

Adapting driver behaviour for lower emissions

Low-emission driving assistant

Dr. Sébastien Faye – Luxembourg Institute of Science and Technology (LIST)

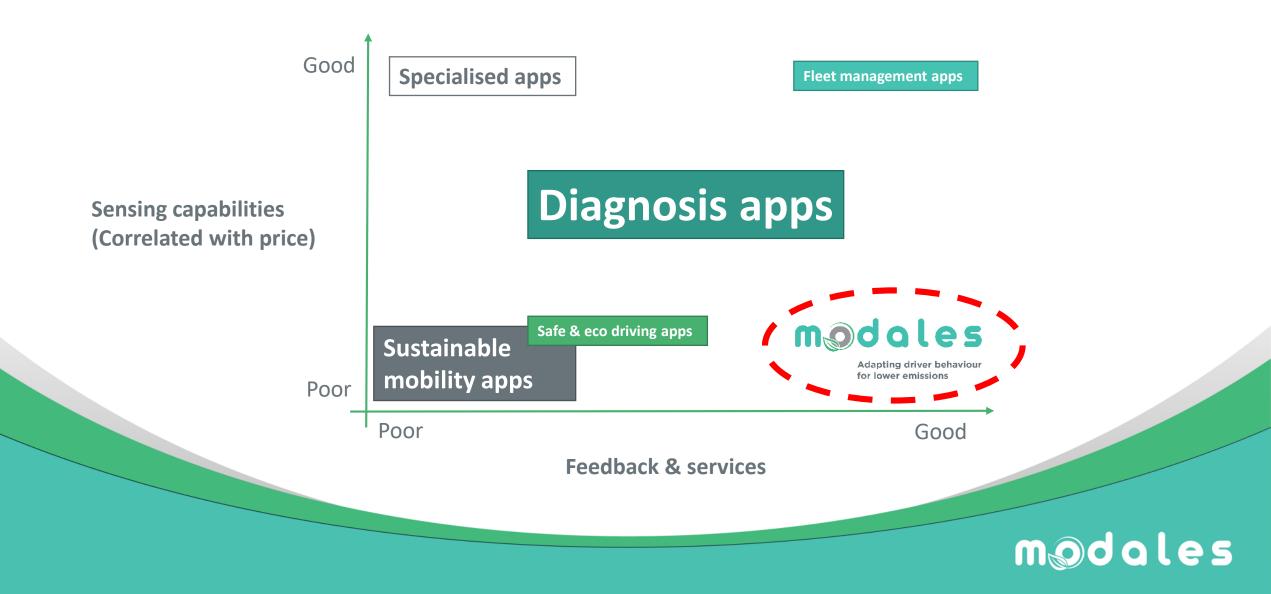
With contributions from: Joan Baixauli – LIST, Mael Cornil – LIST, Camino Ramino – LIST

MODALES Final Conference, Brussels, 12 May 2023

Driving application



What's the need?



Overview of the solution

Mobile analytics to understand, assess and guide user's driving choices:

- Module 1 In-vehicle data collection from:
 - Smartphone sensors
 - OBD dongles

• Module 2 – Data interpretation:

- On-device artificial intelligence techniques
- Privacy-friendly approach



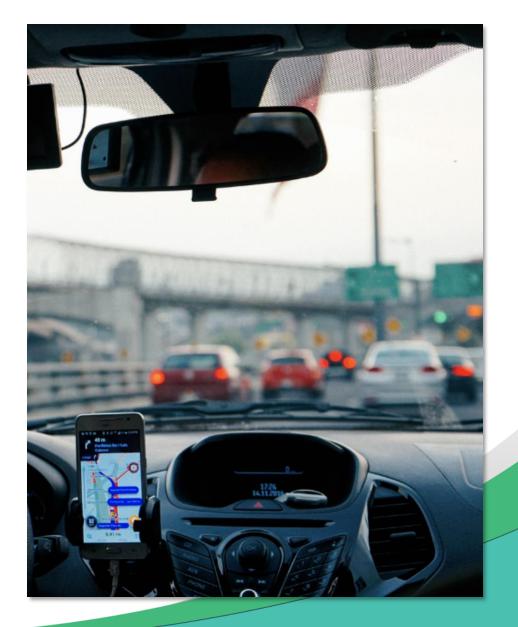


Overview of the solution

• Module 3 – Recommendations:

- Active recommendations:
 - When the user is driving
 - Research prototype → simplified recommendations and HMI, using only the phone sensors
- **Passive** recommendations:
 - After a trip
 - Complete report,

using the phone sensors, OBD data and external web services (e.g., weather, traffic index)



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Research challenges

- Learn useful driving indicators from raw data in real time.
- Design a user interface for the journey without compromising safety.
- Build a recommender system.
- Handle different connectivity scenarios.
- Ensure privacy policies.
- Analyse behaviour changes.





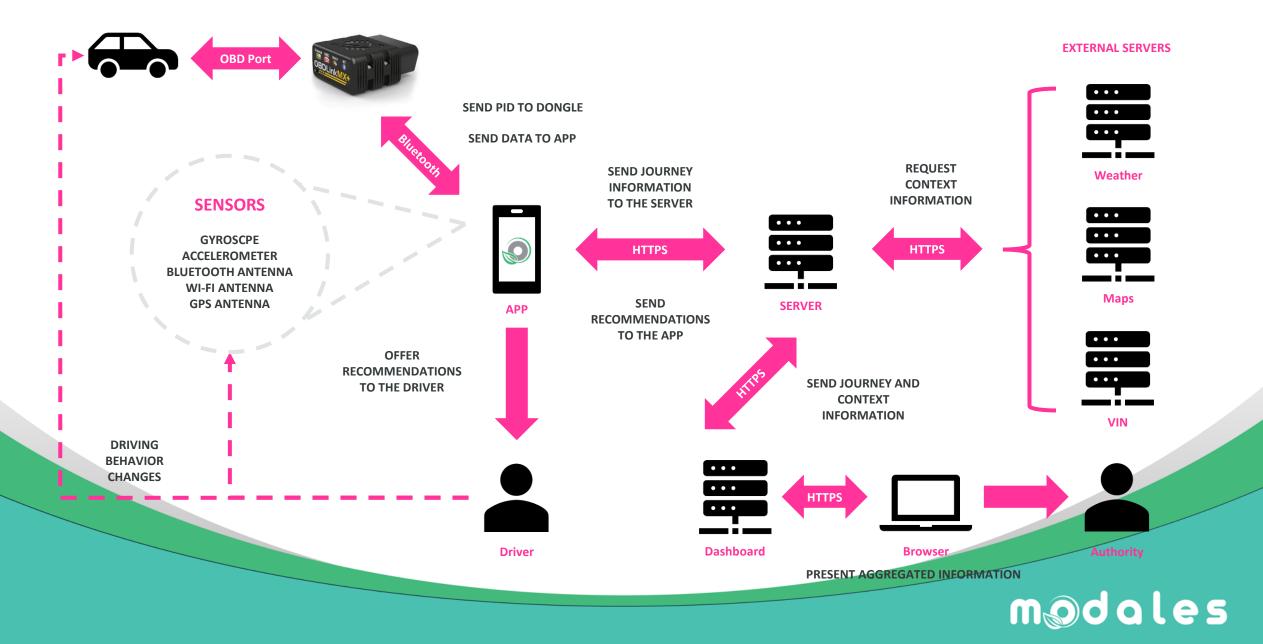
Simple user interface Flutter

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Architecture overview



OBD data

More reliable:

- Absolute barometric pressure
- Absolute throttle position
- Accelerator pedal position
- Air flow rate
- Ambient air temperature
- Catalyst temperature
- Engine coolant temperature
- Engine fuel rate
- Engine speed
- Vehicle speed

Less reliable:

- Intake air temperature
- NOx sensor





Smartphone data

Raw driving data:

- Accelerometer
- Gyroscope
- Wi-Fi and Bluetooth traces
- User activity (in vehicle or not)
- Manual inputs from the user
- GPS (stored temporarily)

Extended data:

• Scores, journeys, ...

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Database - Context information

Weather:

- humidity
- temperature
- total snow
- visibility
- wind speed

Traffic:

- historical average speed
- historical free flow speed
- historical jam factor
- historical traversability
- real-time confidence
- real-time traffic speed

Road:

- average roughness category
- curvature
- distance to intersection
- functional class
- has end of no overtaking sign
- has no overtaking sign
- has pedestrian crossing sign
- has stop sign
- has traffic signal
- has yield sign
- heading
- intersection category
- international roughness index

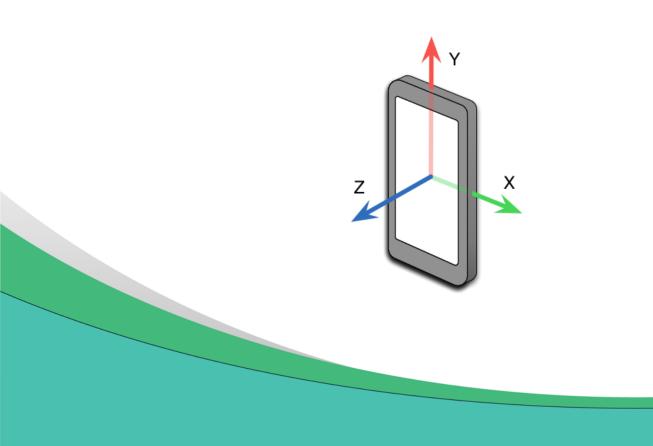


- is bridge
- is intersection
- is long haul
- is ramp
- is roundabout
- is tunnel
- is urban
- lane category
- radius
- road type
- slope
- speed category
- speed limit
- speed limit trucks

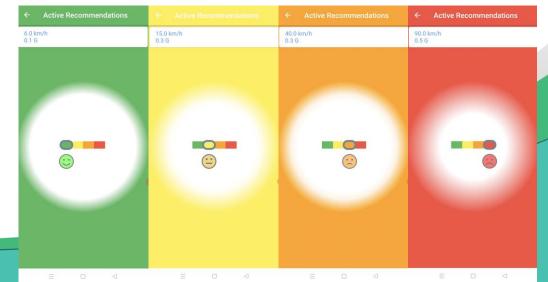


Active recommendation

- **Real-time** display with colour codes, proportional to the acceleration.
- Based on accelerometer data







Passive recommendation

- Delivered to the user after his/her driving session.
- Four **scores** generated.

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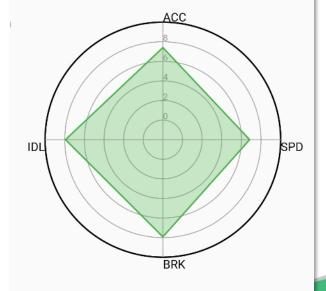
← Passive recommendations

41 Min

Start: 01/12/22 - 18:57 Stop: 01/12/22 - 19:38 Duration: Idle 10 Min / Driving 29 Min

Distance: 42.532 Km

Advice: [Good Eco Driving] You are doing pretty well. Thank you for emission friendly driving!!



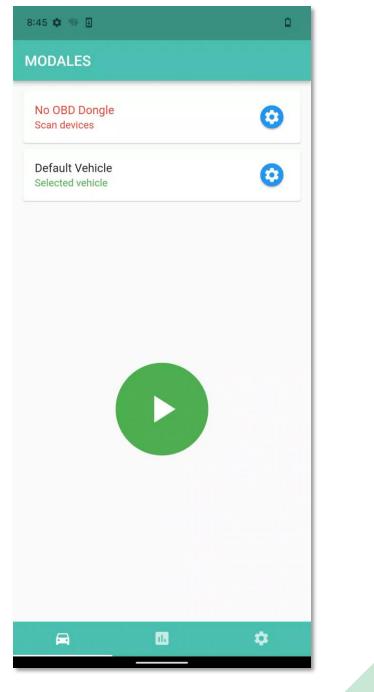
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Demo















Internal reporting platform



T5.3: Internal reporting platform

- Data sharing with partners
- Data filtering and following: evolution of the data collection and the participation for each trial site

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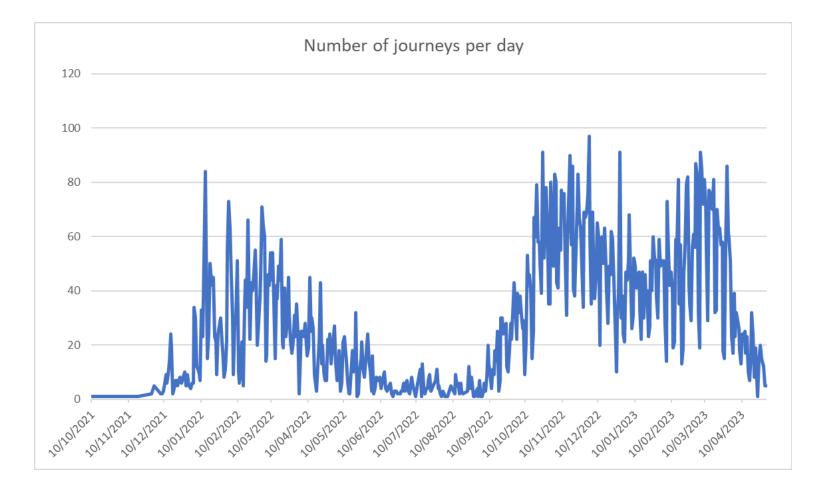


Data collected & lessons learned



Some statistics...

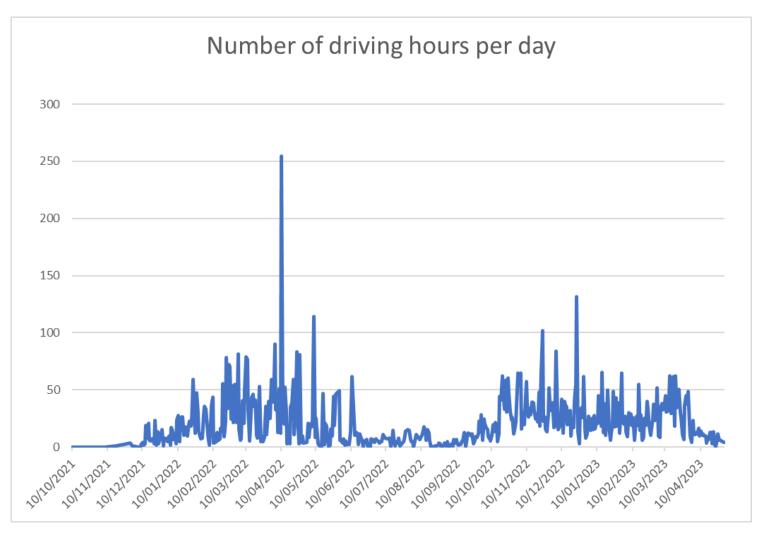






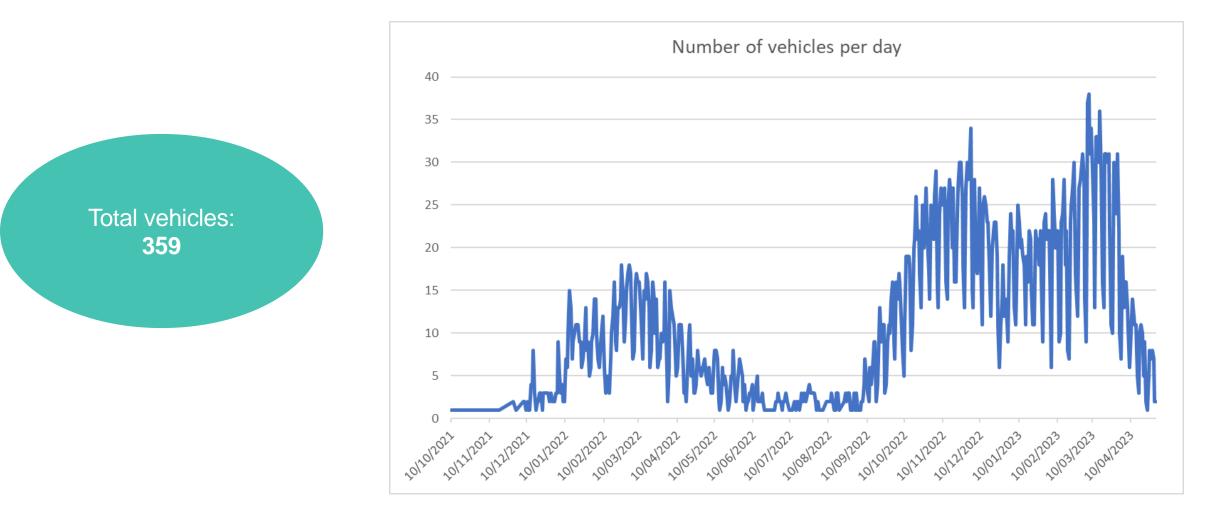
Some statistics...

Peak: **250 hours** recorded in a day



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Some statistics...





Users' feedback

1. Data transfer and connectivity not easy to manage from an end-user perspective.

- Multiple countries, with connectivity constraints, and asynchronous data transfer.
- <u>Solution</u>: more flexibility in the configuration of the mobile app, but difficult to manage.

2. OBD integration.

- Not all PIDs are available
- Difficult for the end-users to manager an additional device.
- <u>Solution</u> (not implemented): rely on car manufacturer data solutions.

3. Start and stop of the mobile app.

- Users are forgetting
- <u>Solution</u>: implementing an automatic start/stop solution.
- 4. Issues with the graphical interface on some phones.
 - Difficult to manage all phones and OS.
- 5. Specific issues with **iOS**.
 - Difficult to manage all phones and OS.





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Thank you

Linked in MODALES project

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Adapting driver behaviour for lower emissions

Scoring Algorithm Methodology

Orhan Alankuş Istanbul Okan University

MODALES Final Conference, Brussels, 12 May 2023

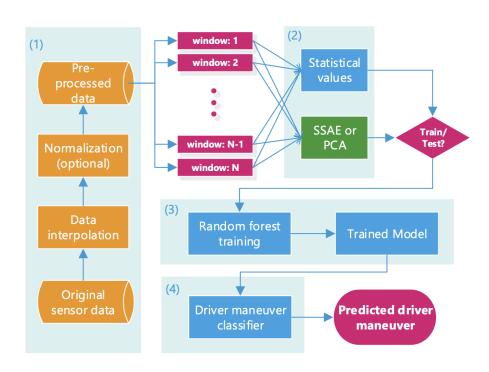
Scoring System

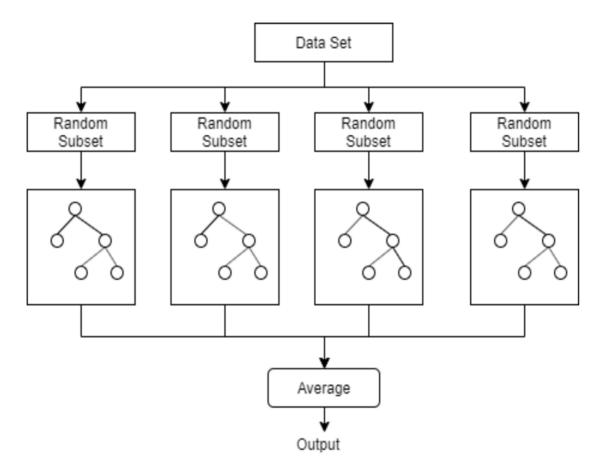
- An integrated system for «Driver Support Application»
- It is necessary to have a system that gives a methodology to determine the correlation between driving style and the emissions
- The emission correlations must include CO₂, NO_x and PMs including that of from tires and brakes
- Driving style parameters are selected as v.a and RPA (Relative Positive Acceleration) in line with EU regulation 2018/1832
- The system must be flexible as to be applicable for different type of vehicles and engines



Event Detection

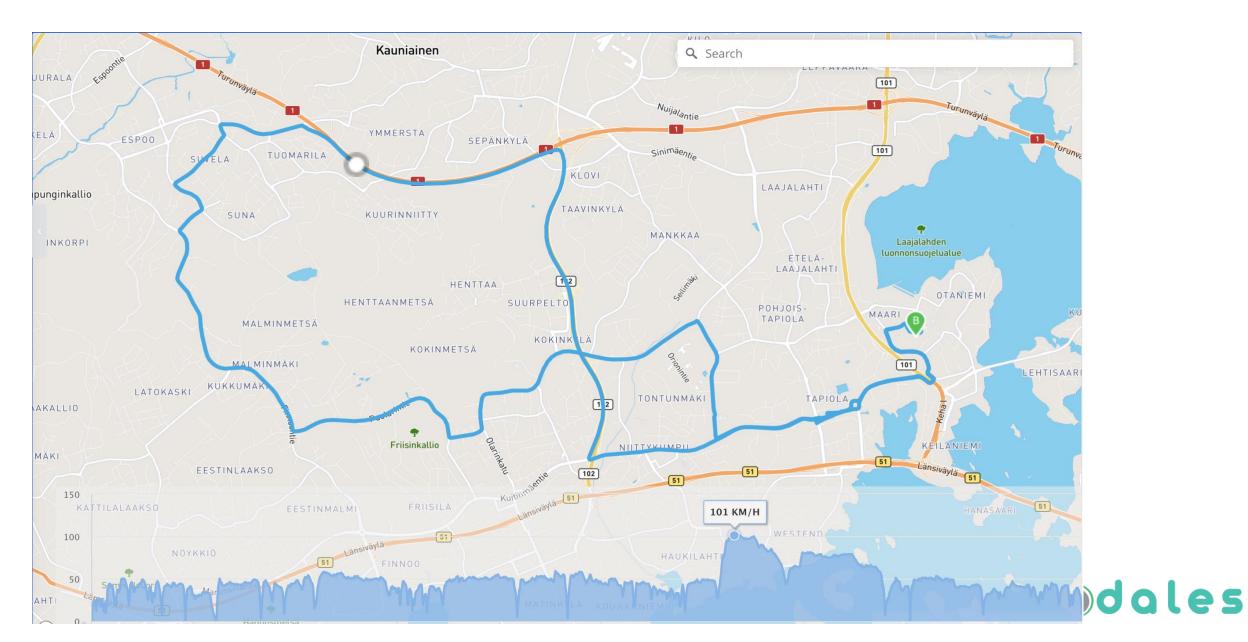






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21PE060_DriverG-Run#1

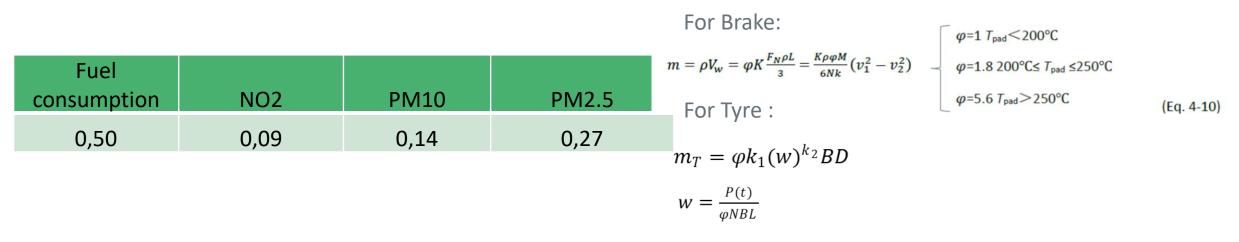


21PE059_DriverG-Run#1



Multi-Objective Optimization and Aggregate Emission Value

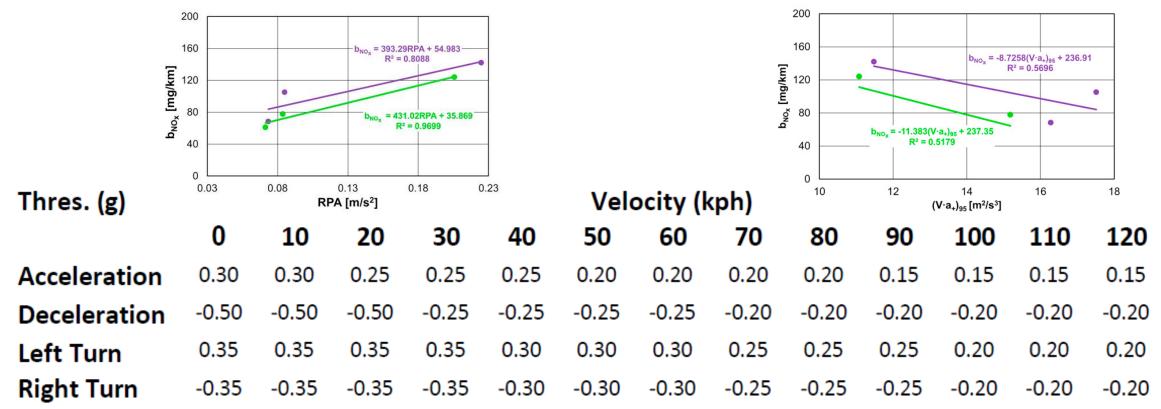
- Using Air Quality Index Standards and Cost of emissions on human health weight parameters for multi-objective optimization has been determined
- Brake and Tyre emissions are calculated and added to the PMs and training tables have been created using VTT data



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Scoring Threshold Values Through Lit. Survey and Training

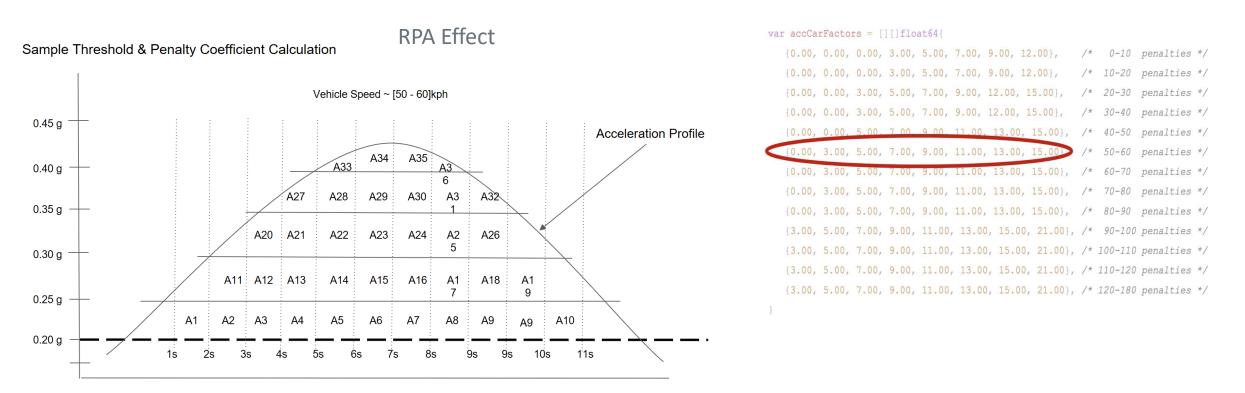


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Karolina Kurtykaa, Jacek Pielechaa, "The evaluation of exhaust emission in RDE tests including dynamic driving conditions" (13th International Scientific Conference on Sustainable, Modern and Safe Transport (TRANSCOM 2019)

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Score Calculation



Penalty Point Calculation:

Penalty Factor=(A1+A2+...+A10) * 3 + (A11+A12+...+A19) * 5 + (A20+A21+...+A26) * 7 + (A27+A21+...+A32) * 9 + (A33+A21+...+A36) * 11

SCORE = 100-(Penalty Factor/total acceleration time)*100

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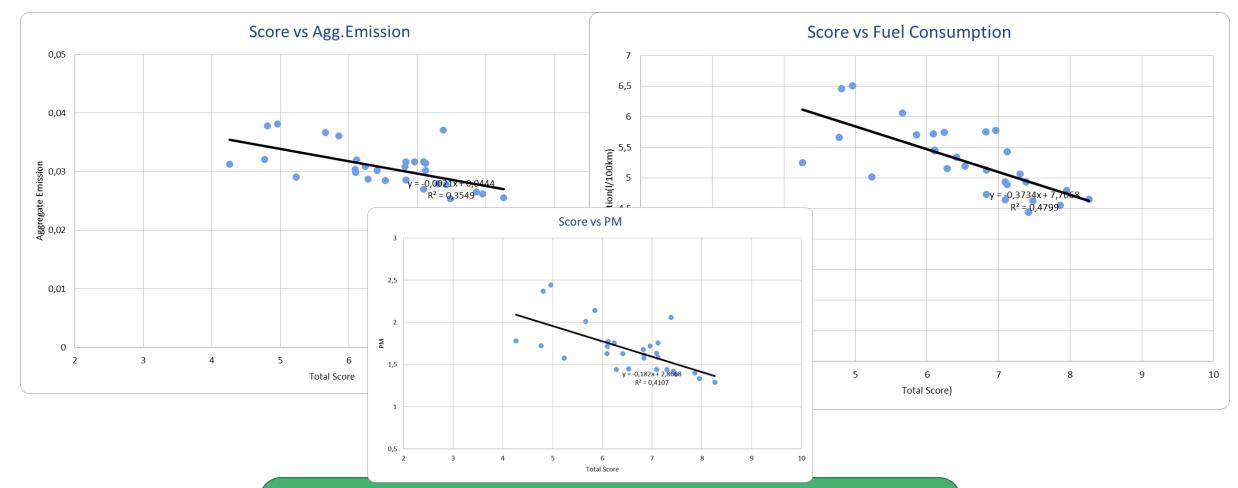
Recommendation System

- GOOD_ECO_DRIVING = "You are doing pretty well...."
- ORANGE_ACCELERATION = "You seem to accelerate quite frequently......"
- RED_ACCELERATION = "You seem to accelerate harshly or aggressively......"
- ORANGE_DECELERATION = "You seem to brake quite hard......"
- RED_DECELERATION = "You seem to brake very harshly......"
- ORANGE_SPEEDING = "Your driving is quite fast on occasions......"
- RED_SPEEDING = "Your driving is often at excessive speeds......"
 - Orange is if your score is between 70-90
 - Red is if your score is less than 70



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Correlations



Results show that an improvement of the score by 20% brings a reduction of 18,6% in fuel consumption, 27,8% in PMs and 23,8% in aggregate emissions for the score range given in the graphs.

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