D6.1 Analysis of task complexity factors

Interview with Evita Papazikou

The aim of this report is to examine the impact of task complexity factors, such as road layout, traffic, time of day, weather, etc., on risk. The objectives are to determine which task complexity factors have the most significant impact on risk, create statistical models to understand how task complexity affects the Safety Tolerance Zone (STZ) and compare the effects of task complexity on risk for different countries and transport modes during the four phases of the i-DREAMS road-trials. Evita Papazikou from Loughborough University spoke with us about this report in this interview.

Hello Evita, thank you for having me and a pleasure to meet you! So, you tried to determine which task complexity factors have the most impact on risk and how it affects the STZ. Can you start with clearly explaining what task complexity is?

EVITA: *"OK, I will try! Task complexity relates to the current status of the real-world context in which a vehicle is moving around. This context consists of various individual elements which, together, determine the complexity of the task imposed on the driver. To monitor task complexity, it is important to register contextual elements such as road layout (i.e., highway, rural, urban), time and location, traffic volumes (i.e., high, medium, low) and weather. But that was a first challenge we had to deal with. Despite a unified data collection design, technical issues such as sensor failures and driver availability arose during the data collection process in different countries. As a result, different datasets were obtained, and different variables were selected to examine the impact of task complexity on risk."*

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What implications did that have?

EVITA: *"Due to those issues, it was not possible to make a direct comparison between countries or transport modes. In some cases, not only the variables that represent task complexity vary, but also the variables that represent risk differ. Thus, the results could only be interpreted on a country and transport mode basis. It is noteworthy that age and gender were not significant factors in any of the models across different countries and transport modes."*

In order for you to analyse the impact of task complexity on risk, you used different models. Can you explain those models?

EVITA: *"Let me first explain the purpose of those models. We collected massive amounts of data and we of course want to analyse them via models to identify the relationship between risk and factors contributing to risk. This is important because, knowing what that relationship is, can help us to better understand the underlying reasons of driving behaviour and ultimately help us improve interventions (both in-vehicle and post-trip). Furthermore, it can also help us to evaluate the effectiveness of interventions. Another important reason to use models, and thus to analyse data, is to make predictions. Based on this, real-time interventions in the vehicle can be adapted in the future, for example."*

And what method did you use to analyse the data?

EVITA: *"Our processed data analysis methods include two families of techniques. On the one hand we used Generalized Linear Models (GLM) to do multivariate regression analysis. This 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 Structural Equation Models (SEM) to do latent variable analysis. 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."*

Can you elaborate a bit on the outcome of both these modelling techniques?

EVITA: *"Yes, but like I said before, due to technical issues and driver availability in the different test sites, we ended up with very different datasets. In each site, we were able to measure specific task complexity variables and risk variables, but they differed very much between test sites, therefore we were not able to make comparisons between countries and/or modes, but we needed to interpret the results on a country and transport mode basis."*

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Understood! Please feel free to share some of those results!

EVITA: *"For the German car trial, we used GLM's to look into the relationship of some key performance indicators such as speeding, headway, overtaking and fatigue and several explanatory variables of task complexity such as distance travelled, duration, harsh acceleration, time and the use of the high beam (serves as an indicator for limited visibility).*

For all the key performance indicators we saw that all the explanatory variables were statistically significant and we did see some correlation effects (see Table 1).

Table 1: Correlation effects between key performance indicators and explanatory variables of task complexity

Key Performance Indicators	Explanatory variables of task complexity: Distance	Duration	Acceleration	Time	High Beam
Speeding	+	+	+	+	+
Headway	-	+	+	-	+
Overtaking	-	+	+	-	+
Fatigue	+	+	-	+	+

For speeding we saw a positive correlation all the way. This means that speeding is increasing when values increase for 'distance', 'duration' and 'acceleration'. Furthermore, speeding increases in later hours of the day (= 'time') and when the 'high beam' is used.

There was a negative correlation between headway and 'time'. This means that drivers tend to keep safer distances from the vehicle in front of them during the night. Interestingly, the use of the 'high beam' was positively correlated with headway, which means that the number of headway events increases when the 'high beam' is not used. Moreover, 'harsh accelerations' and 'duration' appeared to have a positive correlation with headway as well, whereas 'distance travelled' was negatively correlated. This means that if more distance is covered, the chance of headway events occurring decreases.

We saw the exact same pattern for overtaking as for headway: a positive correlation with 'duration', 'acceleration' and 'high beam' and a negative correlation with 'distance' and 'time'. The latter implying that drivers were not willing to perform an illegal overtaking during night, possibly due to low traffic volumes.

For fatigue all the explanatory variables were positively correlated, except for 'acceleration', indicating that the longer the distance and duration is, the later the time of day and the more the high beam is used, the higher the probability becomes of a driver being fatigued. A driver seems to accelerate less when he is more fatigued."

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Why did you use the GLM techniques only for the German car trials and not for the other trials?

EVITA: *"GLM techniques are planned to be implemented to the other trials data, as well, but due to time restrictions these results are not available yet. They these results will be available in the final version of the deliverable though."*

SEM's were unleashed on all car trials (in Belgium, UK, Germany and Greece) and on the truck trials in Belgium. Can you share your findings on that?

EVITA: *"In terms of the SEM analysis, four models were developed per risk indicator (e.g., speeding and headway), one for every STZ phase in order to detect any difference in the way task complexity affects risk. An explicit comparison between countries or transport modes was finally not feasible due to the aforementioned issues. The results of these SEM analyses are described in great detail in deliverable D6.1, but that is all very technical I'm afraid. In Table 2 we summarized our finding on the effects of task complexity on risk per risk indicator, per STZ phase and per country/transport mode.*

Measuring task complexity and its correlation with risk was very challenging due to the limited number of variables that could be collected and utilized, leading to the use of proxies. For instance, the weather conditions were approximated by the use (or not) of wipers and the lighting conditions or night-time driving was determined by the use of high beams.

Table 2: Effect of task complexity on risk per risk indicator, STZ phase and country/transport mode

		Task complexity			
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)	speeding	+	+	+	+
GR (cars)	speeding	+	+	+	+
	headway	+	+	+	+

When we look at the car trials in the UK, Germany and Greece we found a positive correlation between task complexity and risk in each phase of the STZ for the risk indicators mentioned in Table 2. We also found that positive correlation in phases 2 and 4 of the Belgian car trials for the risk indicator 'speeding'; and in phases 1, 2 and 4 of the Belgian truck trials for 'vehicle control events'. In all other cases, task complexity affected risk in a different way, since a negative correlation was found."

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Analysis of risk factors

OK Evita, from what I understood, it was not easy to measure risk indicators and task complexity variables. Although the goal was to measure it in the same way in each trial, that turned out not to be possible due to some challenges. Nevertheless, you were able to illustrate that there is an effect of task complexity on risk. What that effect is, depends on the task complexity variables that are taken into account, the STZ phase, the risk indicator that is focused on and the specific transport mode. Is that correct?

EVITA: *"I could not have said it any better!"*

Thanks Evita, for helping me understand the complex things you did in D6.1.

Kind regards,

Edith

i-DREAMER in the spotlight

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Tasks in i-DREAMS: *Statistical modelling and data analysis of risk factors*

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