# Scoring Algorithm Development for Aggregate Emission Optimization

(Paper ID 278)

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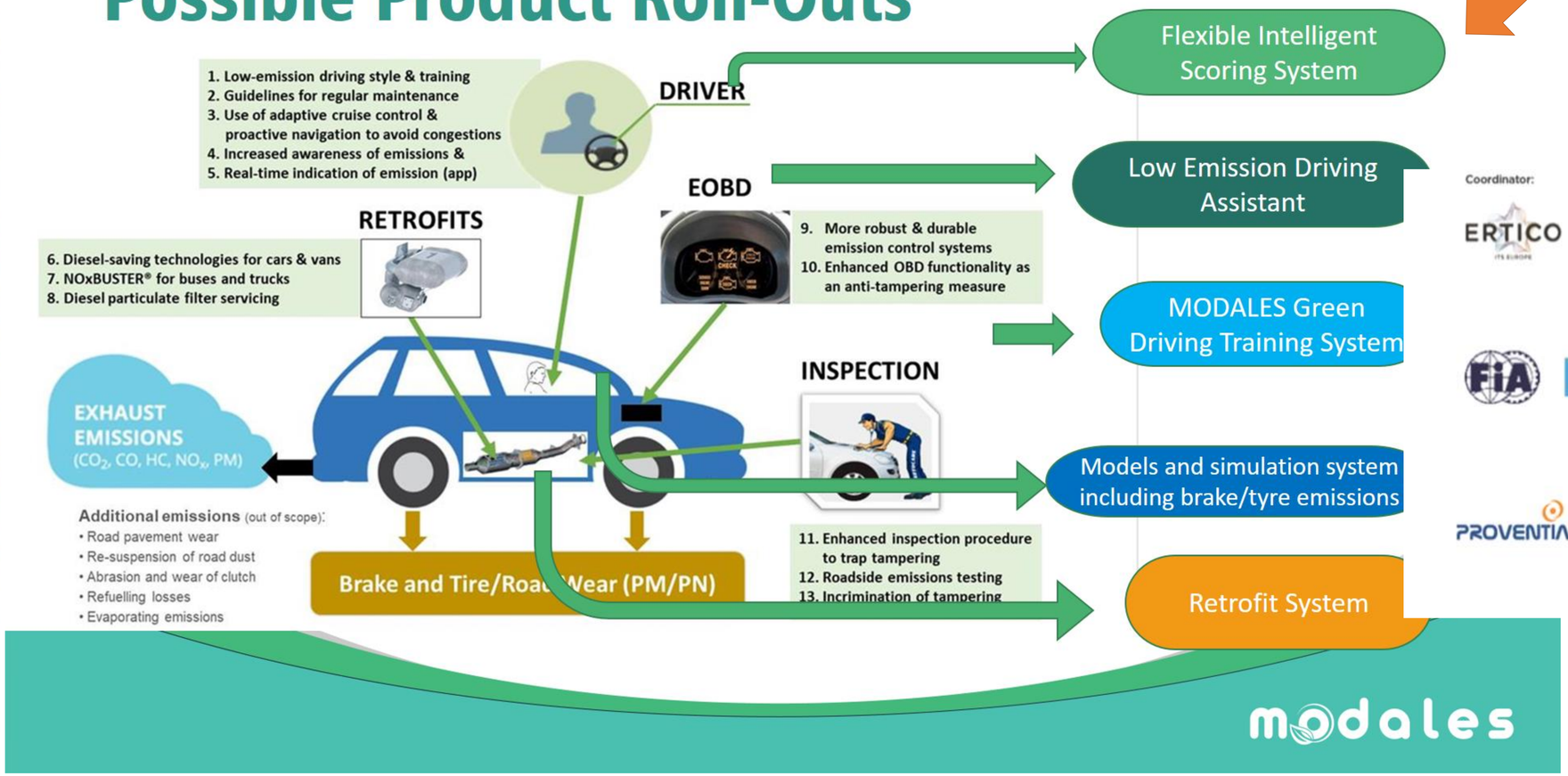
# MODALES Concept and Innovations

Scoring Algorithm Development for Aggregate Emission Optimization

## Possible Product Roll-Outs

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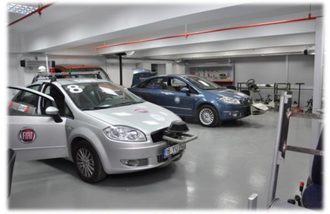
# Istanbul Okan University Introduction

**Vision:** Innovative and leading «World University» which can answer the requirements of society and business world  on the state of art level – **Fourth Generation University**

OKAN UNIVERSITY TRANSPORTATION TECHNOLOGIES & INTELLIGENT AUTOMOTIVE SYSTEMS APPLICATION AND RESEARCH CENTER

**«TTIS»**

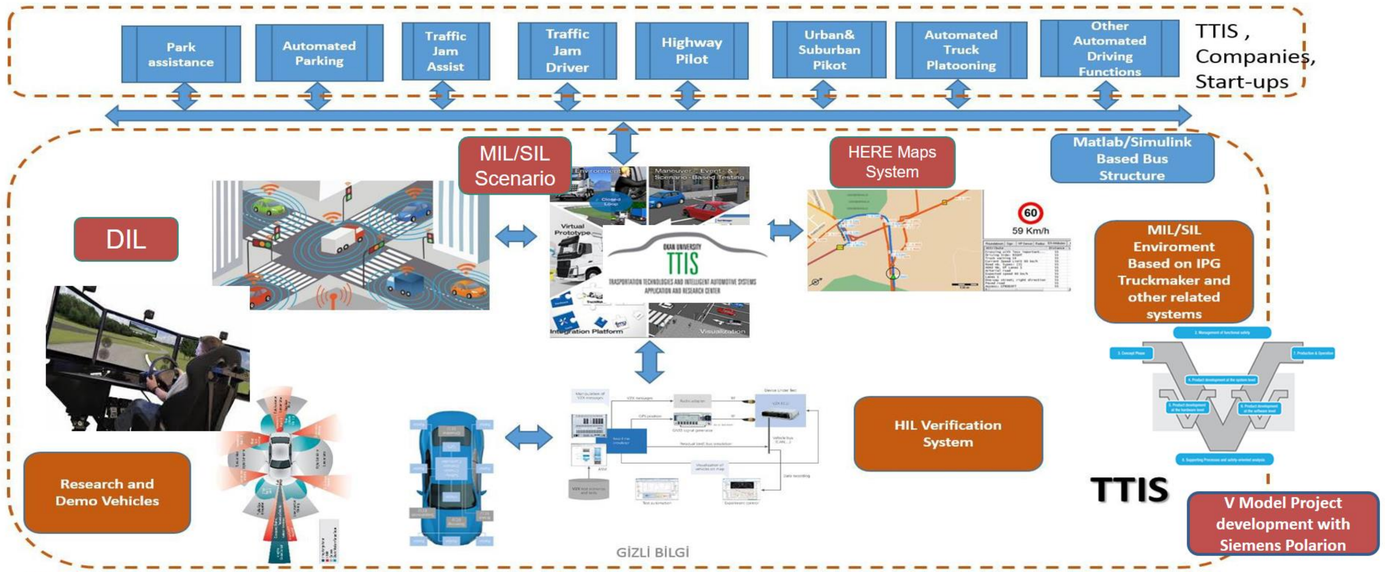


- TTIS aims to be a World Wide recognized node of knowledge and research as well as a Centre of Excellence in the field of Intelligent Transport Systems by 2030
- Member of ERTICO, and EGVIA(2Zero),CCAM, Batteries Europe, ASAM, AUTOSAR and founder and management board member of  National ITS Association(AUS_Türkiye)

Research Areas

- Intellient vehicles
- Communicating Vehicles
- Intelligent Energy manageme systems
- Battery packaging and management systems
- Electric machine and inverter development
- Traffic management
- Big data management

OPEN INNOVATION AUTONOMOUS VEHICLE DEVELOPMENT PLATFORM (OPINA-IPAII PROJECT)




ORGANISED BY: ERTICO ITS EUROPE

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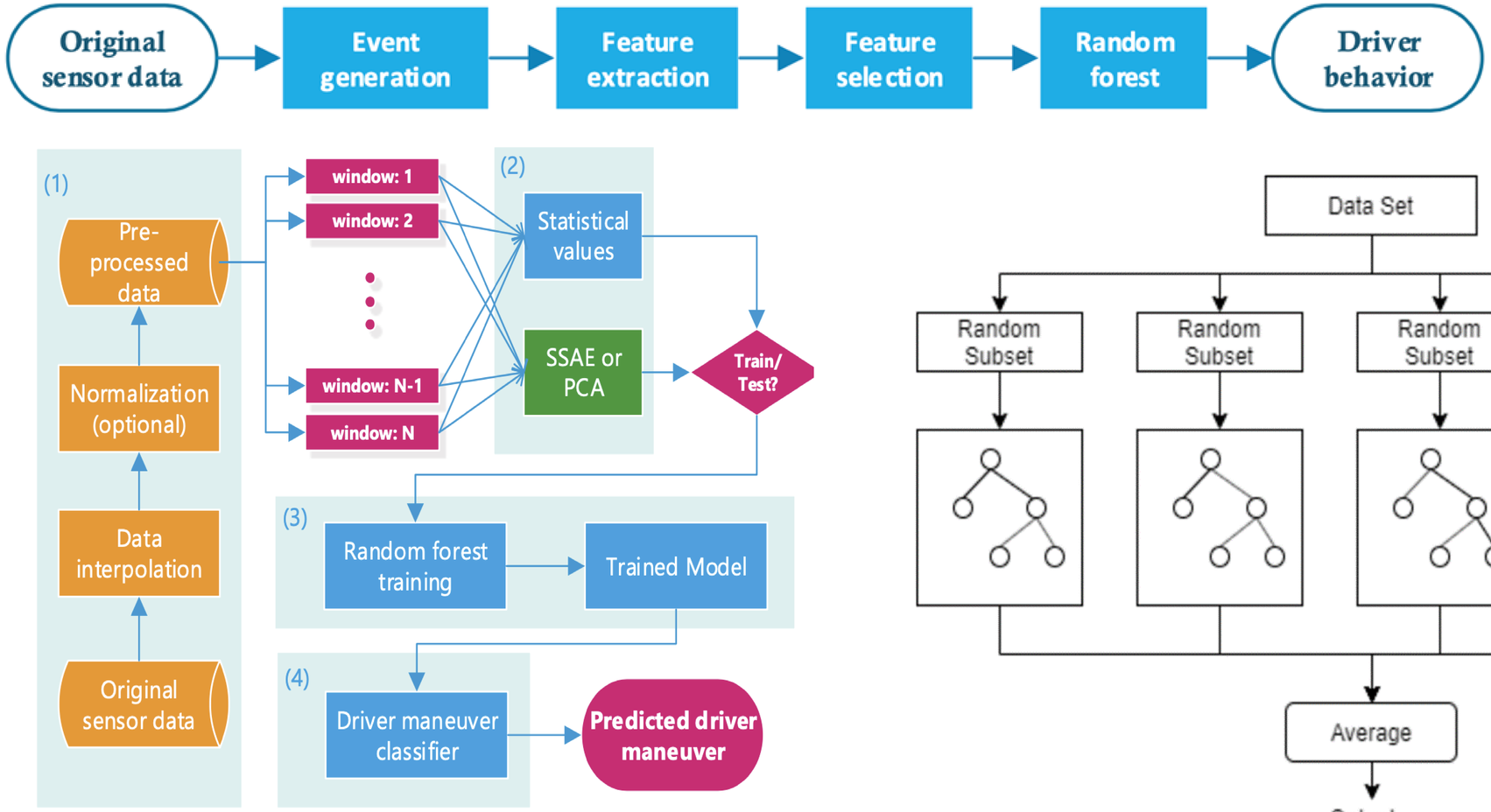
LISBON, PORTUGAL
22-24 MAY 2023
ITS: The Game Changer.

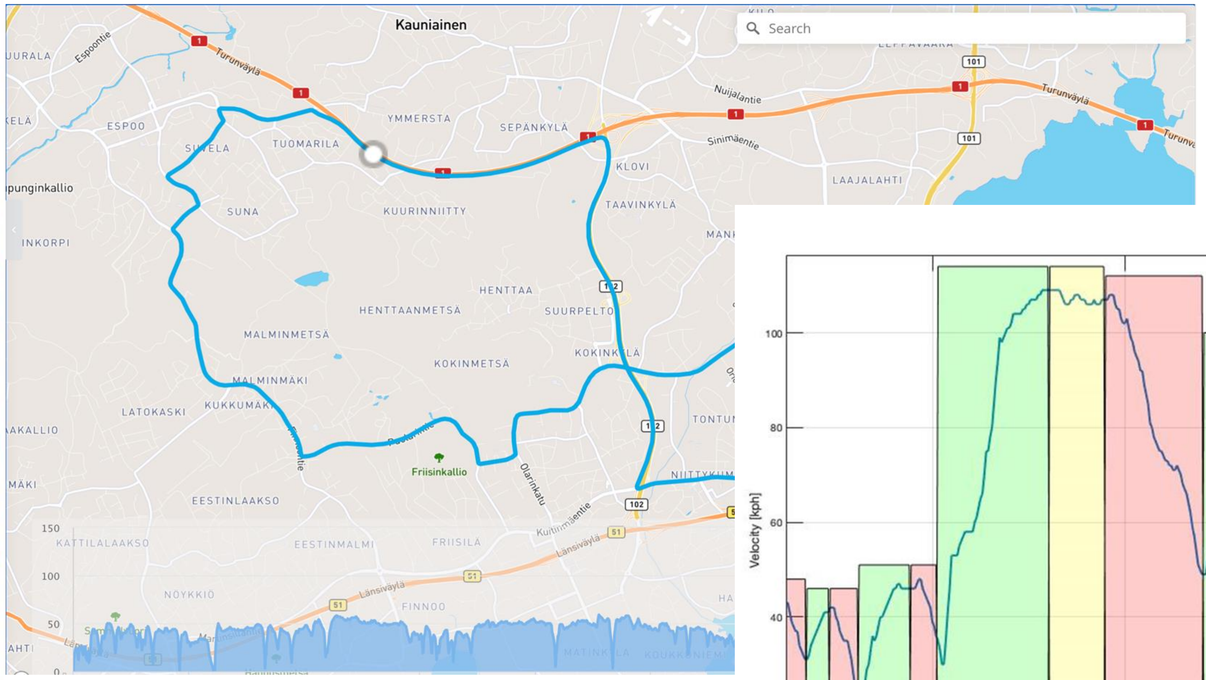
# Scoring System

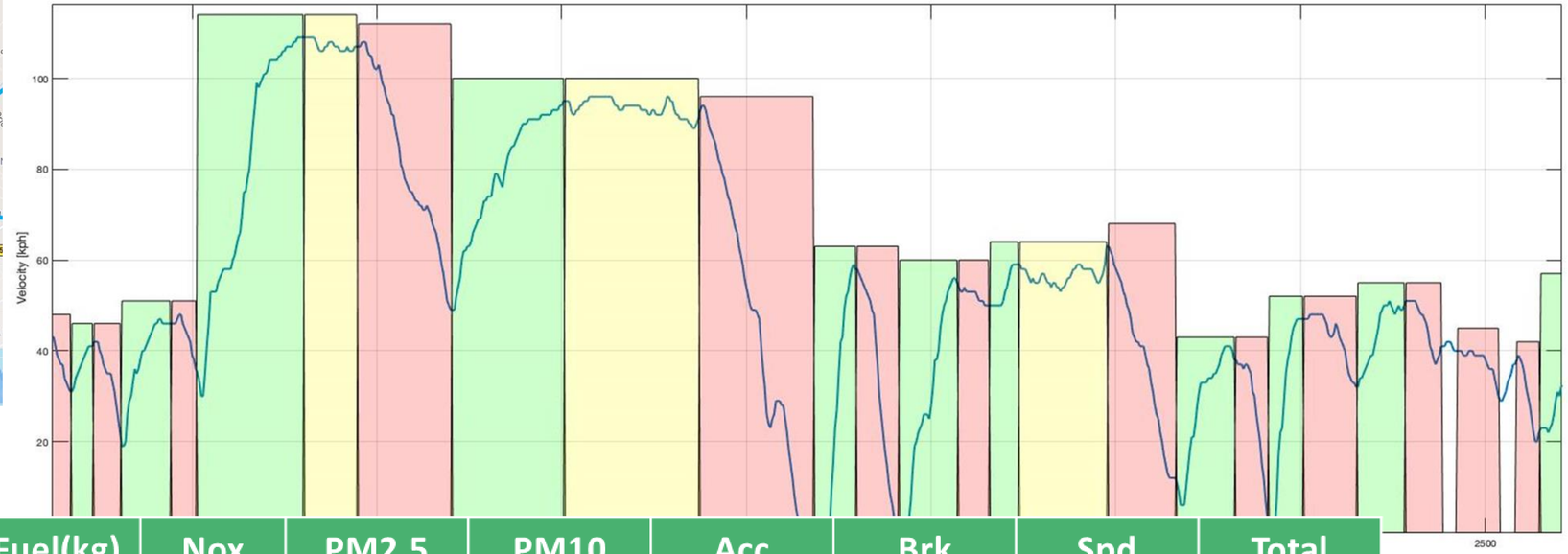
- An integrated system for «Driver Support Application»
- A methodology to determine the correlation between driving style and the emissions
- The emission correlations must include CO2, NOx and PMs including that of from tires and brakes
- Driving style parameters are selected as v.a and RPA (Relative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

# Event Detection



# Driving Tests of VTT with PEMS (Portable Emission Measurement System)




| Distance(m) | Fuel(kg) | Nox | PM2.5 | PM10 | Acc Score | Brk Score | Spd Score | Total Score |
|---|---|---|---|---|---|---|---|---|
| 30710 | 50% | 9% | 14% | 27% | 87 | 60 | 100 | 82 |

# 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 PM's and training tables have been created using VTT data

## Aggregate Emissions Parameter Weights

| Fuel consumption | NO2 | PM10 | PM2.5 |
|---|---|---|---|
| 0,50 | 0,09 | 0,14 | 0,27 |

**For Brake:**

$$m = \rho V_w = \varphi K \frac{F_N \rho L}{3} = \frac{K \rho \varphi M}{6Nk}(v_1^2 - v_2^2)$$

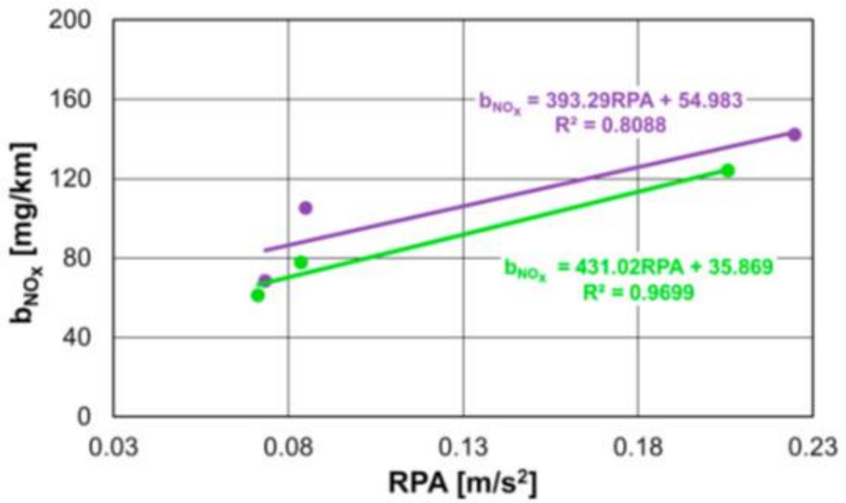
$$\begin{cases} \varphi = 1 & T_{pad} < 200°C \\ \varphi = 1.8 & 200°C \leq T_{pad} \leq 250°C \\ \varphi = 5.6 & T_{pad} > 250°C \end{cases}$$

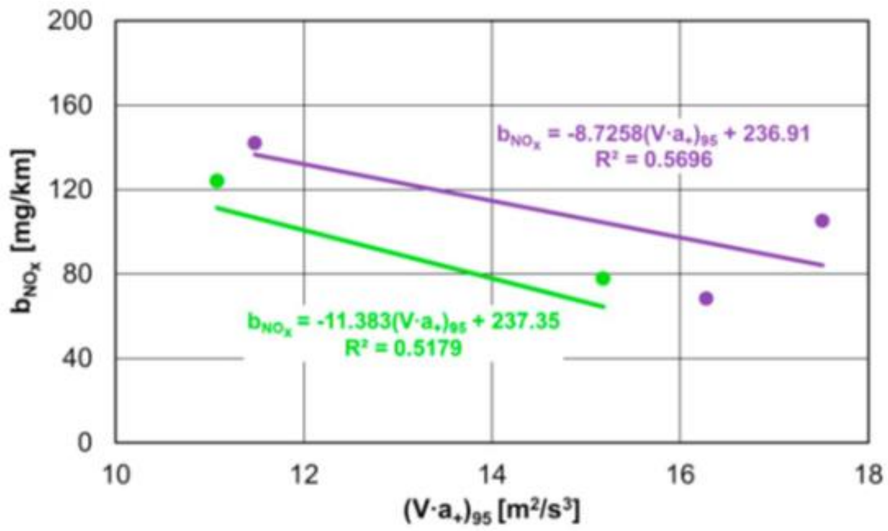
**For Tyre :**

$$m_T = \varphi k_1 (w)^{k_2} BD$$

$$w = \frac{P(t)}{\varphi NBL}$$

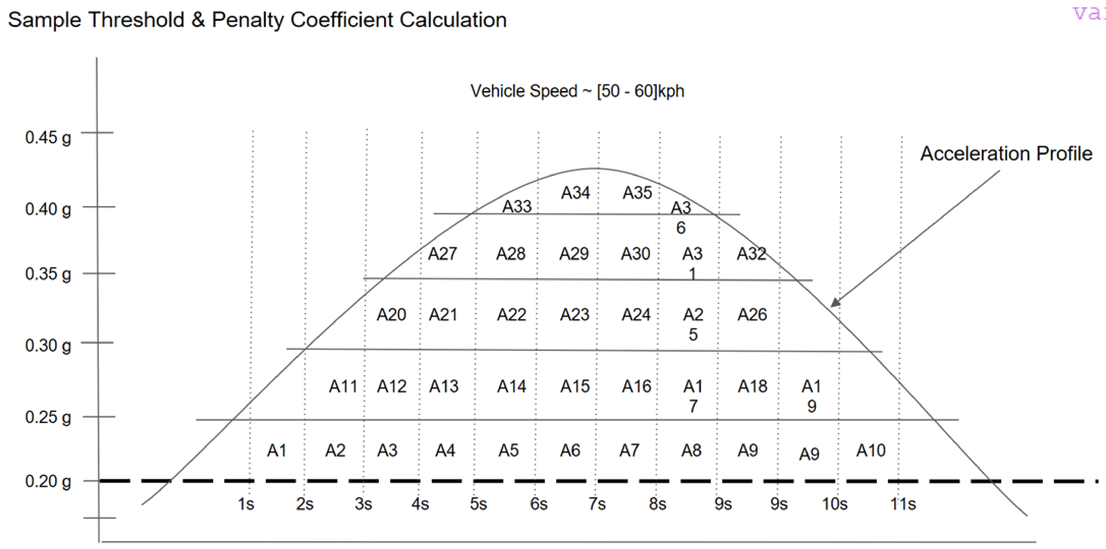
# Scoring Threshold Values Through Literature Survey and Training




| Thres. (g) | Velocity (kph) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 |
| Acceleration | 0.30 | 0.30 | 0.25 | 0.25 | 0.25 | 0.20 | 0.20 | 0.20 | 0.20 | 0.15 | 0.15 | 0.15 | 0.15 |
| Deceleration | -0.50 | -0.50 | -0.50 | -0.25 | -0.25 | -0.25 | -0.25 | -0.20 | -0.20 | -0.20 | -0.20 | -0.20 | -0.20 |
| Left Turn | 0.35 | 0.35 | 0.35 | 0.35 | 0.30 | 0.30 | 0.30 | 0.25 | 0.25 | 0.25 | 0.20 | 0.20 | 0.20 |
| Right Turn | -0.35 | -0.35 | -0.35 | -0.35 | -0.30 | -0.30 | -0.30 | -0.25 | -0.25 | -0.25 | -0.20 | -0.20 | -0.20 |

# Score Calculation



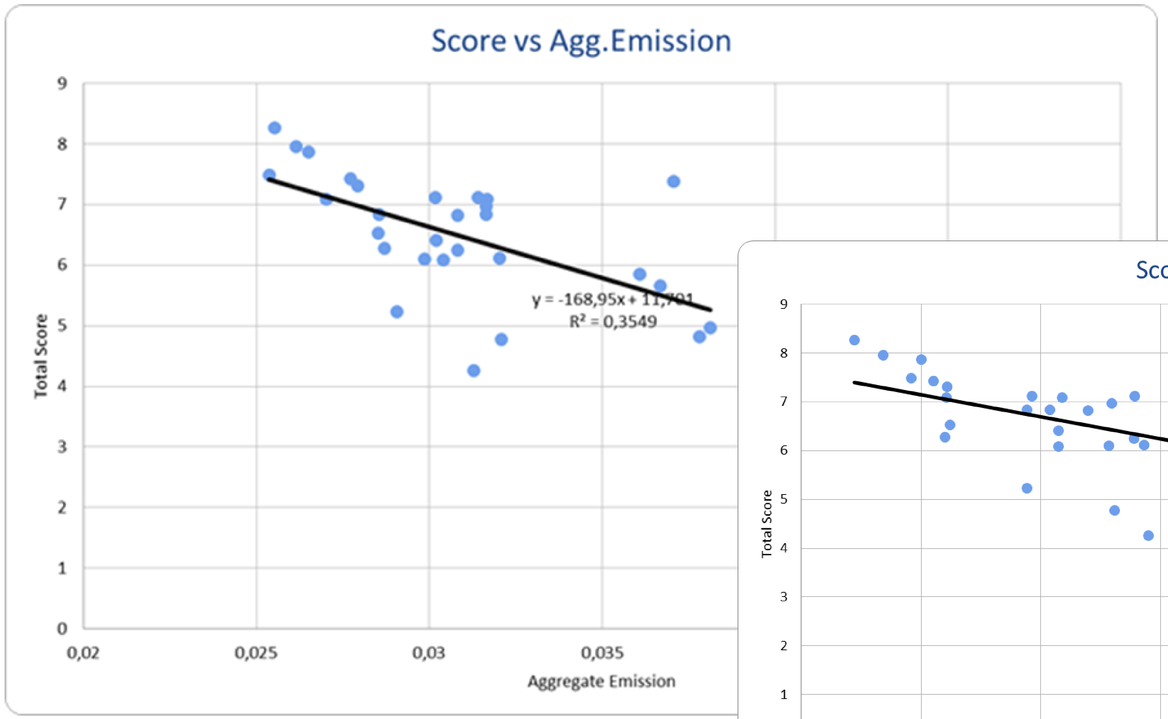

```
var accCarRanges = []float64{0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45, 0.50}

var accCarFactors = [][]float64{
    {0.00, 0.00, 0.00, 3.00, 5.00, 7.00, 9.00, 12.00},    /*   0-10  penalties */
    {0.00, 0.00, 0.00, 3.00, 5.00, 7.00, 9.00, 12.00},    /*  10-20  penalties */
    {0.00, 0.00, 3.00, 5.00, 7.00, 9.00, 12.00, 15.00},   /*  20-30  penalties */
    {0.00, 0.00, 3.00, 5.00, 7.00, 9.00, 12.00, 15.00},   /*  30-40  penalties */
    {0.00, 0.00, 5.00, 7.00, 9.00, 11.00, 13.00, 15.00},  /*  40-50  penalties */
    {0.00, 3.00, 5.00, 7.00, 9.00, 11.00, 13.00, 15.00},  /*  50-60  penalties */
    {0.00, 3.00, 5.00, 7.00, 9.00, 11.00, 13.00, 15.00},  /*  60-70  penalties */
    {0.00, 3.00, 5.00, 7.00, 9.00, 11.00, 13.00, 15.00},  /*  70-80  penalties */
    {0.00, 3.00, 5.00, 7.00, 9.00, 11.00, 13.00, 15.00},  /*  80-90  penalties */
    {3.00, 5.00, 7.00, 9.00, 11.00, 13.00, 15.00, 21.00}, /*  90-100 penalties */
    {3.00, 5.00, 7.00, 9.00, 11.00, 13.00, 15.00, 21.00}, /* 100-110 penalties */
    {3.00, 5.00, 7.00, 9.00, 11.00, 13.00, 15.00, 21.00}, /* 110-120 penalties */
    {3.00, 5.00, 7.00, 9.00, 11.00, 13.00, 15.00, 21.00}, /* 120-180 penalties */
}
```

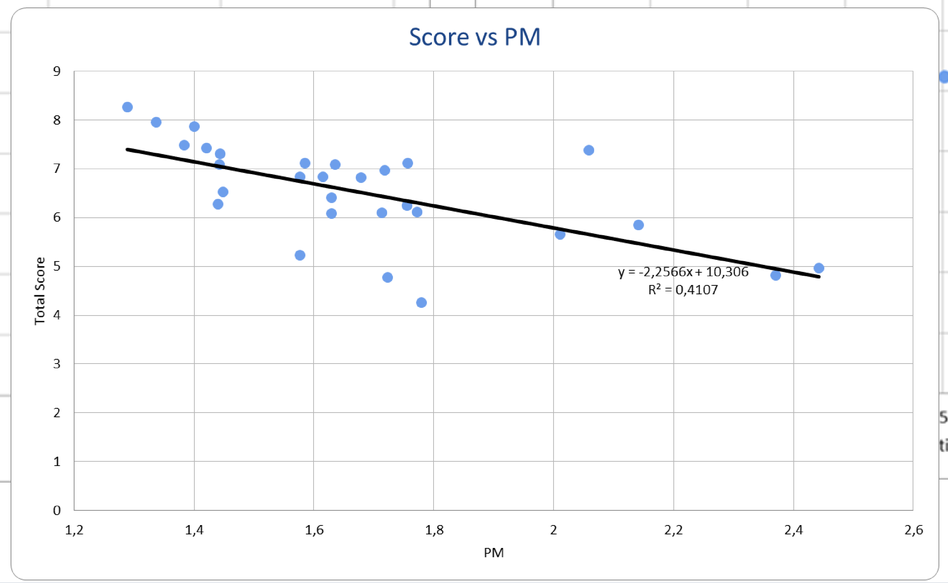
**Penalty Factor Calculation:**

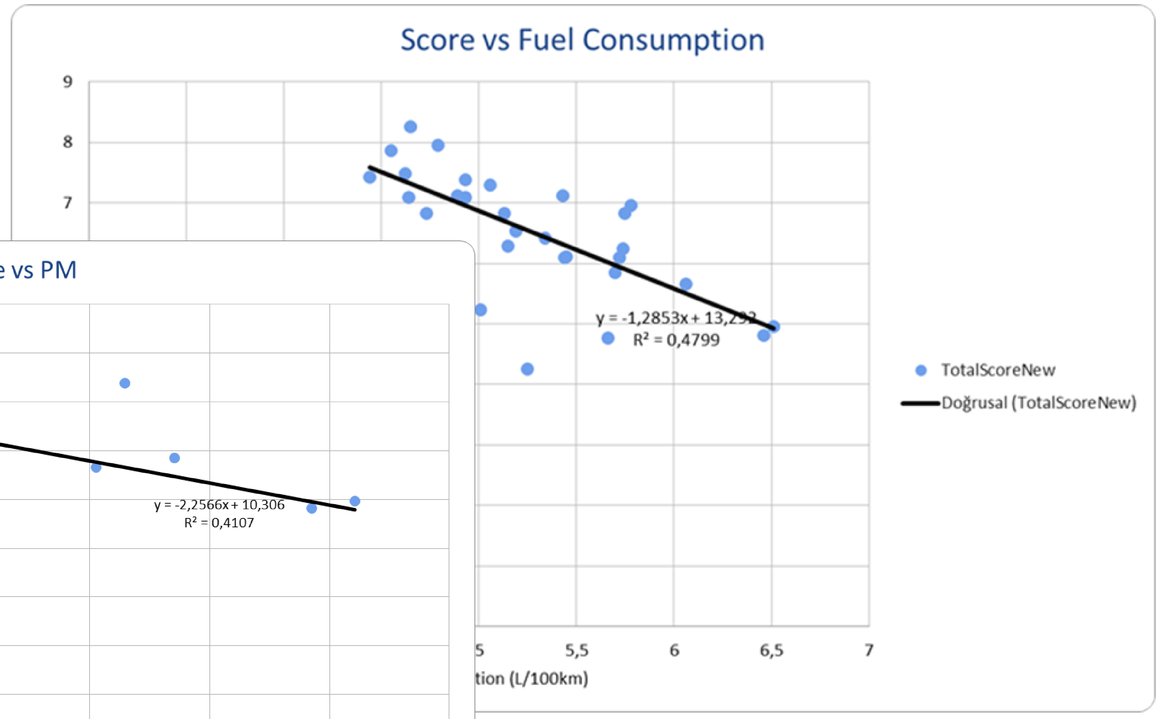
**Penalty Factor=(A1+A2+...+A10) * 3 + (A11+A12+...+A19) * 5 + (A20+A21+...+A26) * 7 + (A27+A21+...+A32) * 9 + (A33+A21+...+A36) * 11**

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

# 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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# Thank you!