# Interactions between road environment and driver state for the identification of safety critical conditions

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## Introduction

Road crashes consist a major but neglected global public health issue, constituting **the leading cause of death** between ages 5 and 29.

Indicators of **driver state**, such as speeding, aggressiveness, distraction through mobile phone use, fatigue and drowsiness remain a serious threat to road safety. **Environmental** and traffic complexity indicators (e.g. weather, time, road layout) have received so far notably less attention.

## Objectives

The **aims** of this PhD Thesis are summarized below:

- Identification of the most **critical indicators of risk** from both the task complexity and the coping capacity (vehicle and operator state) side
- Examination of the **effect of task complexity and coping capacity** on risk across the phases of i-DREAMS road-trial
- Development of an **integrated model** for understanding the effect of driver-vehicle-environment interaction with risk
- **Comparison of the performance** of such model on different countries and transport modes

## Data Collection

The **cornerstone** of this research is the assessment of task complexity and coping capacity. The former relates to the current status of the real world context in which a vehicle is being operated, while the latter is dependent upon the status of both operator and vehicle. Figure1 illustrates the conceptual framework for risk prediction in function of coping capacity and task complexity.

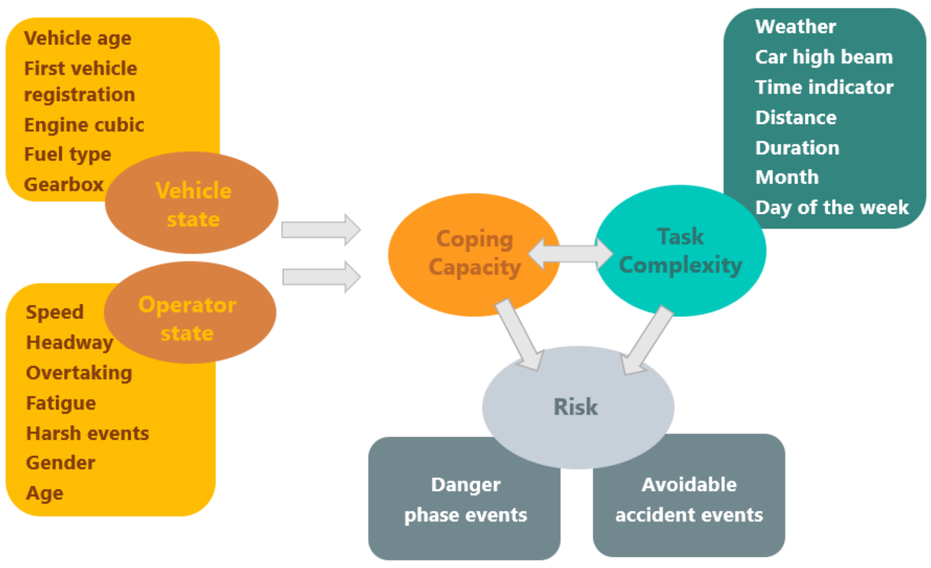
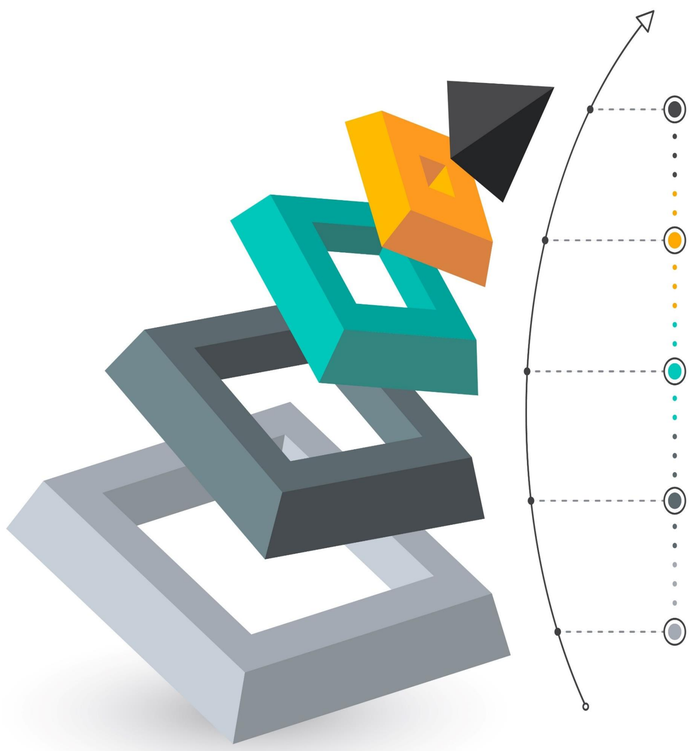



**Figure 1:** Conceptual framework for risk prediction


**Figure 2:** Technology to measure driver, vehicle and environment state

## Methodology



A **naturalistic driving experiment and a simulator** experiment was carried out involving 250 drivers and a large database consisting of 50,000 trips was collected and analyzed.

**Questionnaire data** were also collected both before and after the field trials.

Data collected from **3 different transport modes** (car, bus and truck) **across 5 different countries** (Belgium, Germany, Portugal, Greece and the UK).

Explanatory analyses such as **Generalized Linear Models (GLMs)** were performed.

**Structural Equation Models (SEMs)** were also developed in order to identify the relationship between observed (i.e. number of speeding events) and latent or unobserved variables (i.e. crash risk).

## Results

✓ **Higher task complexity was associated with an increased crash risk**. Drivers could probably become overwhelmed by the demands of complex tasks, leading to reduced attention to the road and other traffic participants.

**Table 1:** Parameter estimates and multicollinearity diagnostics of GLM

| Variables | Estimate | SE | z-value | Pr(\|z\|) | VIF |
|---|---|---|---|---|---|
| (Intercept) | 1.105 | 0.057 | 19.549 | < .001 | - |
| Duration | 0.003 | $3.414\times10^{-5}$ | 73.366 | < .001 | 1.262 |
| Distance | $5.735\times10^{-4}$ | $3.723\times10^{-5}$ | 15.404 | < .001 | 1.029 |
| Harsh acceleration | $1.282\times10^{-4}$ | $1.974\times10^{-6}$ | 64.951 | < .001 | 1.222 |
| Fuel type - Petrol | 0.219 | 0.010 | 21.446 | < .001 | 1.328 |
| Vehicle age | $3.162\times10^{-5}$ | $3.340\times10^{-6}$ | 9.469 | < .001 | 1.277 |
| Gender - Female | -0.275 | 0.021 | -13.025 | < .001 | 1.256 |
| Drowsiness | $1.009\times10^{-5}$ | $2.656\times10^{-6}$ | 3.800 | < .001 | 1.113 |
| Time indicator | $8.547\times10^{-5}$ | $1.925\times10^{-6}$ | 44.405 | < .001 | 1.080 |
| High beam - On | 0.817 | 0.059 | 13.963 | < .001 | 1.073 |

✓ Conversely, drivers with **limited coping capacity** may struggle to effectively manage complex tasks, leading to higher crash risk. Reduced coping capacity can manifest as slower reaction times, impaired judgment, and difficulties in prioritizing information.

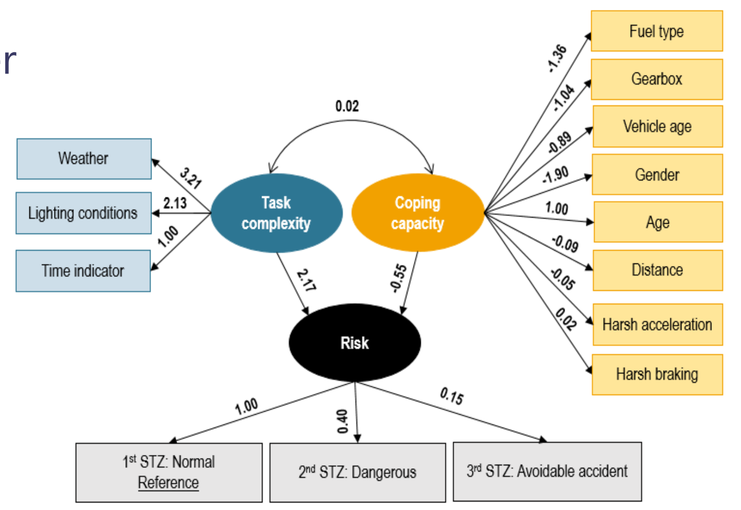



**Figure 3:** Results of SEM on risk

✓ **Higher task complexity was associated with higher coping capacity** implying that drivers, when faced with difficult conditions, tend to regulate well their capacity to apprehend potential difficulties, while driving.

## Conclusions

- ❑ The **integrated treatment** of task complexity, coping capacity and risk can improve behavior and safety of all travelers and all transport modes through the unobtrusive and seamless monitoring of behavior.
- ❑ Authorities can use data systems at population level to **plan mobility and safety interventions**, set up road user incentives, optimize enforcement and enhance community building on safe traveling.

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