State of the art on measuring driver state and technology-based risk prevention and mitigation Findings from the i-DREAMS project

Susanne Kaiser[a], Christos Katrakazas[b], Eva Aigner-Breuss[a], Fran Pilkington-Cheney[c], Apostolos Ziakopoulos[b], George Yannis[b], Tom Brijs[d]

[a]*KFV, Austrian Road Safety Board, Schleiergasse 18, 1100 Wien, Austria*
[b]*National Technical University of Athens, Department of Transportation Planning and Engineering, 5 Heroon Polytechniou str., GR-15773, Athens, Greece*
[c]*Loughborough University, Transport Safety Research Centre, LE11 3TU Loughborough, United Kingdom*
[d]*UHasselt, Transportation Research Institute (IMOB), Science Park – Building 5, 3590 - Diepenbeek, Belgium*

Hosted and organised by: MINISTRY OF TRANSPORT AND COMMUNICATIONS TRAFICOM VÄYLÄ BUSINESS FINLAND VTT
Co-organised by: European Commission
Together with: ACARE alice ECTP ERRAC ERTRAC ETRA WATERBORNE

Outline

- The i-DREAMS Project
- Literature Review Methodology
- Significant findings
- Next steps

The i-DREAMS project (1)

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.

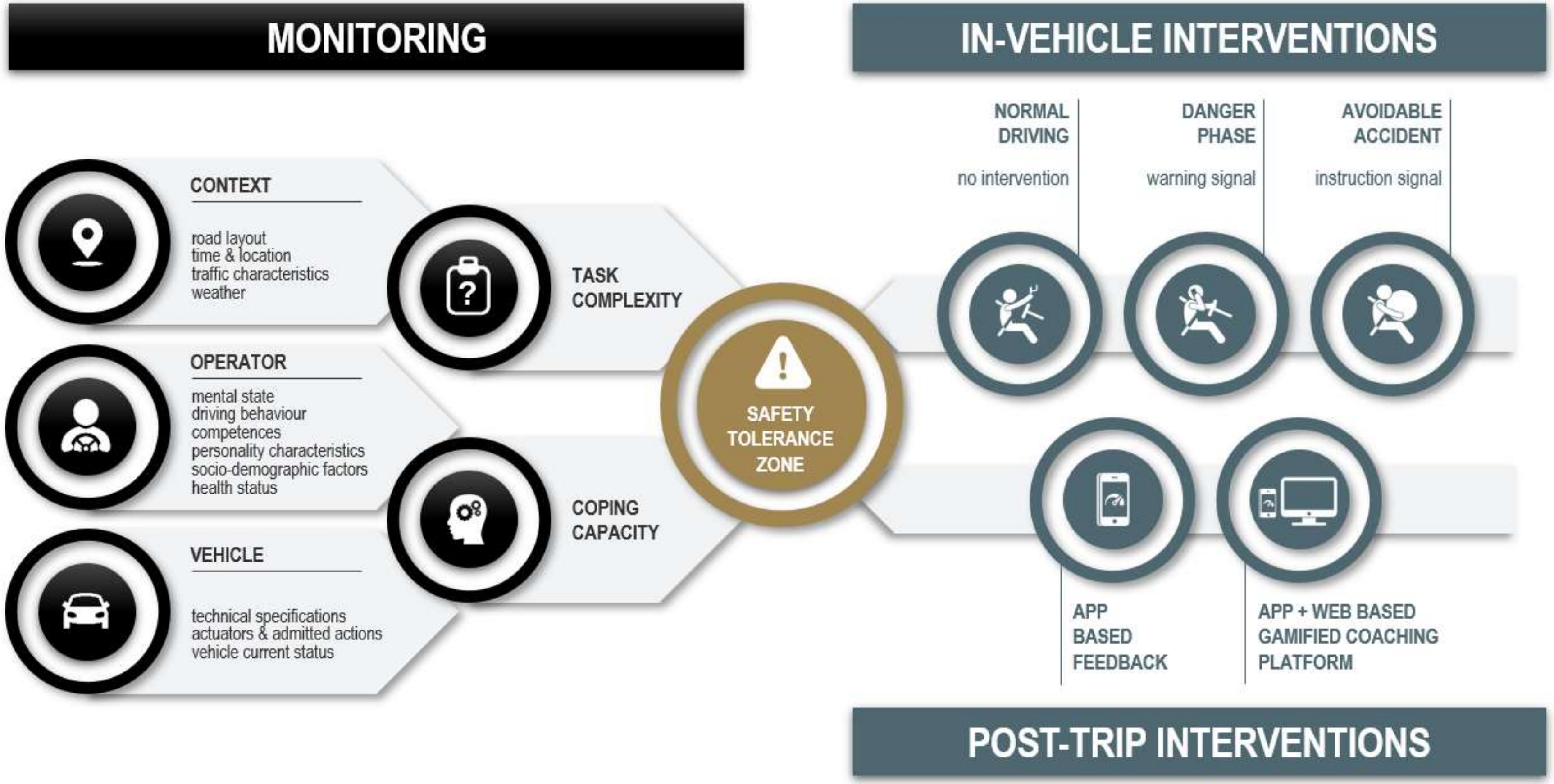
Duration of the project:

36 months (May 2019 – May 2022)

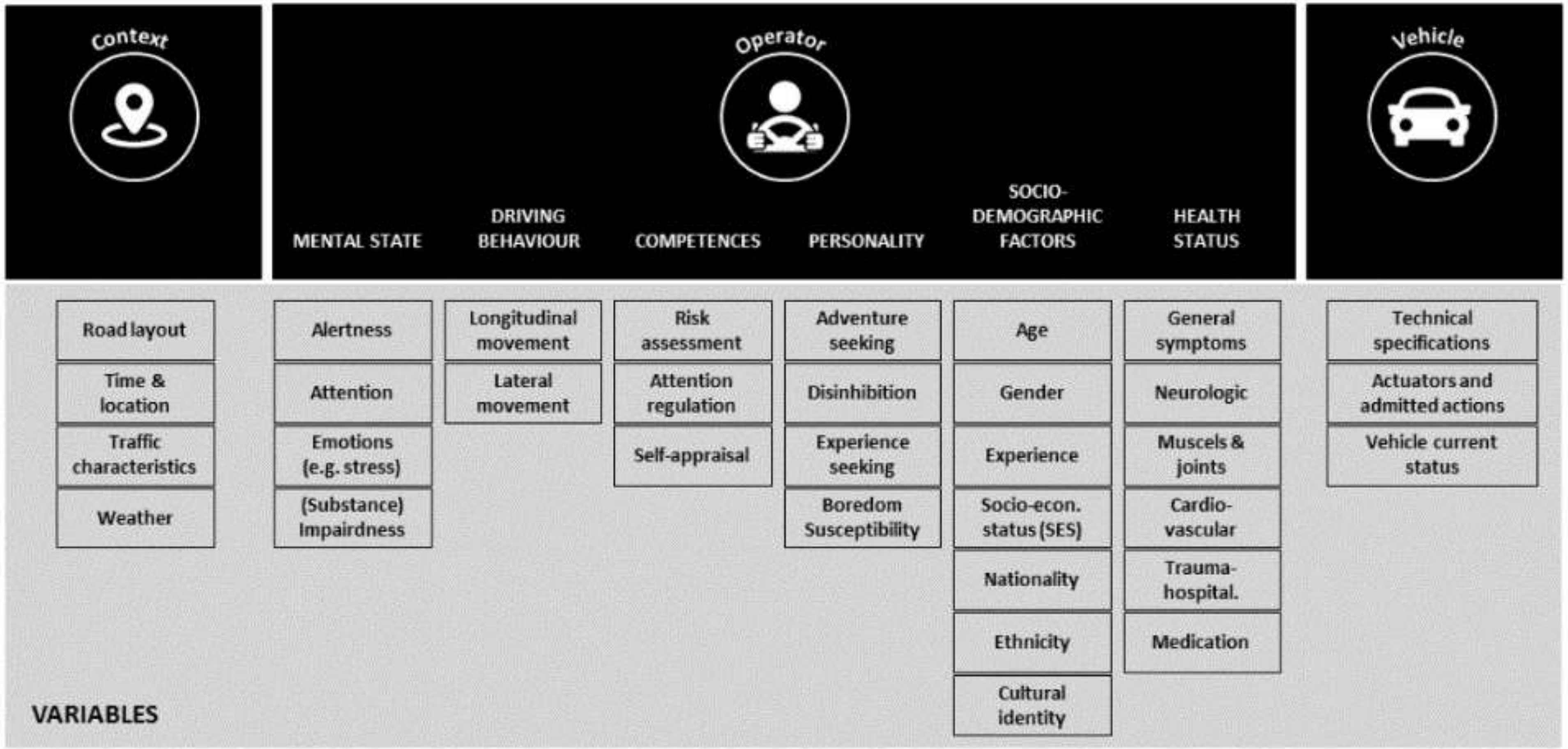
TRA 2020 HELSINKI

The i-DREAMS project (2)

Definition, development, testing and validation of a context-aware ‘Safety Tolerance Zone’ for driving



Measurements considered in i-DREAMS



Literature Review

Systematic Literature Review

- Identification of terms
- Title & Abstract screening
- Focus on underlying constructs (e.g. emotions, distraction types), indicators, technical equipment, results and conclusions

Factor	Key words (without word stem variations)	Screened papers	Included papers
Task Demand	"task demand" AND "driving measures" OR "performance measurements" OR "driver characteristics" OR "driving monitoring" OR "workload" OR "traffic conditions" OR "traffic" OR "weather" OR "road layout" OR "time of day"	413	11
Distraction	"distraction" OR "distracted" OR "inattention" OR "inattentive" AND "driver monitoring" OR "driver measure"	417	32
Emotions	“emotion” OR “affect” OR “arousal” OR “stress” OR “anger”” AND “measure” OR “driver monitoring” OR “workload” OR “physiological” AND “driving” OR “road safety” OR “traffic” OR “driving performance” OR “car”	403	38
Fatigue and sleepiness	“fatigue” OR “sleep” OR “drowsy” OR “alert” OR “monotonous” OR “tired” OR “bored” OR “weariness” OR “time on task” AND “driver monitoring” OR “physiological measure” OR “blink” OR “perclos” OR “yawning” OR “eye movement” AND “ drive” OR “car” OR “professional driver” OR “commercial driver” OR “raffic” OR “road safety”	1,545	187

Task Demand

- Task demand as result of exogenous factors
  - Road
  - Traffic environment
  - Weather
  - Time of day

- Task demand as cognitive workload

Road layout	Traffic environment	Weather	Time of day
• High number of lanes • Narrow lanes • Wider lanes with high traffic volume • Length of deceleration lane • Roundabouts • Highway curves • Geometric design	• Annual average daily traffic • Through traffic per lane • Congestion	• Rain • Sun • Wind • Frost • Snow • Fog	• Darkness • Twilight • Peak hours
	Train drivers • Track changes • Monotony of environment • Behaviour of passengers • Obstruction of tracks	Train drivers • Obstruction due to weather condition	Train drivers • darkness

Table 1: Exogenous factors affecting task demand

TRA 2020 HELSINKI

Task Demand - Cognitive load

- Studies mainly on road layout, traffic condition, weather
- Rarely on time of day
- Measured most frequently by physiological indicators, e.g. ECG
- Other indicators measured through
  - EEG
  - Vehicle kinematics
  - Skin conductance
  - Occular indicators

↑ Speed variation
- Increase in HGV composition
- Shorter time headway

Acceleration signatures
- Changes in road type

↓ Heart rate
- dense traffic
- adverse weather (fog)
- transition highway to urban traffic

↑ Heart rate
- Lange changing events
- Transition motorway to urban traffic

↑ Oxygenated haemoglobin
- Changes in road type

↓ Blink rate
- Sharper road curves

↑ Horizontal spread
- Changes in road type

↑ SCR
- Higher visibility conditions
- Changes in road type

Task demand findings

- Mainly simulator experiments

- No thresholds provided

- Most reliable indicators (work load)
- Cardiac measures (heart rate, heart rate variability)
- Duration of fixations

TRA 2020 HELSINKI

Attention and Distraction

- Most studies on visual distraction
- Main method used: eye-tracking
- Very heterogenous study designs and equipment > excacerbates comparison
- No thresholds for driver behaviour indicators
- No mode-specific measurement methods

Mental State

- More studies on sleepiness than fatigue and in simulators
- Most in-built commercial systems use occular measures (PERCLOS and Blink Duration)
- Source of reduced attention and distractability needs to be defined for interventions
- Consideration of professional vs. non-professional drivers
- Mental state', 'emotions', etc. are theoretical constructs that need a decisive definition.

Conclusions & recommendations

- Most of the evidence is available for car drivers.
- ‘Using at least two approaches for driver state monitoring is beneficial for validity and reliability
- Cameras, eye tracking, and heart rate sensors should be considered
- Drivers’ traits and characteristics should be explored.
- Thoroughly testing indicators and measures at the simulator stage is indispensable

State of the art on measuring driver state and technology-based risk prevention and mitigation Findings from the i-DREAMS project

Susanne Kaiser[a], Christos Katrakazas[b], Eva Aigner-Breuss[a], Fran Pilkington-Cheney[c], Apostolos Ziakopoulos[b], George Yannis[b], Tom Brijs[d]

traconference.eu #TRA2020 #rethinkingtransport @TRA_Conference

Hosted and organised by: MINISTRY OF TRANSPORT AND COMMUNICATIONS TRAFICOM Finnish Transport and Communications Agency VÄYLÄ BUSINESS FINLAND VTT

Co-organised by: European Commission

Together with: ACARE alice CEDR ECTP ERRAC ERTRAC ETRA WATERBORNE