

D2.1 State of the art on monitoring driver state and task demand.

The **goal of i-DREAMS** is to develop a system that assists drivers to drive safely. To make sure the driver stays in a 'safe zone', the driver's mental state (e.g. alertness), the driving context (e.g. speed limits, weather conditions) and concrete driver behaviour (e.g. lane positioning, headway) will be monitored in real-time. How safely the driver is driving is reflected by his position in what is called the 'Safety Tolerance Zone'.

The STZ is a continuum that distinguishes 3 stages: (1) the *normal or safe driving* stage where no interventions are required, (2) the *danger phase* where the risk of a collision is increasing and where the driver will be informed about potential dangers and (3) the *avoidable accident phase* where the system issues concrete warnings to avoid a collision. Besides in-vehicle interventions during the trip, post-trip interventions will further educate drivers about their specific safe and unsafe driving performances. To realize this ambition, the consortium tackles a complex set of tasks of which intermediate progress and results are reported in technical reports.

The **aim of deliverable 2.1** was to review and assess state-of-the-art approaches and methods to monitor the driver's mental state and contextual factors of the driving environment that impact task demand. In addition, a selection of driver trait factors (including measurement methods) were summarized and driver behaviour indicators were reviewed.

'Keep drivers in the Safety Tolerance Zone' ... in other words, make sure drivers drive as safely as possible. Isn't that what a lot of road safety research is focusing on? What makes this project unique and different from other research projects?

SUSANNE KAISER: *"Without a doubt the diagnostic power of an intervention system that is dynamic and that is based on the driver's state and environment information. In-vehicle real-time interventions are ideal to help making safe decisions in potentially dangerous situations. But by also incorporating post-trip interventions, we have the opportunity to change habits. I don't think anything that holistic has already been done before. And don't forget, we are not limiting our research to one transportation mode. Besides cars, we also focus on buses, trucks, trams and trains."*

How do you start with something like that?

SUSANNE KAISER: *"Well, in scientific research you first start exploring what has already been done. In this case we started reviewing a tremendous amount of literature to find out what the best ways are to monitor the mental state of a driver and the environment in which the driver operates. The driver's mental state can limit the ability to cope with complex driving tasks. Furthermore, we also looked into what has been written about the impact of driver characteristics such as competences, personality traits, past and habitual driving behaviours, health factors and socio-demographics and how to measure them."*

In general, what information can be found in this report then?

SUSANNE KAISER: *"Actually, in this report, we documented all the factors we should consider throughout the project and we reviewed and assessed measuring methods and technologies for research in both the simulator and in the real-world driving environment."*

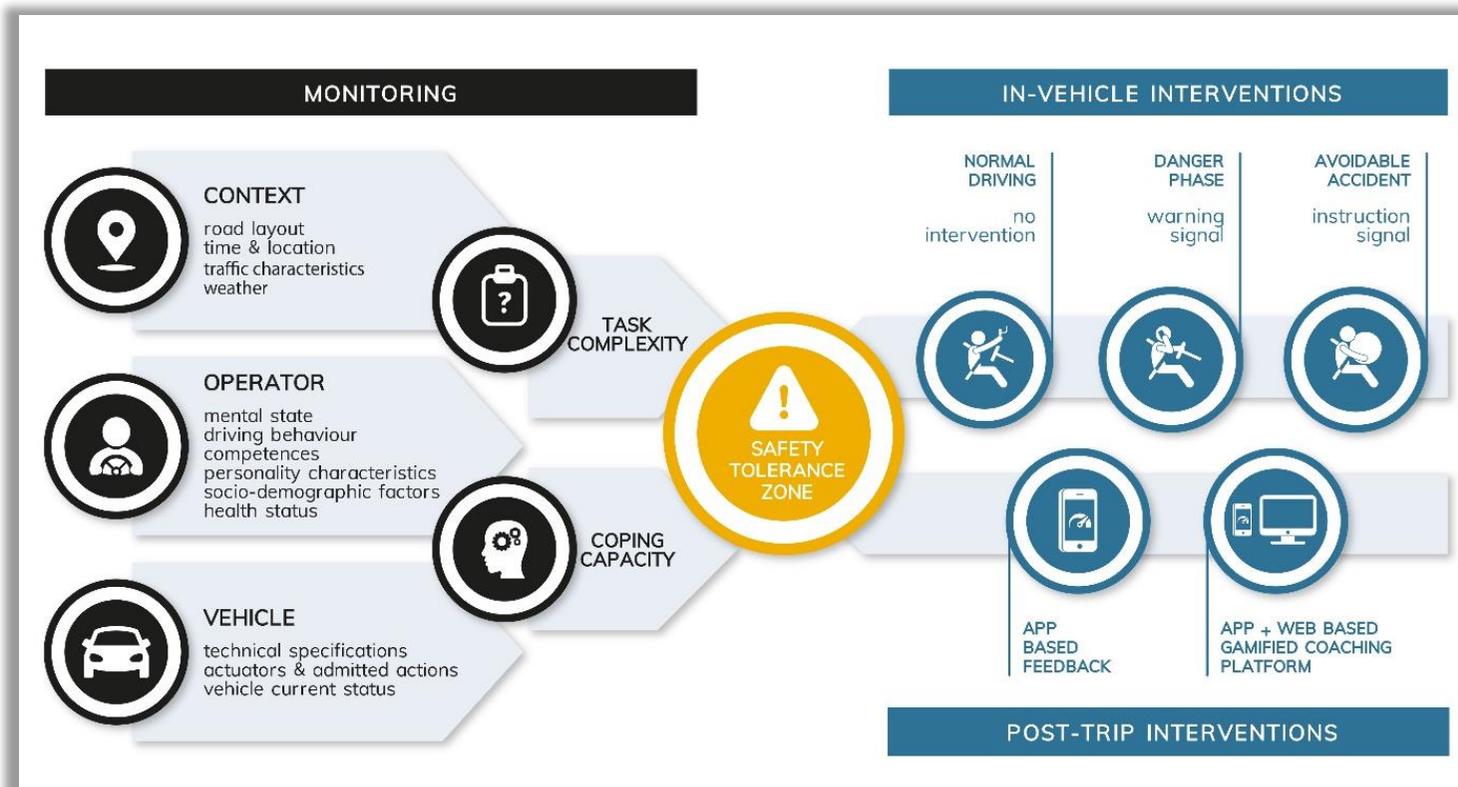


What literature did you review specifically?

SUSANNE KAISER: *Most of the literature we reviewed was about car driving. But since we are also looking into other modes like trucks, buses, trains and trams, we investigated if we could assume that conclusions from that literature are transferable to other modes. We did not find anything concrete that contradicts this assumption. However, the particular situation of professional driving should be borne in mind at all times. The target audience of professional drivers will play an important role in the project.*

I got to know i-DREAMS via the project's general flyer. In that flyer the project was illustrated via an infographic. This image shows what aspects play a role in creating that 'Safety Tolerance Zone'. Where does this report fit in, in that infographic?

SUSANNE KAISER: *"The work presented in this report addresses the left half of the infographic which is about monitoring the driver. In order to monitor if the driver is operating within safe boundaries of driving, we need to know about the current task complexity due to*



environmental factors and the capacities available to the driver to cope with the task demand. The ultimate goal is to determine in which phase of the safety tolerance zone the driver is situated at any given point in time of the drive.”

When you talk about ‘task demand and task complexity’, what exactly are you referring to?

SUSANNE KAISER: *“The complexity level of a driving task is determined for example by the road environment, traffic restrictions, weather conditions, the time of the day or the location. However, the complexity of the driving task is also associated with the driver’s current performance like how fast is he driving, what is the following distance, etc. All possible mechanisms of the driving context can add to the ‘task demand’ of the driving task and thus increase the driver’s workload.*

How are you going to monitor the driver’s state this in the project?

SUSANNE KAISER: *“By measuring specific indicators. We will measure physiological indicators such as the heart rate. These indicators cannot (or can hardly) be controlled by willpower. But we will also measure behavioural indicators such as distraction as a result of handheld mobile phone use behind the wheel. Our literature review indicated that the most frequently used method to measure physiological and behavioural indicators is via ECG (a graphical representation of the electrical activity in the heart muscle) and via the number and duration of eye fixations. We will capture ECG via the CardioWheel technology that has sensors on the steering wheel and by means of a wearable. Handheld mobile phone use behind the wheel will be detected by an algorithm that analyses movements from accelerometer sensor data in the*

smartphone. But besides these physiological and behavioural indicators, we will also measure driving performance by monitoring, for example, lateral position deviation, speed and time headway. We will use a combination of CANbus data, an intelligent camera, mobile phone technology and self-developed technology to do that. However, when we measure task demand, physiological and behavioural measures always have priority over driving performance measures.”

The driver’s mental state is considered as a crucial factor that has an impact on where the driver is positioned in the Safety Tolerance Zone. What does ‘mental state’ refer to exactly?

SUSANNE KAISER: *“This refers to the cognitive state (think of the attention level, how tired the driver is, the current workload etc.) but also to the emotional state. Within the system that we are developing, interventions in real-time or through post-trip coaching will target specific triggers that influence attention and distraction, fatigue and sleepiness, emotions and stress as well as substance impairment.”*

What a driver is thinking or feeling, can influence the driving behaviour. Which indicators of driving behaviour will be looked into and how will you do that?

SUSANNE KAISER: *“We have reviewed 30 different indicators of driving behaviour and we will focus on the ones available and most promising. I am talking about speed, trajectory, acceleration, latitude and longitude, jerk, acceleration/brake pedal status, steering angle, yaw rate, time/distance headway, lane position, speed limits, time over speed. All these indicators can be measured by the equipment that is available or developed in the consortium. I am talking about tools such as CardioWheel, Mobileye, but also On-Board-*



Diagnostics systems, GPS, etc. Of course, before the actual trials start, all of the indicators and technologies to measure them will be thoroughly tested in the simulator and in on road pilots.”

In the infographic I can also see that besides a driver’s mental state and driving behaviour, you will look into a number of driver characteristics. Why is that?

SUSANNE KAISER: *“Because they influence a person’s driving style as well as the capacity to cope with specific driving tasks. But not all of these characteristics can or need to be measured in real-time while driving. For example, factors such as personality traits, driving experience or health status are relatively stable over time, so they will not change suddenly. So we will take them into account via a one-time measurement.”*

I assume you will do this via questionnaires?

SUSANNE KAISER: *“Yes, indeed. We will most likely survey these characteristics before starting the trials. Questionnaires will be used for this, but we will also apply a few additional performance tests such as measuring attentional regulation capabilities.”*

OK, thank you for having this talk with me. I am impressed by the consortium’s ambitions and by the preparatory work you have already carried out. It seems like you have thought of every detail, so I am very curious about what will happen when you put all of this into practice. I wish you the best of luck!

Edith Donders
i-DREAMS DisCom manager

**Deliverable 2.1 is part of WP2:
State of the art on measuring the driver state
and technology based risk prevention and mitigation**

Researcher in the spotlight



**SUSANNE
KAISER**

Graduated as psychologist in 2011
Employed at Austrian Road Safety Board (KFV) since 2013
Passionate about interior design and crafting
Tasks in i-DREAMS:
*Coordination of systematic literature review
and deduction of the status quo regarding
driver state monitoring and intervention approaches*

