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SMART CITIES &
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LATENT MODEL ANALYSIS FOR THE INVESTIGATION OF DRIVING BEHAVIOUR BASED ON DRIVING SIMULATOR DATA

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Outline

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Background

- **Human factors** are the basic causes in 65-95% of road accidents (Salmon et al., 2011).
- Human factors involve a large number of specific factors that may be considered as **accident causes**, including (Yannis et al., 2013):
  - **Driver injudicious action** (speeding, traffic violations etc.)
  - **Driver error or reaction** (loss of control, failure to keep safe distances, sudden braking etc.)
  - **Behaviour or inexperience** (aggressive driving, nervousness, uncertainty etc.)
  - **Driver distraction** (cell phone use, conversation with passenger etc.)
  - **Driver impairment** (alcohol, fatigue etc.)

Driving simulator characteristics

Driving simulators allow for the examination of a range of driving performance measures in a controlled, relatively realistic and safe driving environment

Advantages

- Safe environment
- Greater experimental control
- Large range of test conditions (e.g., night and day, weather conditions, road environments)

Disadvantages

- Data generally include the effect of learning
- Feeling of safety
- Simulator sickness

Objectives

- To investigate whether **Latent model analysis** through a Structural Equation Model can be implemented on driving simulator data
- To investigate and quantify the effect of several risk factors including distraction sources, driver characteristics, road and traffic environment on the **overall driving performance** and not in specific driving performance measures

Driving simulator experiment

- **Driving simulator**
  - Foerst Driving Simulator (1/4 cab)
- **Road environment**
  - Rural: 2.1 km long, single carriageway
  - Urban: 1.7 km long, dual carriageway
- **Traffic scenarios**
  - QL: Low traffic - 300 vehicles/hour
  - QH: High traffic - 600 vehicles/hour
- **Unexpected incidents at each trial**
  - Child crossing the road
  - Sudden appearance of an animal

Experiment design

Distraction conditions

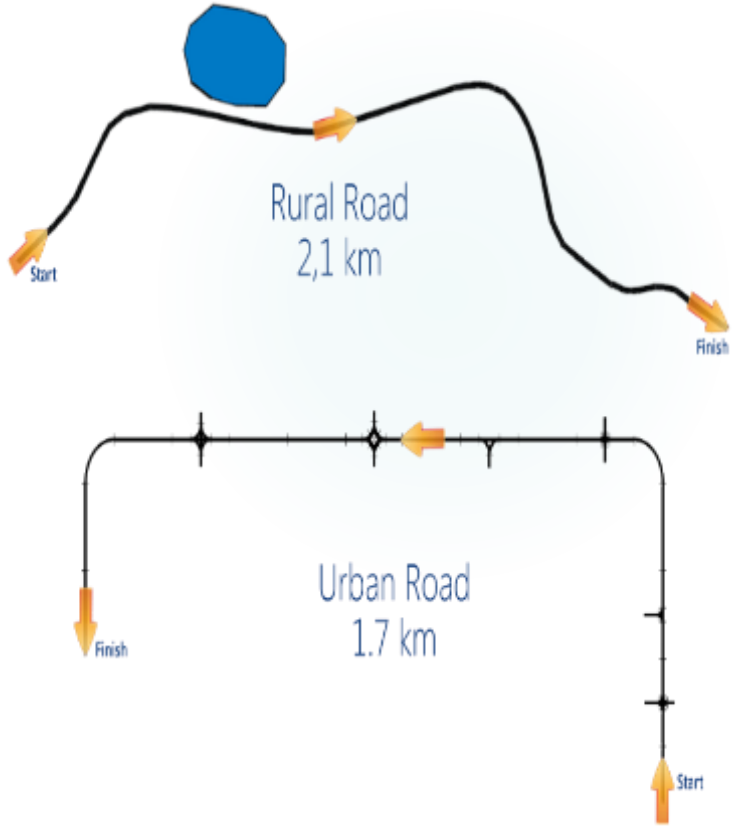
- No distraction
- Cell phone use
- Conversation with the passenger

Randomization

Randomization was implemented in the order of area type, traffic scenarios as well as distraction scenarios

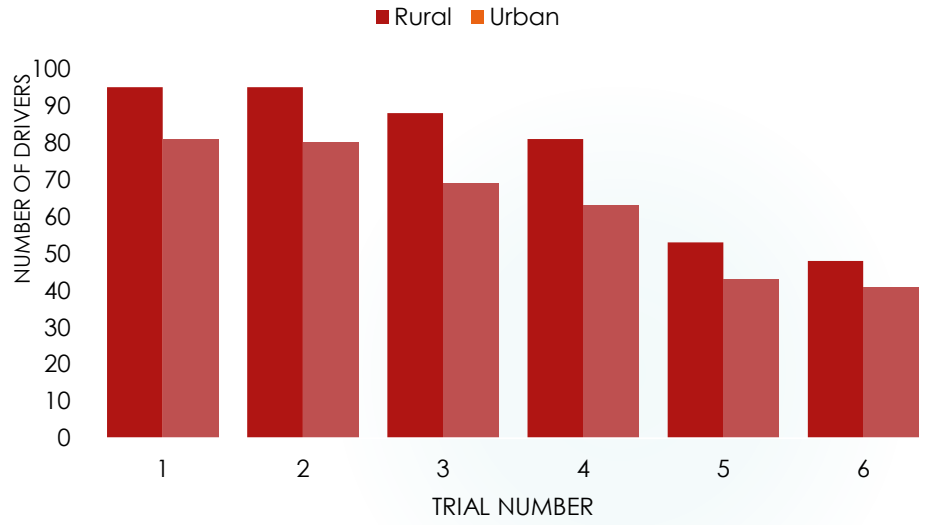
Familiarization

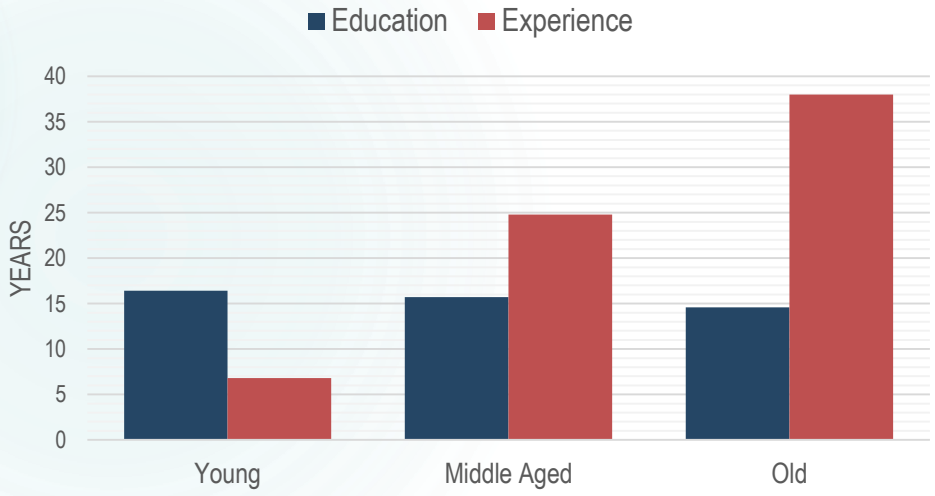
The participant practiced in handling the simulator, keeping the lateral position of the vehicle, keeping stable speed, etc.

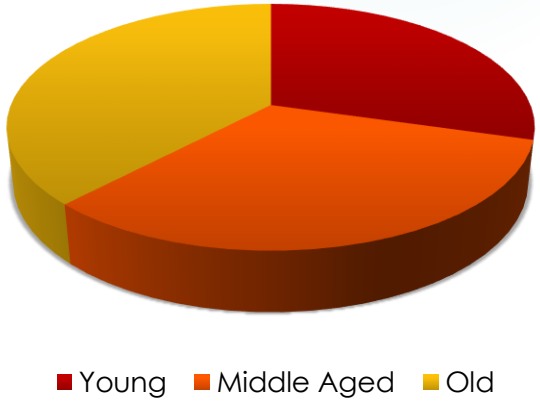


Sample characteristics

- 28 young drivers (18-34)
- 31 middle aged drivers (35-54)
- 36 older drivers (55+)







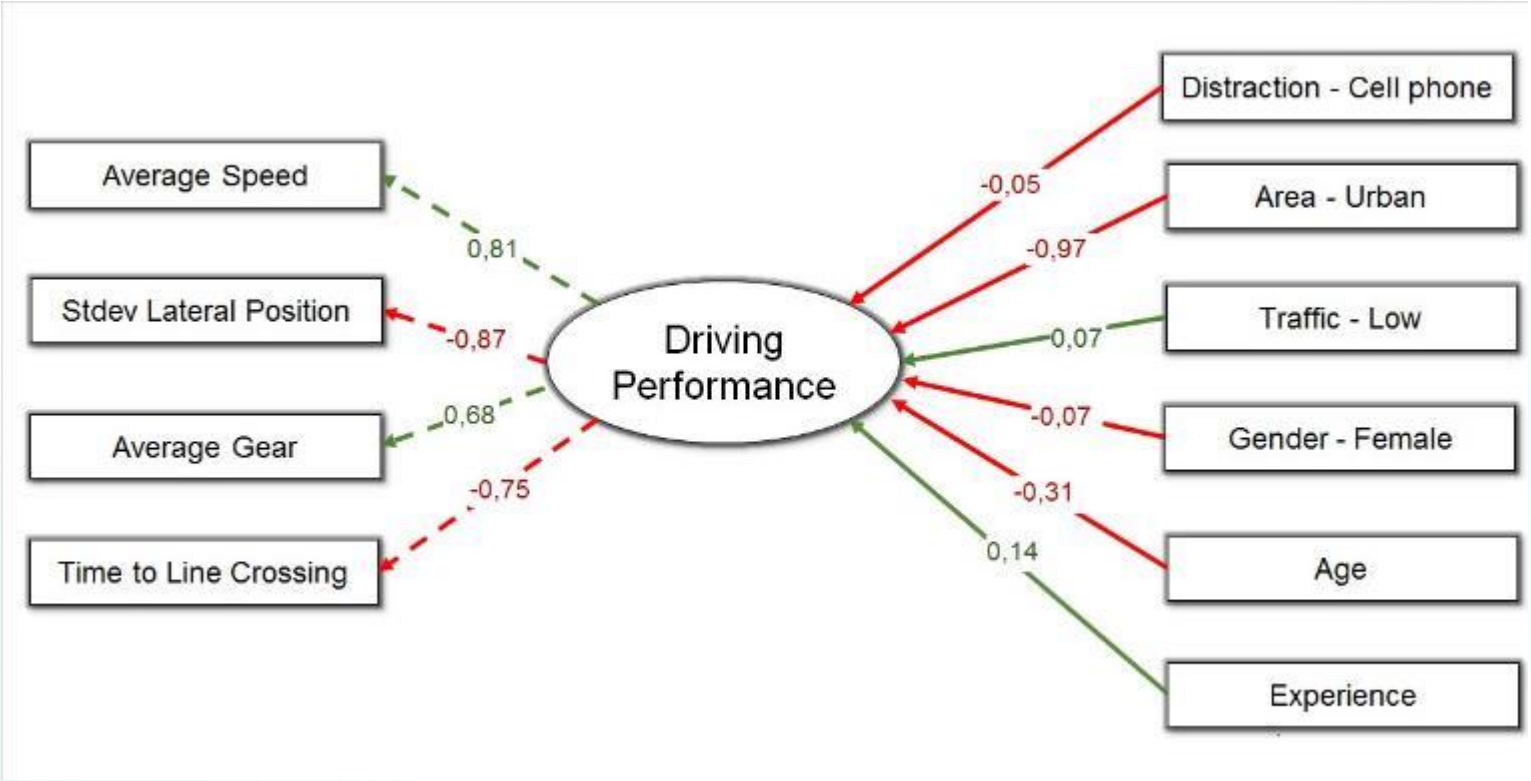
Analysis method

- **Structural Equation Modeling** is a very general, powerful multivariate analysis technique that includes several analysis methods
- SEM involves the evaluation of two models:
- **Measurement Model**
  - The part of the model that relates indicators to latent factors
  - The measurement model is the factor analytic part of SEM
- **Structural model**
  - This is the part of the model that relates variable or factors to one another (prediction)

Structural Equation Model results

	Est.	Std.err	t value.	P(>|z|)
Latent Variable				
Driving Performance				
Average Speed	1.000	-	-	-
Stdev Lateral Position	-0.085	0,004	-23,909	0.000
Average Gear	0.048	0,002	21,887	0.000
Time to Line Crossing	-0.109	0,005	-19,972	0.000
Regressions				
Driving Performance				
Distraction – Cell phone	-1.099	0.342	-3.213	0.001
Area - Urban	-15.596	0.467	-33.410	0.000
Traffic - Low	1.123	0.285	3.943	0.000
Gender - Female	-1.154	0.303	-3.802	0.000
Age	-0.155	0.027	-5.755	0.000
Experience	0.083	0.032	2.630	0.009
Summary statistics				
Minimum Function Test	305.74			
Degrees of freedom	20			
Goodness-of-fit measure				
SRMR	0.061			

Structural Equation Model path diagram



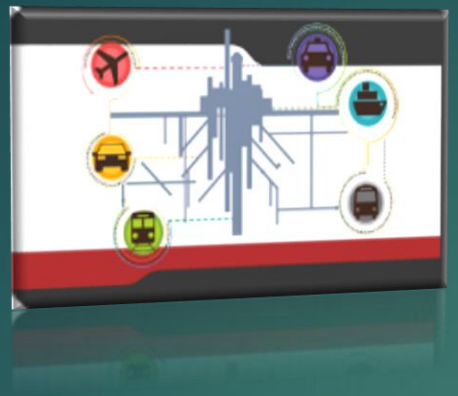
- The effect of **cell phone** on driving performance is definitely negative
- **Conversation with the passenger** does not has a statistically significant effect
- **Risk factors** that affect driving performance include driver characteristics (age, gender, driving experience), area type and traffic conditions

Conclusions

- Results allow an important scientific step forward from piecemeal analyses to a sound **combined analysis** of the interrelationship between several risk factors and driving performance
- The selection of the specific **measures** that define overall performance should be guided by a rule of representativeness between the selected variables
- **Driver-related characteristics** play the most crucial role in overall driving performance
- The **worst driving performance** is achieved by an old, unexperienced female driver, on urban area with high traffic while talking on the cell phone

Further research

- Investigation of the effect of other parameters such as **alcohol**, **fatigue** etc. on driving performance through latent analysis
- Development of **Structural Equation Model** on different experimental methods (Naturalistic experiments, field test etc.)
- Further investigation of the parameters that affect the **compensatory behaviour** of the driver
- Investigation of different types of **distraction** such as a hands-free, bluetooth, typing an sms etc.)



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