D3.1 Framework for operational design of experimental work in i-DREAMS.

As you know, the overall objective of the i-DREAMS project is to setup a framework for the definition, development, testing and validation of a context-aware safety envelope for driving ('Safety Tolerance Zone'), within a smart Driver, Vehicle & Environment Assessment and Monitoring System (i-DREAMS). Taking into account driver background factors and real-time risk indicators associated with the driving performance as well as the driver state and driving task complexity indicators, a continuous real-time assessment will be made to monitor and determine if a driver is within acceptable boundaries of safe operation. Moreover, safety-oriented interventions will be developed to inform or warn the driver in real-time in an effective way as well as on an aggregated level after driving, through an app- and web-based gamified coaching platform (post-trip intervention).

The **aim of deliverable 3.1** in this context was twofold:

- To outline the theoretical framework that relates to driver and context monitoring in the i-DREAMS platform, with a specific focus on the Safety Tolerance Zone. This includes an overview of the theories describing the driving task and a detailed theoretical description of the i-DREAMS concept of Safety Tolerance Zone.
- To define the modes of transport investigated in i-DREAMS and to indicate the differences that could influence the development of the control and communication tools developed in the project. For this purpose, a survey was also carried out among the important stakeholders

It has already been explained in a previous deliverable interview (on deliverable 2.1), but can you refresh our memory again? What is the 'Safety Tolerance Zone' (STZ)?

RACHEL TALBOT: *"The Safety Tolerance Zone (STZ) is a theoretical concept that guides the development of the algorithm that determines the operation of the i-DREAMS platform. It is simply the zone where the demands of the driving task (task complexity) are balanced by the driver's ability to cope with them (capacity).The STZ distinguishes 'normal or safe driving', a 'danger phase' where the risk of a collision is increased and an 'avoidable accident phase' where action needs to be taken to avoid a collision. Our i-DREAMS system detects when a driver enters the danger phase and issues a warning. When transitioning into the 'avoidable accident phase', a more urgent sounding warning signal will be given. We call this the 'in-vehicle interventions'. Besides those, we will also provide information after the trip, the so-called 'post-trip interventions' to advise about when driving was safe and unsafe."*

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In this deliverable you have provided an overview of theories that describe the driving task. Is there a specific theory we should keep in mind according to you?

RACHEL TALBOT: *“We have actually described several theories from four relevant theory types: the control theories, the motivational theories, the crash models and the computational models. Control theories assume that the driving actions of drivers depend on the perceptions of these drivers and the resulting decisions. Motivational theories acknowledge that safety is not a drivers’ only motivation. Crash models demonstrate that multiple phases lead to collisions. And computational models provide a bridge between theoretical and mathematical models. The concept of the 'Safety Tolerance Zone' has its roots in control theory. A very well-known theory from this category is ‘Fuller's Task Capability Interface Model’ (TCI). This theory states that driving is safe when the task matches the driver's ability.*

So how can you apply this theory to the Safety Tolerance Zone of i-DREAMS?

RACHEL TALBOT: *“Well, I already explained to you the three phases in the STZ. If you apply the TCI-theory we can derive the following: In the 'normal driving phase', the driver's ability to drive comfortably meets the demands of the task. In many cases, the driver will even be able to perform more complex driving tasks. In this phase, there is no need for intervention. In the ‘danger phase’, the driver's processing capacity will deteriorate or the complexity of the task will increase, pushing the driver to the edge of his capacity. In this case the risk of a collision increases. In this phase a warning is issued. In the 'avoidable accident phase' the driving task demands more than the driver's capacity and a crash situation is imminent. There is still time to take action. In this phase a more ‘urgent’ sounding warning is required. However, it must be considered that these warnings may be ignored if the driver does not recognise that there is an increased risk.”*

Will this have implications for the i-DREAMS platform?

RACHEL TALBOT: *“The STZ already takes into account the fact that the driver’s risk perception guides their actions and there can be a mismatch between this ‘subjective reality’ – or the perception of risk - and the ‘objective reality’ - the actual likelihood of a crash. In i-DREAMS, this 'subjective reality' will be addressed by means of post-trip interventions. These are interactions with the driver after the trip in which we explain the behaviour shown and give tips and incentives on how to do it better. But also in the real-time interventions, we take into account the subjective risk recognition and interpretation of drivers.”*

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I read in the report that a survey was conducted among stakeholders in the transport sector. Can you tell us more about this?

RACHEL TALBOT: *"The stakeholder survey aimed to gather opinions on the main problems leading to incidents and accidents in certain modes of transport, and how the i-DREAMS platform could best address these problems. Stakeholders from different modes of transport (passenger cars, buses, trucks, trains and trams) were asked to provide information on the main types of accidents, the factors involved in causing these accidents, and how technology can help to reduce the number and risk of accidents. The survey also aimed to gather opinions on barriers to the successful implementation of the proposed i-DREAMS system, to provide information on experiences with technology currently being used within the various stakeholders, and on what they would like to see implemented in the future."*

Who participated in the survey?

RACHEL TALBOT: *"In total, the survey elicited 103 responses. Since this is a small sample size, the results are not statistically significant and limited in their conclusions and implications. However, it provides important information on stakeholder opinion. Most respondents were academic or commercial researchers (37) and operators (20), with a small proportion of policy makers (8). 14 respondents selected "other" as their area of work.*

Most of the responses concerned passenger cars (63), followed by buses (25), trucks (10), trains (4) and trams (1). The responses provided valuable information on stakeholder views on the cause and prevention of accidents and on the current and desired use of the technology."

What were the most important conclusions from this survey?

RACHEL TALBOT: *"Going into detail would get us too far, but all the details are described in the report. Overall, the results showed several similarities between the different modes. But some differences were noticed between the rail modes and the other modes, indicating that rail modes may work differently. But there were also some differences between modes that were more likely to have passengers (buses & rail modes) and the other modes (cars & trucks), in terms of safety. In general, the key collisions selected for each mode were different, and this was also reflected in the additional technologies that stakeholders would like to see, which in some cases were related to the key collisions between the different modes. Regarding the main safety violation, loss of control, following another vehicle and sudden braking were mentioned in all modes. Regardless of the safety violation, inattention/distraction was considered an important factor for all modes. This is consistent with the results indicating that additional or desirable future technologies should focus on measuring and monitoring driver states such as attention/distraction and fatigue. There was also a consensus on how the i-DREAMS system could assist with safety breaches, with timely warnings as the most popular suggestion.*

Regarding barriers and constraints to real-time assistance and incentives for post-trip deployment, there was generally a consensus among stakeholders. The results suggested that it is important to involve drivers in the implementation process and use the system in an established safety culture. It was indicated that rewards, positive reinforcement and evidence-based suggestions and feedback would help to encourage people to engage in post-trip feedback. In terms of the key technology currently used, the results focused on driver performance indicators, while future technologies were more focused on measuring/monitoring aspects of the driver's condition."

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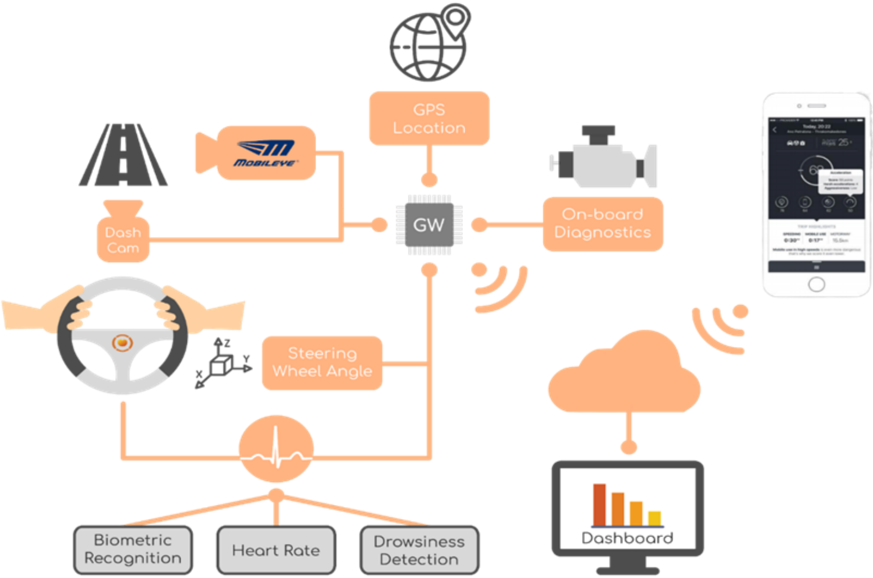
You are talking about technologies … what technologies are used by the i-DREAMS system you are developing in the project?

RACHEL TALBOT: *"Our technology set is visualized on the image. Although the basic technology set will be used in all the road transport modes (buses, cars, trucks), it will need to be adapted for rail vehicles. The steering wheel cover (CardioWheel) to measure heart rate will be replaced by a wearable heart rate (ECG) monitor. This will also be the case for heart rate monitoring in the car, since we expect that private drivers are less likely to accept a steering wheel cover. The MobilEye unit measures headway and lane departure, neither of which are relevant for trains although headway could be useful in the case of trams.*

In relation to the STZ concept, the technology visualized in the image will measure the context, vehicle and operator measures that will be used to calculate driver capability and task demand in order to calculate which phase of the STZ the driver is operating in. The CardioWheel or wearable will measure the operator state, the on-board diagnostics will provide information on the vehicle and the MobilEye, dash cam and GPS location provides data on the context."



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Deliverable 3.1 is part of WP3:
Operational design of i-DREAMS

This all sounds very challenging. Do you have an idea what the most important challenges are that you will be facing?

RACHEL TALBOT: *"There are a lot of challenges in this project. I think too many to describe them all. While doing the work for this deliverable, we of course encountered a couple of those challenges. During the preparation and the executions of the trials, there will be numerous challenges to prepare for. First is the recruitment of the trial participants. This will not be easy in these strange Corona times. But also technical issues (e.g. different vehicle types, technology level in vehicles), and human issues (e.g. identification of drivers that drive the same vehicle in the case of buses for example, drivers damaging equipment, drivers forgetting to wear their wearable) will play a role. But also with respect to the STZ concept, some mode related considerations will have to be taken into account. The demarcation of the STZ phases is likely to differ between modes. For example, truck drivers may require an earlier warning than car drivers if differences in stopping distance are to be taken into account. In other words, it is unlikely that a 'one size fits all' approach will be appropriate when designing the i-DREAMS platform. Instead, the monitoring and intervention modules and the decision-making processes to determine the status of the STZ will have to be optimised for each transport mode considered.*

Rachel, thanks a lot for this conversation. Good luck on what is to come!

Edith Donders

i-DREAMS DisCom manager

Researcher in the spotlight

RACHEL TALBOT

Graduated as psychologist in 2002

Employed at Loughborough University since 2004

Passionate about reading and going on walks with my family

Tasks in i-DREAMS:
Coordination of the development of the operational design including the methodology for the simulator and field trials; Coordinator of the Loughborough University contribution to i-DREAMS (rail and car modes)

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