6th International Symposium on
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Featuring the 6th Urban Street Symposium

Impact of Road and Traffic Characteristics on Driver Behaviour and Safety Using Data from Smartphones

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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 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:**
  - 26 months (October 2021 –November 2023)

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

SmartMaps Objectives

- Integration of high resolution data from various complementary sources
- Naturalistic data collection of daily driving behaviors in real conditions using the OSeven application
- Validation of previous measurements and road conditions by conducting wide field research
- Generalization and transferability investigation by conducting population surveying

Research Scope

- To exploit large-scale spatio-temporal data from smartphone sensors to investigate harsh events throughout the selected road axes, specifically at the road segment and junction levels

Data collection (1/2)

- A mobile application to record user's driving behavior (automatic start / stop)
- 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)
- 300 drivers in Athens

Data collection (2/2)

- Traffic Management Center (TMC) of Attica Region.
- 26 measuring positions of traffic volume and occupancy in Vouliagmenis Ave. and Mesogeion Ave.
- Geometry characteristics of the 2 urban expressways using the online mapping service provided by Google Maps:
  - number of entrances/ exits at junctions
  - number of outgoing/ ingoing traffic lanes to/from junctions
  - presence of sideway
  - number of right exits/ entrances of the road segment
  - presence of bus lanes

Data preparation

- Visualization of the collected data through a Geographic Information System (GIS) application
- The data were separated to daytime (07:00-22:00) and nighttime (22:00-07:00)
- The values of the descriptive variables (minimum number, maximum number, standard deviation, range, mean) were calculated through the geo-processing model

harsh events during daytime

harsh events during nighttime

Statistical Analysis

- Log-linear regression models

	Harsh accelerations		Harsh Brakings	
	Day	Night	Day	Night
Junctions	1	2	3	4
Road segments	5	6	7	8

Results

- Independent variables used for the models

Independent Variables	Description
V	Average Traffic Velocity (km/h)
O	Average Traffic Occupancy (%)
Speed_Diff	Speed difference that caused the event (km/h)
Event_Speed	Speed of vehicle at the start of the event (km/h)
Distance	Distance of accelerometer
No. Left Entrances	Number of left entrances in junction
No. Right Exits/Entrances	Number of right exits from the segments and entrances to the road segments
Length	Length of road section (m)
Sideway	Presence (1) or absence (0) of sideway

Results- Junctions

	Harsh accelerations								Harsh brakings							
	Day				Night				Day				Night			
	β	t	ei	ei*	β	t	ei	ei*	β	t	ei	ei*	β	t	ei	ei*
Constant	-1,234	-2,195	-	-	-0,113	-0,116	-	-	-0,347	-0,782	-	-	1,57	1,799	-	-
V	-0,034	-4,064	1,063	-4,07	-0,056	-3,497	2,431	-5,081	-0,051	-6,263	1,149	-4,672	-0,069	-4,67	2	-11,69
MAX_Event_Speed	0,007	2,379	-0,261	1	0,011	3,349	-0,478	1	0,008	2,999	-0,246	1	0,005	2,352	-0,171	1
MAX_Speed_Diff	0,037	2,414	-0,487	1,867	0,064	4,053	-0,897	1,875								
No Left _Entrances	0,137	2,209	-0,08	-	0,173	2,981	-0,118	-								
Sideway									0,173	2,024	-0,045	-	0,17	2,036	-0,049	-
R^2	0,661				0,670				0,621				0,486			

- The determining factor at a junction is the average traffic velocity (V); as V increases, there is a decrease of harsh event frequencies
- The increase of the maximum of the speed difference of an event and the existence of a sideway increase harsh events

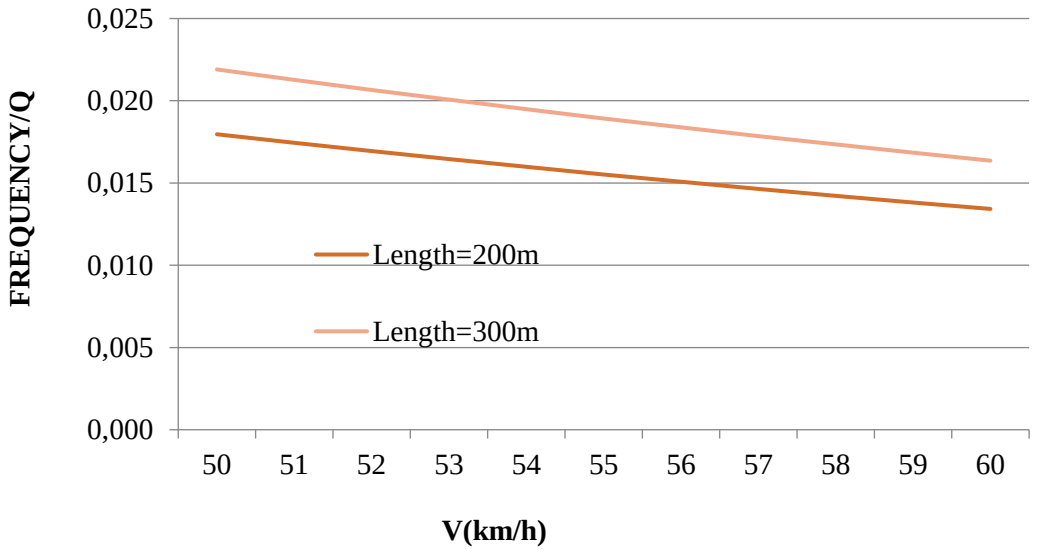
Results - Segments

	Harsh accelerations								Harsh brakings							
	Day				Night				Day				Night			
	β	t	ei	ei*	β	t	ei	ei*	β	t	ei	ei*	β	t	ei	ei*
Constant	-2,32	-7,81	-	-	-1,772	-4,887	-	-	-1,53	-2,555	-	-	1,074	1,317	-	-
V									-0,013	-1,733	0,399	-3,164	-0,04	-2,833	3,648	-16,41
O	0,068	3,605	-0,427	2,202	0,377	4,876	-1,517	3,748								
MAX_Event_Speed	0,006	2,575	-0,194	1	0,004	1,876	-0,405	1								
MIN_Speed_Diff									-0,038	-1,998	-0,455	3,601	-0,038	-2,272	-1,151	5,175
MIN_distance	-0,302	-4,212	0,357	-1,839	-0,276	-4,447	0,773	-1,91	-0,239	-3,217	0,265	-2,099	-0,213	-3,873	0,501	-2,254
No.Right Exit/Entrance	0,075	2,487	-0,073	-	0,103	3,691	-0,307	-								
Length									0,001	2,385	-0,455	1	0,001	1,815	-0,222	1
R^2	0,565				0,676				0,571				0,502			

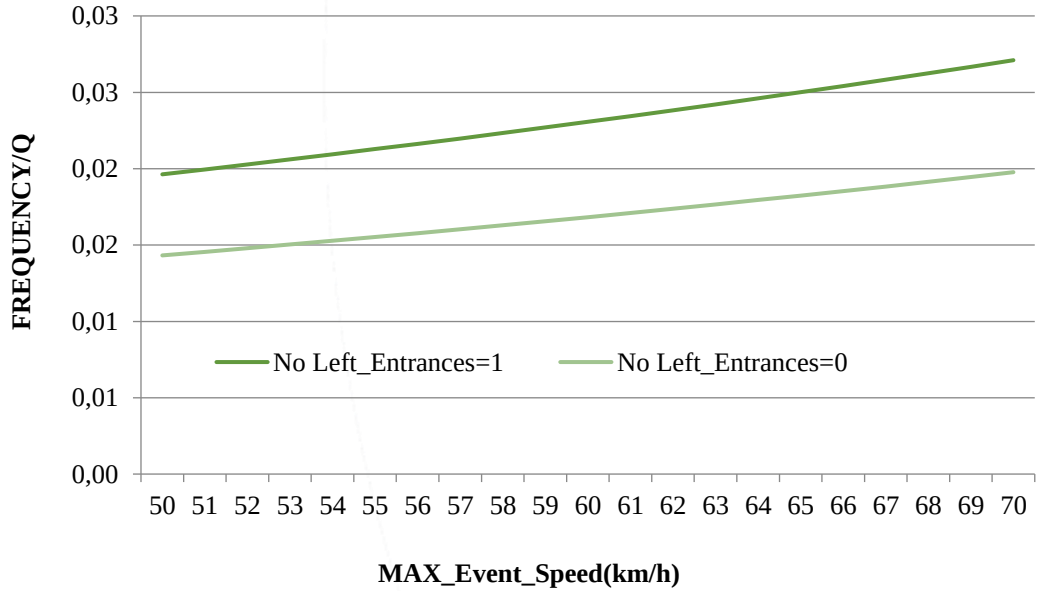
- As the average traffic velocity increases the harsh brakings decrease
- As the mean occupancy increases, so do the harsh accelerations

Sensitivity analysis

- As the **average traffic speed** increases, the frequency of harsh decelerations in a road segment decreases



- The higher the increase in **max event speed** the more harsh accelerations occur



Conclusions (1/2)

- Traffic parameters (speed and occupancy) have the most statistically significant impact on the frequency of harsh events

- The geometrical characteristics:
  - As the **length of the road segment** increases, more harsh brakings occur
  - As the number of **left entrances** in a junction and the number of **right exits and entrances** in a segment increase, more harsh accelerations occur
    The existence of a **sideway** increases the occurrence of harsh brakings in a junction

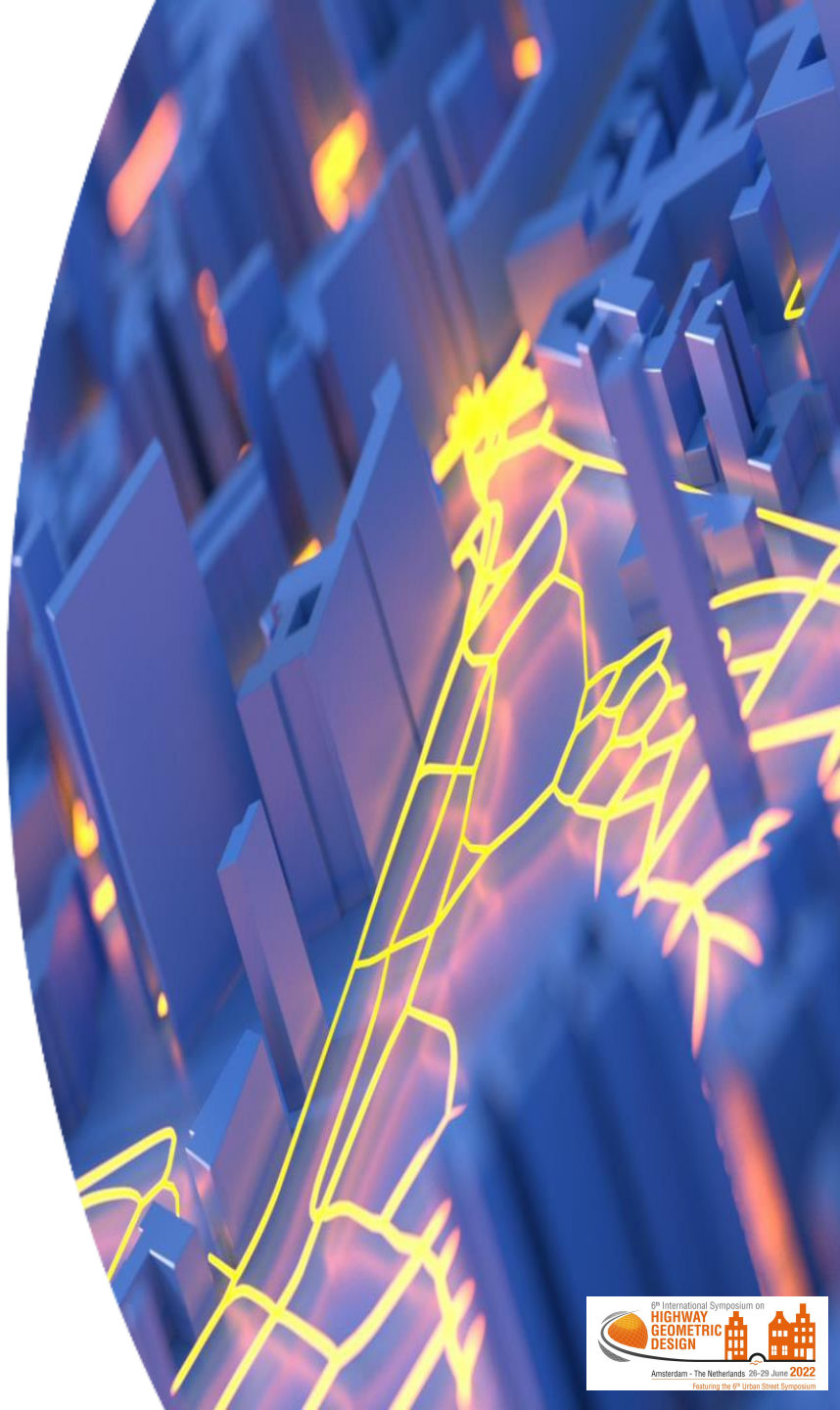
Conclusions (2/2)

- An increase in the maximum speed of events causes an increase in harsh events occurring on a junction and a road segment.

- The increase of the maximum of the speed difference indicated an increase in harsh accelerations in junctions, whereas the increase of the minimum of the speed difference decreases the frequency of harsh brakings in a road segment.

Future Challenges

- Selection of representative study areas and driver samples
- The influence of weather and traffic conditions while driving by using naturalistic driving data
- The examination of additional methods of analysis:
  - factor analysis
  - logistic regression
  - econometric techniques such as time-series analysis
- Methodological topics regarding dataset harmonization and spatial scale normalization



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