D6.2 Analysis of coping capacity factors: vehicle and operator state

Interview with Eva Michelaraki

The aim of this report is comparable to the aim of D6.1. There where the latter look into the impact of task complexity factors on risk, D6.2 investigates the impact of coping capacity factors on risk. Eva Michelaraki from the National Technical University of Athens helped us to understand the essence of D6.2.

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Hello Eva, nice to see you again. In D6.2 you tried to find out what the impact is of coping capacity (vehicle and operator state) on risk. Can you explain what coping capacity is?

EVA: *"Coping capacity depends on two underlying aspects, vehicle state and operator state. Vehicle state is defined by three aspects: technical specifications (such as average speed, braking power, accelerations performance…), actuators and admitted actions (measured on the basis of accelerator, brakes, steering wheel…) and current status (measured on the basis of fuel efficiency, maintenance schedule, real-time information from on board systems or smartphones…). The latent variables associated to operator state entail six aspects: mental state (e.g. alertness, attention, emotions…), behaviour (e.g. speeding, harsh acceleration, seat belt use…), competencies (e.g. risk assessment, attention regulation…), personality (e.g. adventure seeking…), sociodemographics (e.g. gender, age, nationality…) and health status (e.g. cardiovascular indicators)."*

End which variables did you end op using?

EVA: *"There are many variables you can take into account, but what we ended up using, is summarized in the table below."*

Table 1: Variables for coping capacity (vehicle and operator state) and risk

Coping capacity *(vehicle state)*	**Coping capacity** *(operator state)*		**Risk**
Vehicle age	Distance	Inter Beat Interval (IBI)	Headway map levels
First vehicle registration	Duration	Headway	Speeding map levels
Fuel type	Average speed	Overtaking	Overtaking map levels
Engine Cubic Centimetres (CC)	Harsh acceleration/braking	Fatigue	Fatigue map levels
Engine Horsepower (HP)	Forward collision warning (FCW)	Gender	Harsh acceleration levels
Gearbox	Pedestrian collision warning (PCW)	Age	Harsh braking levels
Vehicle brand	Lane departure warning (LDW)	Educational level	Vehicle control events levels

And am I correct when I say that you used the same methods to analyse the effect to coping capacity on risk as for task complexity?

EVA: *"Indeed, we again used Generalized Linear Models (GLM) to do multivariate regression analysis and Structural Equation Models (SEM) to do latent variable analysis. Remember, GLM is a method to model multiple responses or dependent variables, with a single set of predictor variables. For example, if you want to model both speeding and fatigue scores as a function of gender, multivariate regression is the way to do that. On the other hand, we used SEM techniques to perform the analyses. These techniques help us to identify the relationships between observed and latent variables or variables that you cannot measure directly such as happiness, quality of life and in our case, risk."*

And what were the results for coping capacity?

EVA: *"Like in D6.1, we used GLM's, for the German car trial, to look into the relationship of some key performance indicators such as speeding, headway, overtaking and fatigue and several explanatory variables of coping capacity such as fuel type and vehicle age for 'vehicle state' and distance travelled, duration, harsh acceleration, drowsiness, gender and age for 'operator state'.*

For all the key performance indicators we saw that all the explanatory variables were statistically significant and that there were several correlation effects (see Table 2).

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Table 2: Correlation effects between key performance indicators and explanatory variables of coping complexity

Key Performance Indicators

Explanatory variables coping complexity		**Speeding**	**Headway**	**Overtaking**	**Fatigue**
Vehicle state	**Fuel type**	+	-	-	-
	Vehicle age	+	-	-	+
Operator state	**Distance**	+	-	-	+
	Duration	+	+	+	+
	Acceleration	+	+	+	-
	Drowsiness	+	+	+	/
	Gender	-	/	/	-
	Age	-	/	/	/

Vehicle state variables (fuel type and vehicle age) were positively correlated with speeding. In other words, the percentage of speeding during a trip is higher in case of older petrol cars. We also found that when harsh driving behaviour is observed, higher speeds are likely to be present as well. Also, operator state variables 'distance', 'duration', 'acceleration' and 'drowsiness' are positively correlated with speeding. So, when the values of the aforementioned independent variables increase, speeding increases as well. On the other hand, 'gender' and 'age' are negatively correlated, implying that female drivers as well as elderly drivers are less likely to speed.

Headway is negatively correlated with both the vehicle state variables, which means that drivers of older vehicle fleets tend to keep safer distances from the vehicle in front. The operator state variables 'duration', 'acceleration' and 'drowsiness' have a positive relationship with headway. So, if the values of the aforementioned variables increase, headway increases too. Interestingly, 'distance travelled' was negatively correlated with headway. For overtaking a similar pattern was identified as the GLM for headway.

In the case of fatigue, vehicle state variable 'vehicle age' was positively correlated, whereas 'fuel type' had a negative impact on fatigue. Operator state variables such as 'distance' and 'duration' had a positive relationship with fatigue, indicating that the longer the distance and duration is, the higher the probability of a driver being fatigue becomes. 'Harsh acceleration' had a negative relationship with fatigue, as well as 'gender'. The latter implying that female drivers were less fatigued compared to male drivers."

I noticed that, similar to D6.1, the GLM techniques were only used for the German car trials and not for the other trials. Why is that? Was that for the same reason?

EVA: *"Yes it was. The remaining analyses will follow."*

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And then, again similar to D6.1, SEM's were applied to all car trials (in Belgium, UK, Germany and Greece) and on the truck trials in Belgium. Were there any specifics on that front that you can share with us?

EVA: *"In Table 3 we summarized our finding on the effects of coping capacity on risk per risk indicator, per STZ phase and per country/transport mode. This showed us some mixed results. For instance, in the Belgian car trial a counter-intuitive positive correlation of coping capacity with risk was found, whereas in the UK and German car trials and the Belgian truck trial the expected result of a negative correlation of coping capacity with risk was validated. This inconclusivity of results was probably due to the lack of objective coping capacity indicators utilized in the experimental study and their availability in the back-end database at the end of the experiments. Nevertheless, there was a consistency between the effect of coping capacity throughout the phases, with an increasing impact of coping capacity when looking the evolution from Phase 1 to Phase 4 of the experiment in most of the models.*

However, due to the volume and diversity of the data included in each of the analyses, it was not possible to fit an overall 'coping capacity against risk' model for a specific mode, despite extensive efforts from partners to clean and homogenize the data. Nevertheless, ongoing trials may provide more data that could help address these limitations and produce more conclusive results.

Table 3: Effect of coping capacity on risk per risk indicator, STZ phase and country/transport mode

		Coping Capacity			
Country (transport mode)	**Risk (indicator)**	**Phase 1**	**Phase 2**	**Phase 3**	**Phase 4**
BE (cars)	speeding	+	+	+	+
	headway	+	+	-	+
BE (trucks)	vehicle control events	-	+	+	+
UK (cars)	headway	-	-	-	-
DE (cars)	harsh braking	-	-	-	-
GR (cars)	speeding	-	-	-	-
	headway	-	-	-	-

For 'operator state' it was demonstrated that age, confidence of a driver in his/her skills. as well as a sporty driving style were the strongest indicators influencing driving behavior, while vehicle age, fuel type and gearbox were the corresponding ones for 'vehicle state'."

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OK, then maybe one last question. When I look at table 2, I only see a selection of explanatory variables of coping capacity and in table 3, a selection of risk indicators, compared to the summary in table 1. Why is that?

EVA: *"It should be noted that several tests were conducted for different combinations of variables. For each configuration, various alternatives were tested through the respective log-likelihood test comparisons and an attempt was made to use the same independent variables in the model applied. The optimal combination of variables was the one that had a sufficient number of statistically significant independent variables at a 95% confidence level. However, it was not possible to include all the aforementioned variables of coping capacity (vehicle and operator state), as described in Table 1, in the models applied. Thus, the final models were selected as the ones with the independent variable configuration with the highest statistically significance and the lowest AIC[1] and BIC[2] values for each developed model."*

Thanks Eva, for helping us to shine a light on D6.2.

Edith Donders

DisCom Manager

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[1]The AIC (Akaike's Information Criteria) reflects the likelihood of a model to predict/estimate the future values

[2]The BIC (Bayesian Information Criteria) is another criterion for model selection that measures the trade-off between model fit and complexity of the model. A lower AIC or BIC value indicates a better fit.

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i-DREAMER in the spotlight

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