HORIZON 2020

TRUSS
Training in Reducing Uncertainty in Structural Safety

The University of Nottingham
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Speaker: Laura Trupia

Route level analysis of road pavement surface condition and truck fleet fuel consumption

Federico Perrotta, Laura Trupia, Tony Parry and Luis C. Neves

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Introduction

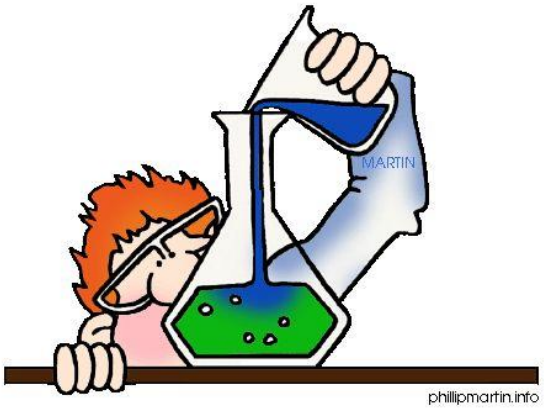
Road roughness can impact fuel economy by up to 5% *(Zaabar & Chatti 2010)*

In England:
£344 billion, value of the road infrastructure
~£4 billion, spent in maintenance (per year)
~36 million tons of fuel consumed (per year)
~25% of the whole energy demand in Europe due to transport
(House of Commons, 2011; Haider et al. 2011)

- significant cost savings;
- reduction of GHG emissions.

Previous studies

- Experimental approach
- Limited number of vehicles;
- Selected road segments;
- Under controlled conditions;
- Do the results represent what really happen at network level under real driving conditions?



Innovation

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… in real conditions …

Impact of the road surface conditions on the vehicle fuel economy

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Truck fleet and road network

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Data

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Fleet managers constantly monitor the performance of trucks to take decisions about training of drivers and maintenance of vehicles (fuel usage, torque, revs, speed, GPS position, etc.)

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Road agencies monitor the condition of their network, annually, to make decisions about maintenance with respect to engineering condition and driver safety (geometry, roughness, texture, skid-resistance, etc.)

Methodology

For this initial study the main objective was to assess the feasibility of the ‘Big Data’ approach.

For this initial study we consider:

- a motorway in England (M18, Doncaster);
- records represent journeys for which the trigger event was the default time or distance (2 mins or 2 miles);
- 3-axle tractor with 3-axle trailer articulated trucks;
- at 85 km/h constant speed (using gear 12);
- With ~12,000 cc Euro 5 and Euro 6 engines.

Results

Vehicles	Avg Fuel Consumption (l/100km)	Standard Deviation (σ)
Euro 5	28.93	9.58
Euro 6	28.66	9.47

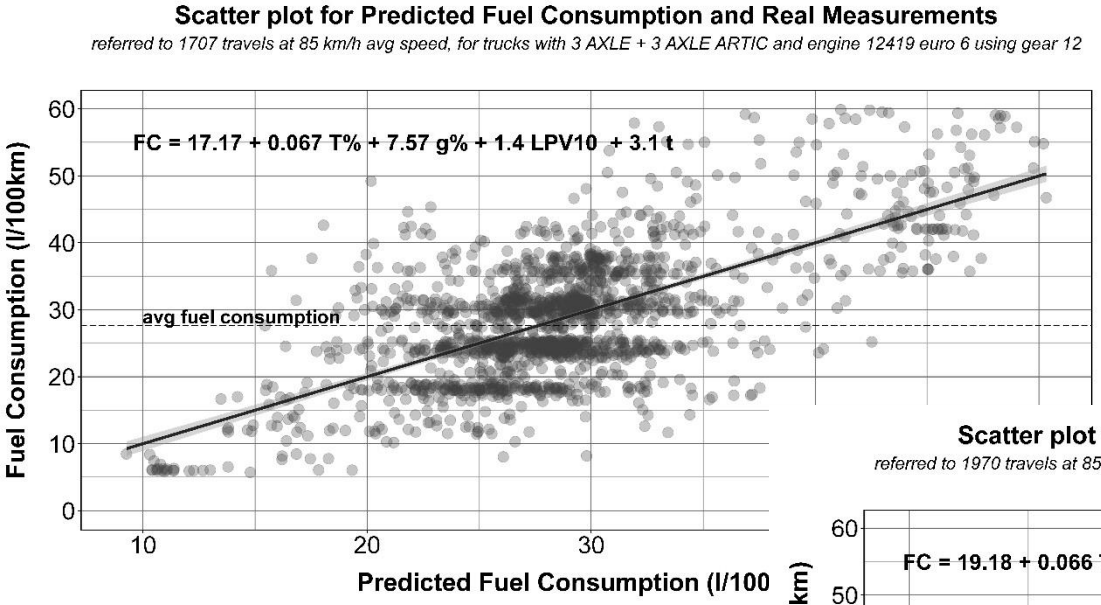
However, a Kolmogorov-Smirnov two-sample test excludes the hypothesis that the two datasets come from the same population.

2 different models

Application of the Akaike Information Criterion (AIC) to the dataset does not exclude the hypothesis that the impact of longitudinal profile variance at 10 m - LPV10 (roughness) and Sensor-Measured Texture Depth - SMTD (macro-texture) on fuel consumption is significant for the considered fleet of trucks.

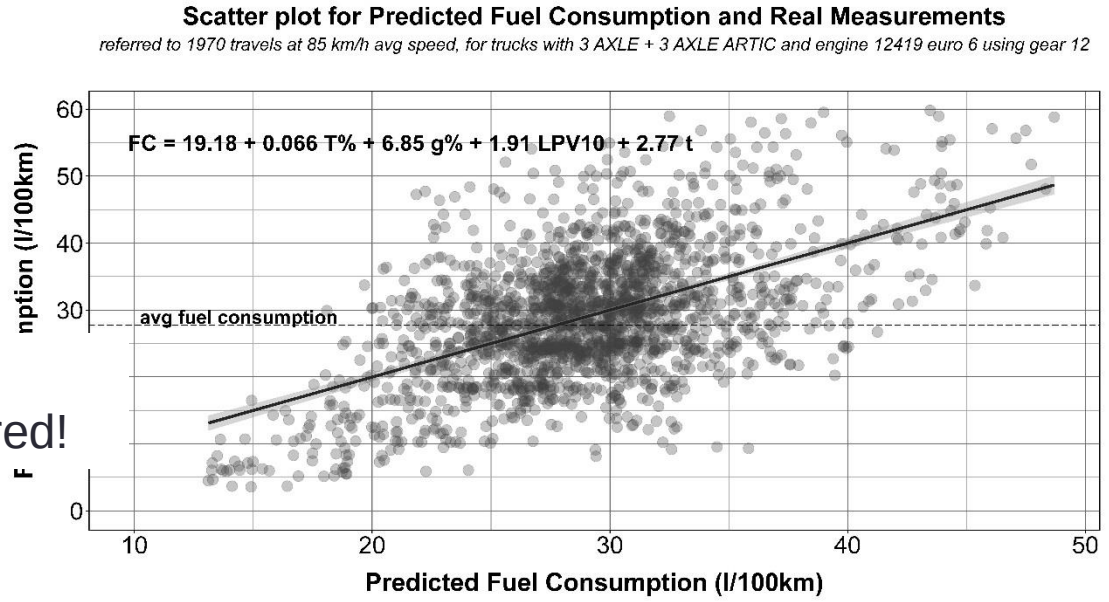
Results

Multiple Linear Regression



What is considered:

Torque (gross vehicle weight ???)
Road gradient
Roughness (LPV10)
Macro-texture (texture)



Correlation is ~55%
More variables need to be considered!

Discussion

- Up to ~42% impact of torque and road gradient;
- Up to 4.5% impact of road roughness;
- Up to 4.1% impact of road macrotexture;
- The remaining fuel consumption is due to different causes not considered in the study.

Similar to previous studies

The model estimates impacts similar to what previous studies obtained, and this gives us more confidence in the used 'Big Data' approach.

Although results of this initial case study seem to be promising, further research is needed.

What is next

Extend the analysis to a wider range of:

- Vehicles
- Speeds
- Roads

Include weather conditions data:

- Air temperature
- Wind speed (and direction)
- Rainfall (and wet roads?)

Assess the significance of the considered variables;

Reduce variance and uncertainties;

Include results in LCA studies of road pavements.

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Federico.Perrotta@nottingham.ac.uk

Thank you all for your attention!

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