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Methodology for the Evaluation of Safety 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

Introduction

- Road crashes, fatalities and serious or slight injuries comprise **important problems** in public health

- In recent decades, **automotive telematics** and driver monitoring systems have been introduced in the industry in order to provide real-time and post-trip feedback to the driver

- A few **driver monitoring technologies** and platforms that have been used to record driving performance, focus on key risk indicators and provide safety

- **Safety interventions** have been indicated to significantly enhance driving behavior and road safety

Background

- The i-DREAMS project aims to define, develop, test and validate the concept of the ‘Safety Tolerance Zone’ (STZ), with a smart Driver, Vehicle & Environment Assessment and Monitoring System

- Driving task complexity indicators (e.g. road layout, weather conditions, time of the day) and driver background factors (e.g. fatigue, distraction, sleepiness) are taken into account

- A continuous real-time assessment is implemented to monitor and determine if a driver is within acceptable boundaries of safe operation (i.e. STZ)

- Safety-oriented interventions and post-trip feedback are provided in order to prevent drivers from getting too close to the boundaries of unsafe operation

Safety Tolerance Zone Concept

The intervention mechanism is based on the STZ concept, which is divided in three different phases:

- **Normal Phase** refers to the phase, where conditions at that point in time suggest that a crash is unlikely to occur and therefore, the crash risk is low and the operator is successfully adjusting their behavior to meet task demand; no real-time interventions are necessary
- **Danger Phase** is characterized by changes to the Normal Phase that suggest a crash may occur and thus, there is an increased crash risk. At this phase, a crash is not inevitable but becomes more likely; an alert will be offered
- **Avoidable Accident Phase** occurs when a collision scenario is developing, but there is still time for the operator to intervene to avoid the crash. At this phase, the need for action is more urgent to denote that if there are no changes or an evasive manoeuvre performed by the operator, a crash is very likely to occur; an intrusive warning signal will be provided

Objectives

- **Provide a methodology** for the evaluation of both real-time and post-trip safety interventions, which will be developed to improve driver safety through keeping the driver within the boundaries of the STZ

- **Identify the appropriate assessment variables** from the i-DREAMS platform, which are related to safety outcomes, safety performance goals, performance objectives and change objectives

- **Define the crucial indicators,** measurements and criteria for the quantification of the impact of real-time and post-trip safety interventions

Methodology

- Since the i-DREAMS interventions aim to improve driver safety, **four different levels** of driver safety are proposed:
  - Safety Outcomes
  - Safety Promoting Goals
  - Performance Objectives
  - Change Objectives

- The performance indicators and potential measurements that appeared to have the **greatest effect** on the assessment of interventions are presented

Safety Outcomes	Safety Promoting Goals	Performance Objectives	Change Objectives	Potential measurements
Frontal crash -Vehicle to Vehicle - Vehicle to obstacle - Vehicle to VRU **Side crash** -Vehicle to Vehicle - Vehicle to obstacle - Vehicle to VRU **Rear crash** -Vehicle to Vehicle - Vehicle to obstacle - Vehicle to VRU **Roll-over/derailment crash** **Crash with injury for passengers**	Driver fitness Vehicle control Sharing the road with others Speed management Use of safety devices	Fatigue Distraction Sleep deprivation Acceleration Deceleration Steering Tailgating Lane discipline Overtaking Forward collision avoidance Lane departure avoidance Vulnerable Road User collision avoidance Speeding (speed limit exceedance)	Capability Opportunity Motivation Behavior	**Distraction** (Handheld mobile phone use, Hands on wheel) **Inattention** (Handheld mobile phone use, Hands on wheel) **Fatigue/ Sleepiness** (KSS score, Long driving hours, Time driving) **Poor visibility/ Weather** (wipers on) **Acceleration/ Deceleration** (number of harsh accelerations/brakings and aggressiveness level) **Speeding** (speeding percentage and average speed over speed limit) **Risky hours** (driving during 00:00-05:00) **Overtaking** **Lane discipline** **Forward collision avoidance**

Criteria

- The evaluation and the adoption of safety interventions can only be successful if **the technology is effective** in reducing the target risk and when it is also used efficiently by the driver

- In particular, the success of the i-DREAMS platform depends on whether drivers find the technology **beneficial for their driving and safety**

- In order to make the evaluations **reach their full potential**, their quality should be as high as possible

- **Two quality requirements** are important in this respect:
  - user acceptance
  - reliability

User Acceptance

- Since user acceptance is related to the intention to use a system, it is based on individual attitudes, expectations and experience, obtained during actual use, as well as their subjective evaluation of expected benefits

- The change (or absence of change) in driver behavior in response to the interventions is an indication of acceptance

- If drivers do not accept the interventions, the technology will not increase their safety

- By observing driver's behavior, conclusions about acceptance can be derived. For instance:
  - if a driver presses or does not press the brake when receiving a warning about braking
  - if the brake response time when receiving a warning is too large

Reliability

- Reliability is typically used so that drivers can compare their individual skills and assess their strengths and weaknesses

- In its most basic form (i.e. how many times did the technology objectively pause to work or encounter problems), reliability can be also taken into account in the i-DREAMS platform

- A reliability assessment looking into whether the technology served its purpose, added value and allowed the user to depend on it in all situations is useful to gather

- For instance, real-time warnings may produce many false positives; thus, this will affect driving behavior

Before-after Analysis

- Before-after analysis can be used for the evaluation of interventions

- "Before" refers to a measurement being made before an intervention is introduced to a group, while "after" refers to a measurement being made after its introduction

- It is the most useful method in demonstrating the immediate impacts of short-term programs which offers a great evidence about intervention effectiveness

- It is suitable for both quantitative (i.e. safety outcomes and safety promoting goals) and observed qualitative indicators (i.e. performance objectives, change objectives)

Discussion

- Taking into account the on-road and simulator studies, the design of a customized feedback strategy will assist in performing the appropriate evaluation of interventions needed for the improvement of driver behavior

- A comparison between countries and different transport modes can be made, which will subsequently enhance the intervention performance evaluation and the quality of the assessment results

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