Effectiveness Evaluation of the i-DREAMS Interventions

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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:
  - 48 months (May 2019 – April 2023)

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

Background

- Rapid steps in transport automation transform the **operator/vehicle/environment interactions**, and require increased understanding of the operator human factors

- Definition, development, testing and validation of a context-aware **'Safety Tolerance Zone'** through:

  - the measurement of risk-related, driver-related and driving environment **indicators**

  - implementation of real-time and post-trip **interventions**

Objectives

The evaluation of the impact of the different interventions in order to assess their impact on driving behavior and driver state.

- Comparisons between the different countries, between the different interventions, and the different outcome variables
- The identification of the most promising intervention schemes for improving driver behavior

Theoretical Framework

- The STZ includes **three different driving phases**: 'normal', 'danger' and 'avoidable' crash
- Both real-time and post-trip **interventions** aim to keep the driver in the normal driving phase for as long as possible
- **Real-time interventions** trigger warnings of varying severity levels, depending on the detected event
- **Post-trip interventions** involve providing drivers with feedback through a smartphone app
- For providing real-time and post trip interventions, **'safety promoting goals'** were identified
- Within these are **'performance objectives'** (POs) aiming to determine if a driver is within the STZ

Phase 1 (Baseline)	• **Intervention**: NO • **Duration**: 4 weeks
Phase 2	• **Intervention**: Real-time • **Duration**: 4 weeks
Phase 3	• **Intervention**: Real-time + Post-trip • **Duration**: 4 weeks
Phase 4	• **Intervention**: Real-time + Post-trip + Gamification • **Duration**: 6 weeks

Data Collection

- Field trials were carried out in five countries, and across four transport modes
- For each Performance Objective, events were detected
- Scores calculated for each trip, for each PO and SPG (based on events registered)
- Events will be presented for 'high severity', 'medium severity', and 'all' (medium + high)
- 'Medium' events correspond to the danger phase of the STZ (danger phase), and 'high' events to the avoidable accident phase

SPG	PO	Drivers informed via
Vehicle Control	Acceleration	Post-trip
	Deceleration	
	Steering	
Speed Management	Speeding	Real-time & post-trip
Sharing the Road with Others	Tailgating	Real-time & post-trip
	Lane departure	
	Forward collision avoidance	
	VRU collision avoidance	
	Illegal overtaking	
Driver Fitness	Fatigue	Real-time & post-trip
	Distraction (hand-held phone use only)	

Analysis Methods

- An outcome evaluation was conducted to examine whether the interventions influenced the following four areas:
  - safety outcomes,
  - safety promoting goals,
  - performance objectives, and
  - change objectives

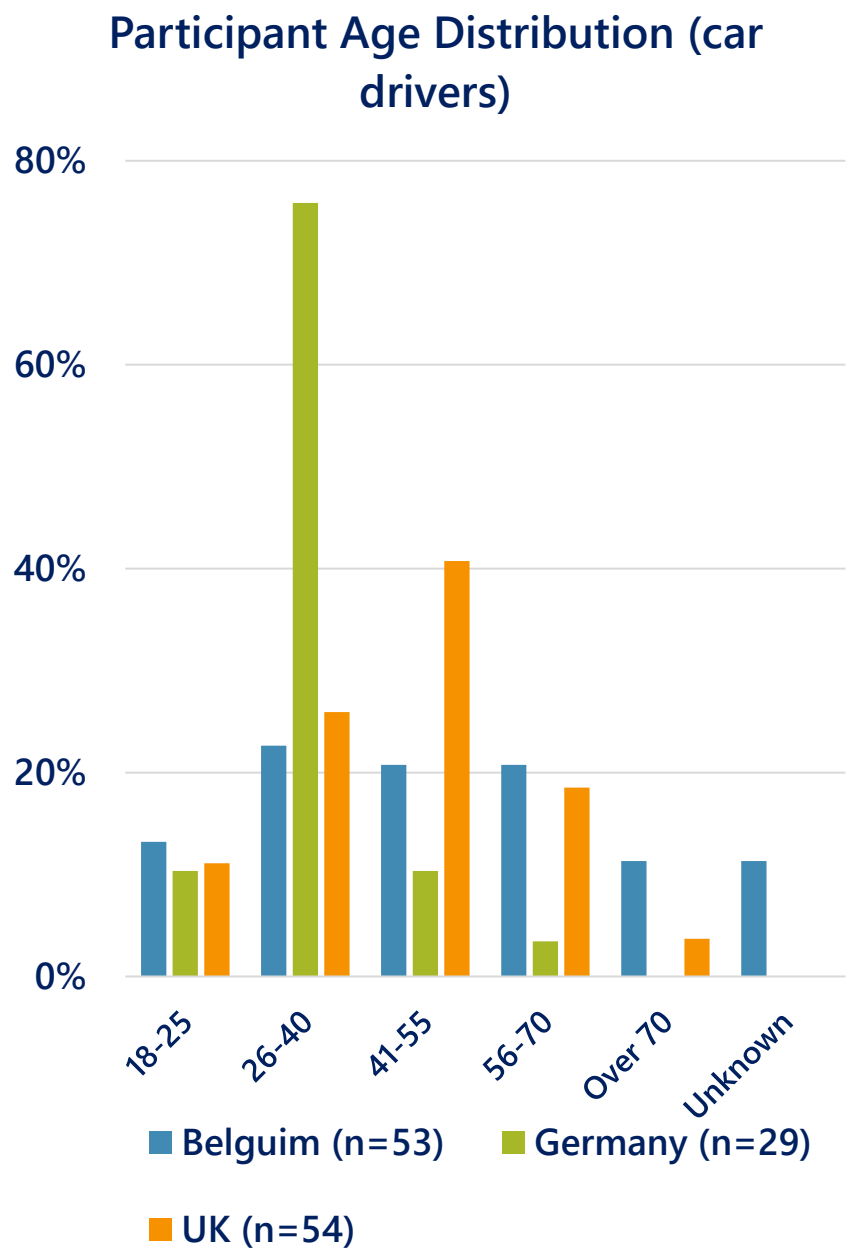
- A 'positive' outcome is seen if the number of events decreased, and/or the score increased.

- Descriptive analysis was conducted to assess changes in events/scores across phases and before/after differences

- Statistical methods (ANOVA or Friedman tests) were conducted to determine if changes are significant

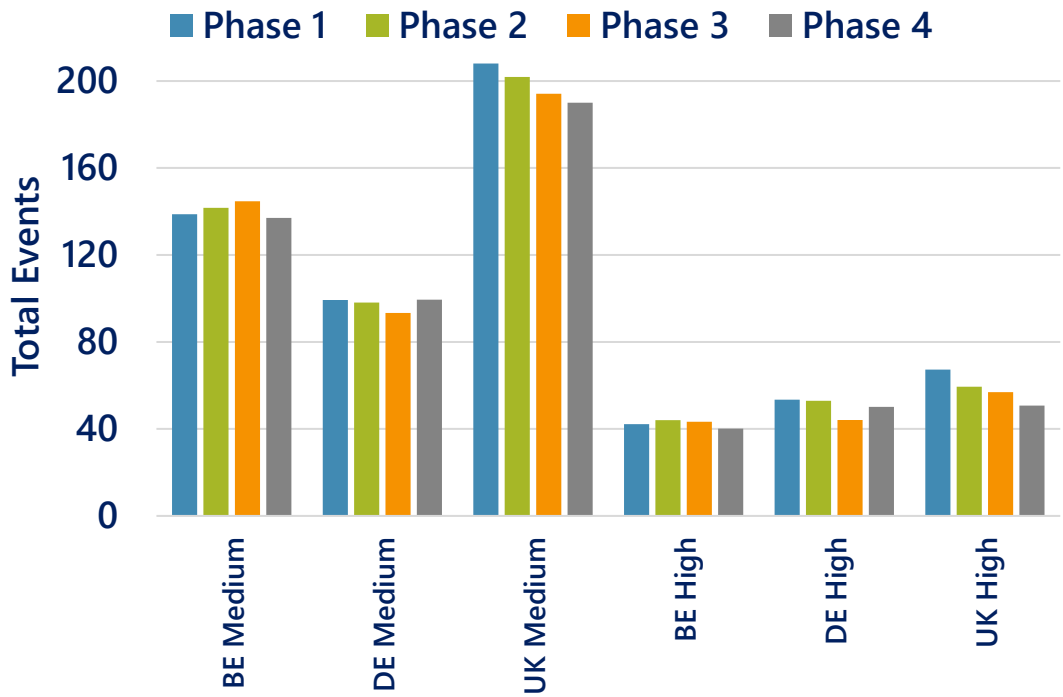
Data Sample

- Car data were analysed for three countries: Belgium (BE), Germany (DE), and the United Kingdom (UK)
- All countries had a similar gender distribution
- The German drivers were typically younger and had less driving experience compared with the Belgian and UK drivers
- A very small proportion of UK drivers currently used ADAS in their vehicle
- A slightly higher proportion of German and UK drivers had been involved in a recent accident compared with Belgian drivers
- Over half of the Belgian drivers had a recent offence



Descriptive Analysis

- ‘Medium’ events represented a higher proportion of total events compared with ‘High’ events
- Events rising then falling for Belgian drivers
- Events falling then rising for German drivers
- Events consistently falling for UK drivers
- UK drivers showed the greatest reduction in events



Phase	Belgium (n=48)		Germany (n=25)		UK (n=49)	
	Total Events / 100km	Overall scores	Total Events / 100km	Overall scores	Total Events / 100km	Overall scores
Phase 1	180.89	85.89	152.72	81.53	275.30	83.81
Phase 2	185.73	85.98	151.05	80.09	261.32	84.43
Phase 3	188.01	85.83	137.38	81.10	251.05	84.43
Phase 4	177.17	86.37	149.59	79.34	240.75	84.68

Statistical Analysis – Belgium Cars

- An **overall decrease** in 'total' and 'road sharing' events, and an overall increase in 'vehicle control' and 'speeding' events
- An increase from **Phase 1 to Phase 2**, except for 'road sharing'
- A decrease from **Phase 3 to Phase 4** for all event types
- The **most significant changes** were generally from Phase 3 to Phase 4, which were all decreases
- **'Road sharing' event** decreases were also statistically significant in multiple phases / severities
- None of the event **increases** were significant apart from overall change in 'speeding' events.

Change in Number of Events: Belgium Cars (n=48 drivers)

Event Type		Friedman / ANOVA test significance	Overall Change (P1-P4)		Change Between Phases					
					P1 - P2		P2 - P3		P3 - P4	
Total	Medium	p = 0.014	↓	0.207	↑	0.910	↑	0.894	↓	0.025
	High	p = 0.053	↓	0.246	↑	0.498	↓	0.436	↓	0.010
	All	p = 0.050	↓	0.151	↑	0.587	↑	0.829	↓	0.013
Vehicle Control	Medium	p = 0.101	↑	0.215	↑	0.601	↑	0.758	↓	0.045
	High	p = 0.355	↑	0.544	↑	0.509	↓	0.221	↓	0.267
	All	p = 0.070	↑	0.207	↑	0.430	↑	0.601	↓	0.066
Speeding	Medium	p = 0.108	↑	0.159	↑	0.430	↑	0.119	↓	0.512
	High	p = 0.281	↑	0.193	↑	0.140	↓	0.559	↓	0.943
	All	p = 0.122	↑	0.077	↑	0.110	↑	0.189	↓	0.878
Road Sharing	Medium	p = 0.228	↓	0.200	↓	0.582	↓	0.532	↓	0.077
	High	p < 0.001	↓	0.003	↓	0.083	↓	0.189	↓	0.014
	All	p = 0.017	↓	0.070	↓	0.128	↓	0.478	↓	0.047

Statistical Analysis – Germany Cars

- An **overall decrease** in most categories, though an overall increase in 'medium total' events, and 'medium' and 'all' 'vehicle control' events
- Events decreased from **Phase 2 to Phase 3** in all categories
- Events increased from **Phase 3 to Phase 4** in all except 'medium speeding'
- **Statistically significant** results were seen for decreases
  - in overall 'speeding' events,
  - in 'speeding' in Phase 2 to Phase 3 ('high' and 'all'),
  - in Phase 2 to Phase 3 for 'total' events ('high' and 'all')
- None of the event **increases** were statistically significant

Change in Number of Events: Germany Cars (n=25 drivers)										
Event Type		Friedman / ANOVA test significance	Overall Change (P1 – P4)		Change Between Phases					
					P1 - P2		P2 - P3		P3 - P4	
Total	Medium	p = 0.311	↑	0.790	↓	0.630	↓	0.290	↑	0.710
	High	p = 0.003	↓	0.165	↓	0.812	↓	0.002	↑	0.442
	All	p = 0.037	↓	0.275	↓	0.791	↓	0.075	↑	0.508
Vehicle Control	Medium	p = 0.874	↑	0.890	↓	0.710	↓	0.490	↑	0.600
	High	p = 0.647	↓	0.370	↓	0.480	↓	0.310	↑	0.350
	All	p = 0.691	↑	0.870	↓	0.790	↓	0.430	↑	0.490
Speeding	Medium	p = 0.323	↓	0.085	↑	0.312	↓	0.751	↓	0.287
	High	p = 0.068	↓	0.230	↑	0.672	↓	0.006	↑	0.411
	All	p = 0.218	↓	0.080	↑	0.958	↓	0.020	↑	0.916

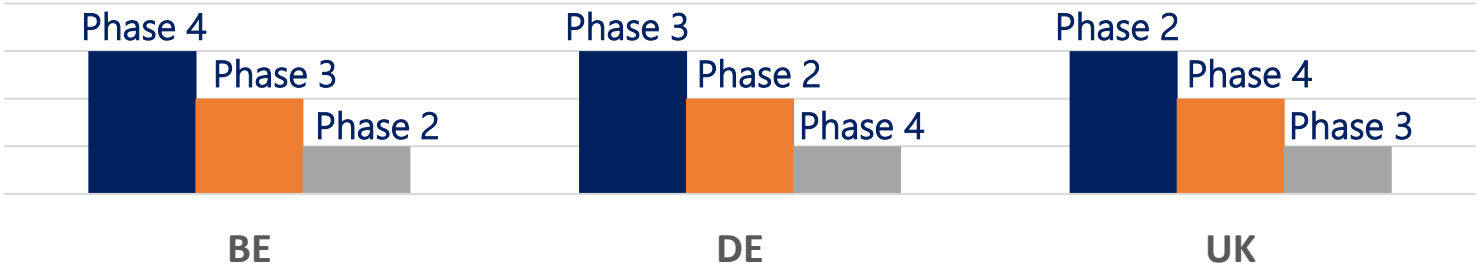
Statistical Analysis – UK Cars

- The events for UK drivers **decreased** for nearly every event category and phase, with only a few increases in vehicle control events
- The overall decrease (Phase 1 to Phase 4) was **statistically significant** for every event type
- Further significant results were seen in other phases, particularly for **'total' and 'road sharing' events**

Change in Number of Events: UK Cars (n=49 drivers)										
Event Type		Friedman / ANOVA test significance	Overall Change (P1 – P4)		Change Between Phases					
					P1 - P2		P2 - P3		P3 - P4	
Total	Medium	p = <0.001	↓	0.001	↓	0.187	↓	0.251	↓	0.259
	High	p = <0.001	↓	<0.001	↓	0.003	↓	0.100	↓	0.024
	All	p = <0.001	↓	<0.001	↓	0.031	↓	0.231	↓	0.094
Vehicle Control	Medium	p = 0.305	↓	0.028	↓	0.644	↓	0.525	↑	0.538
	High	p = 0.428	↓	0.042	↓	0.878	↑	0.340	↓	0.436
	All	p = 0.060	↓	0.016	↓	0.845	↓	0.486	↓	0.406
Speeding	Medium	p = 0.079	↓	0.006	↓	0.132	↓	0.601	↓	0.401
	High	p = <0.001	↓	0.001	↓	<0.001	↓	0.807	↓	0.941
	All	p = <0.001	↓	<0.001	↓	<0.001	↓	0.800	↓	0.672
Road Sharing	Medium	p = 0.010	↓	<0.001	↓	0.104	↓	0.198	↓	0.100
	High	p = <0.001	↓	<0.001	↓	0.001	↓	0.198	↓	0.003
	All	p = <0.001	↓	<0.001	↓	0.007	↓	0.303	↓	0.013

Conclusions

- The i-DREAMS technology led to reduced safety-critical events overall
- Differences were found between the countries and the different Safety Promoting Goals
- UK drivers had the highest number of events, but also showed the greatest reduction across all phases
- German drivers had the highest number of speeding events, whereas Belgian drivers had the lowest
- Road sharing events showed the most improvement, while vehicle control events had mixed results
- The interventions can be ranked as follows



Limitations & Future Directions

Limitations

- It was not possible to form robust conclusions regarding 'fatigue' and 'distraction' events, due to a lack of data
- Specifically for the German drivers, there was an issue with the installations that meant 'road sharing' data was not captured

Future Directions

- Expansion of the STZ to other modes and users (PTWs, Cyclists, Pedestrians)
- Enhancement of data collection approach with more sensors due to rapid technological advancement
- Modification of STZ for higher automation vehicles

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