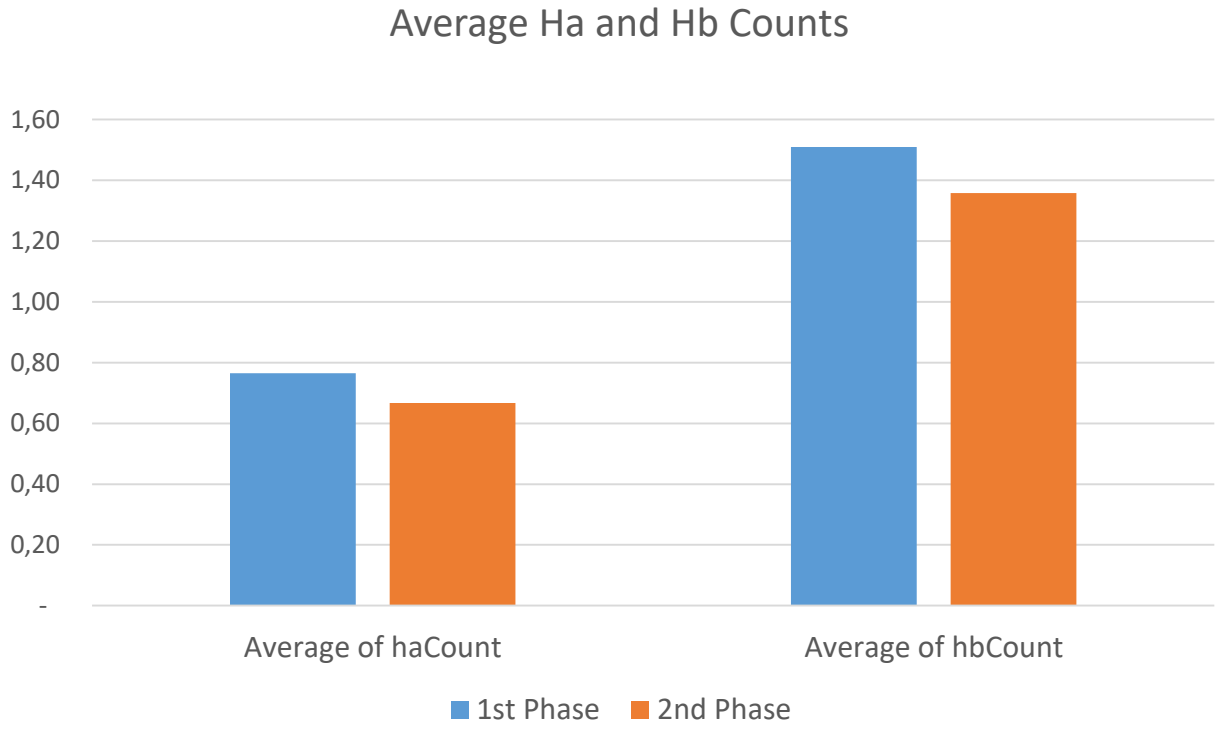
Smartphone data collection (2/2)

- 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

- 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

Methodology

- Analysis scope
  - Among the recorded risk factors, the frequency of harsh events 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 (1/2)

➢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 (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

Findings (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

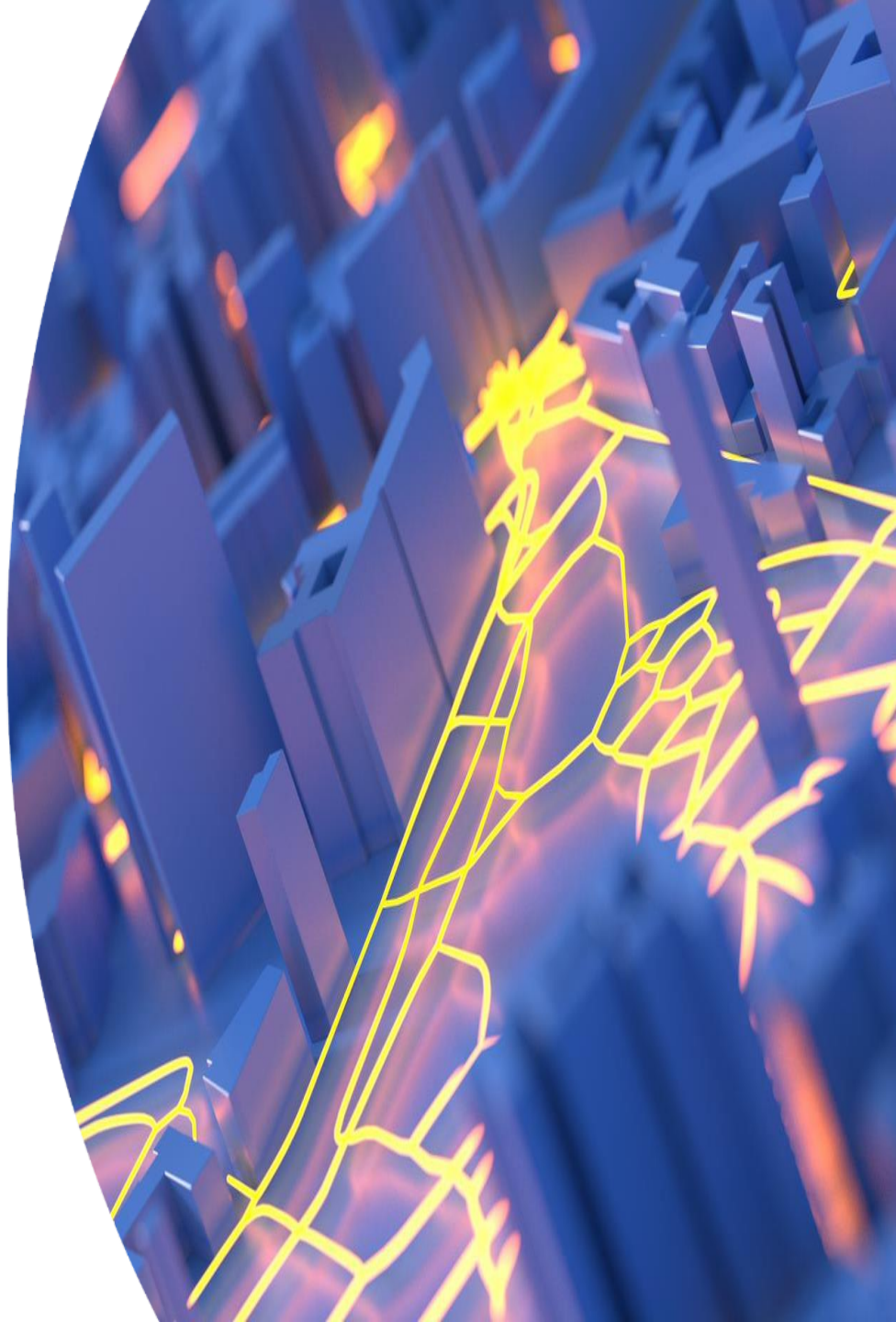
Findings (2/2)

➢ 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 quantifying driver feedback** by measuring its effect on critical driver behaviour **KPIs**

Telematics-based Behaviour KPIs

- Telematics present a very great potential for easy-to-collect and monitor:
  - risk exposure: veh-kms, driver-kms
  - behaviour KPIs (star-rating drivers): average speed, speeding, mobile phone use, harsh breaking / acceleration
- Aggregate KPIs per type of road user, area, vehicle and time.
- Need for coefficients to transform telematics drivers population characteristics into a representative drivers population sample
- Need for business models for cooperation between Authorities and telematics providers for data provision.



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