Adapting driver behaviour
for lower emissions

Technical Inspections in Europe: current situation, gaps and recommendations

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The necessity of a thorough mandatory vehicle inspection: vehicle maintenance

- According to Autonettv (2022), over 80% of the vehicles on the road have one or more service or repair that is needed, but has not been taken care of.
- That translates into roughly over 160 million vehicles in the US alone. Some of the neglected items are minor.
- There are many problems that may occur in a vehicle. Below are listed the most common causes of inspection failure on personal vehicles (2021):
  - Air to fuel mixture may be incorrect
  - Vacuum leak present
  - Exhaust Gas Re-Circulation (EGR) may be malfunctioning
  - One or more worn, damaged, or fouled sparkplugs are present
  - Catalytic converter is clogged, missing, or ineffective
  - Malfunctioning oxygen sensor
  - Internal engine parts may be malfunctioning or damaged
  - Dirty or contaminated engine oil
  - Clogged air filter

The necessity of a thorough mandatory vehicle inspection: vehicle tampering

HD- and NRMM tampering customers' profile

Current customers (on Heavy Duty and Non-Road Mobile Machinery sectors) are divided typically into three categories:

- Those who face NRMM EATS failures -> increased downtime -> requests that the EATS is disabled either temporarily or permanently depending on spare parts price and delivery time.
- Customers who believe that the engine power is lower than rated by the manufacturer, as engine response may be "slow" or lack power in relation to the work load -> request for improvements -> more power = improvements in work efficiency -> "time is money".
- Customers who buy a "rescue kit" -> a backup ECU-flash that is used if any error codes appear that increase the downtime during the work days. These customers want to get the job done in time and will then return the machinery for service after the work is complete.

Analysis of PTI (Periodic Technical Inspection) results from Europe

- MODALES tried to have access to as many data sources as possible, through its members, however the provision of such –sensitive– data from the transport authorities requires the consent from different departments so this is not always possible.

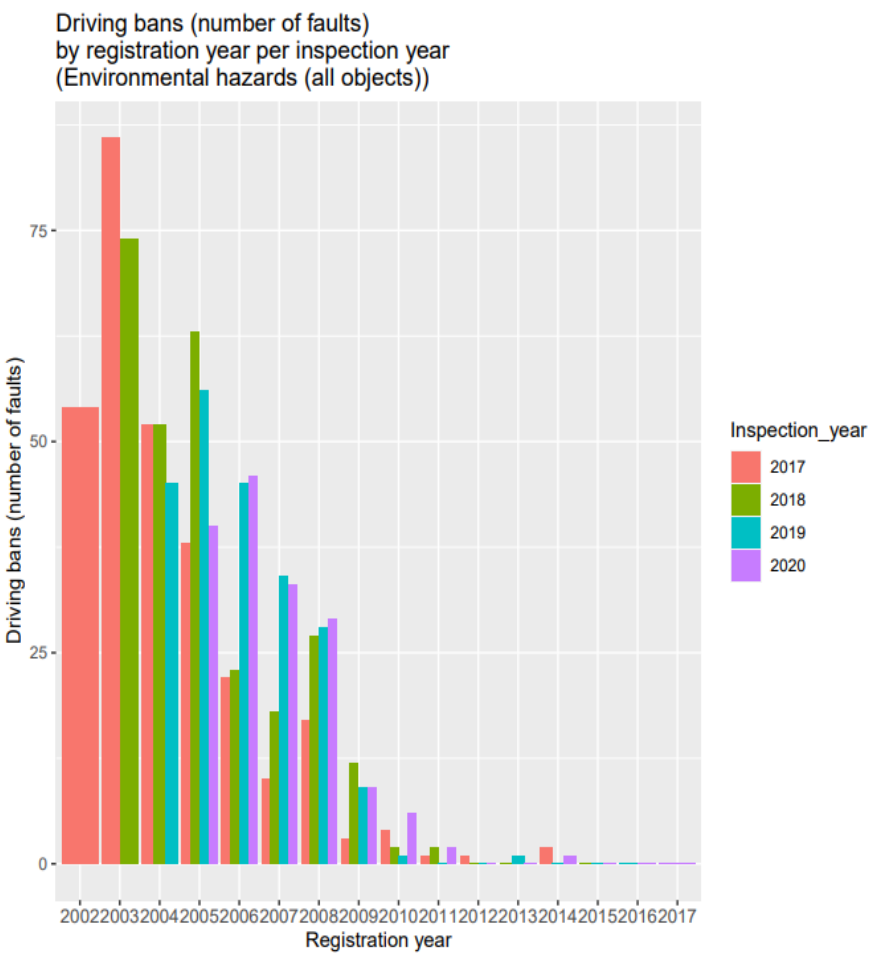
- The consortium analysed data from Turkey, Finland and Spain.

- Not provided in a similar format or level of aggregation.

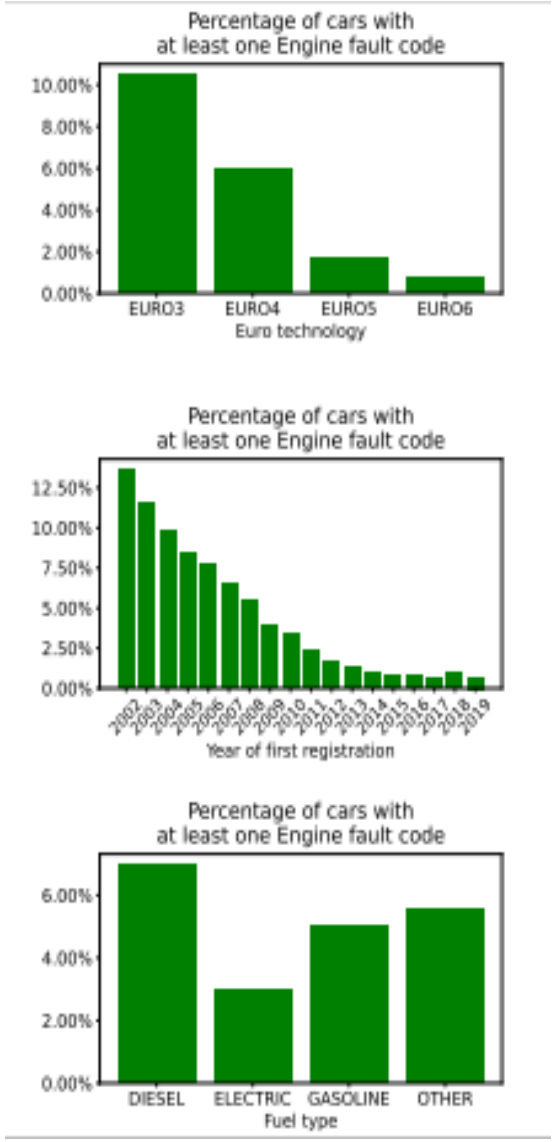
- This fact did not allow us to make a direct comparison of results between these three countries

PTI results: Emissions

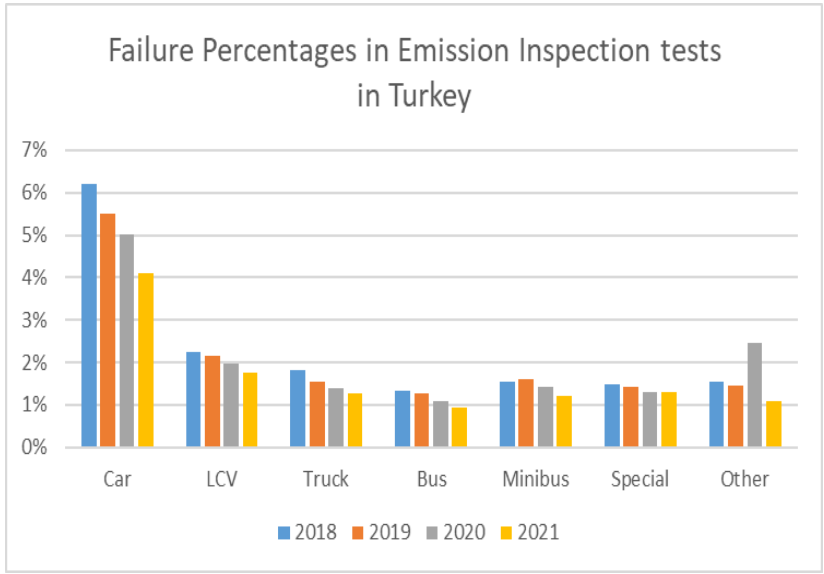
Finland



Spain

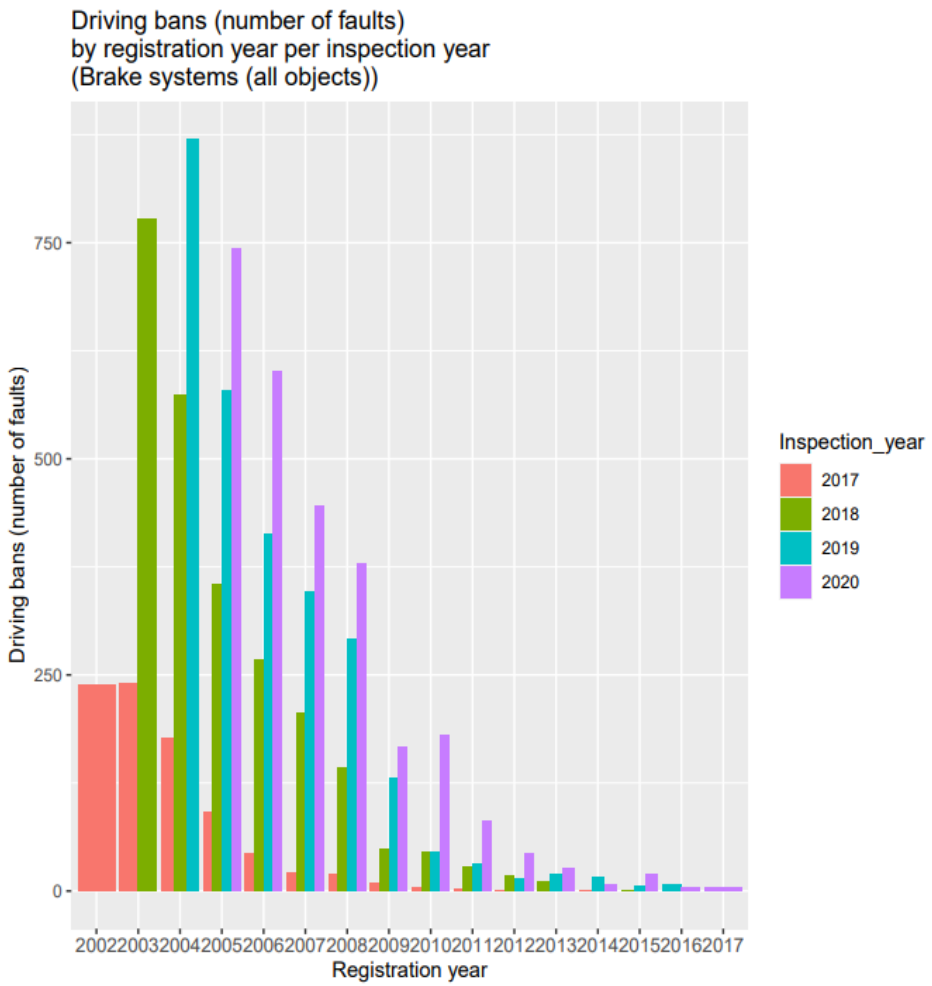


Turkey

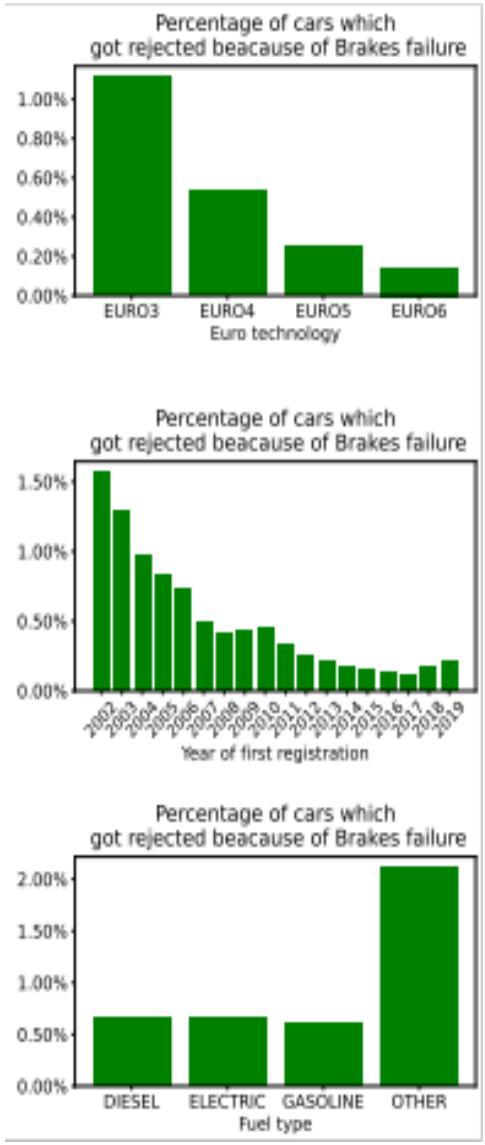


PTI results: Brakes

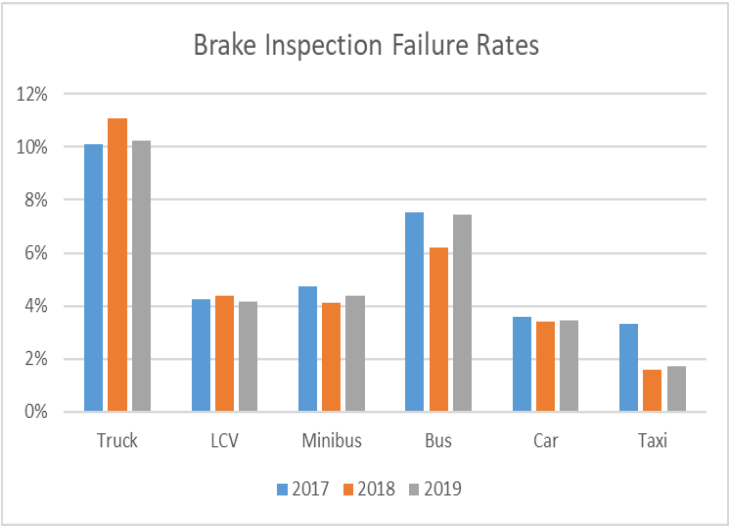
Finland



Spain

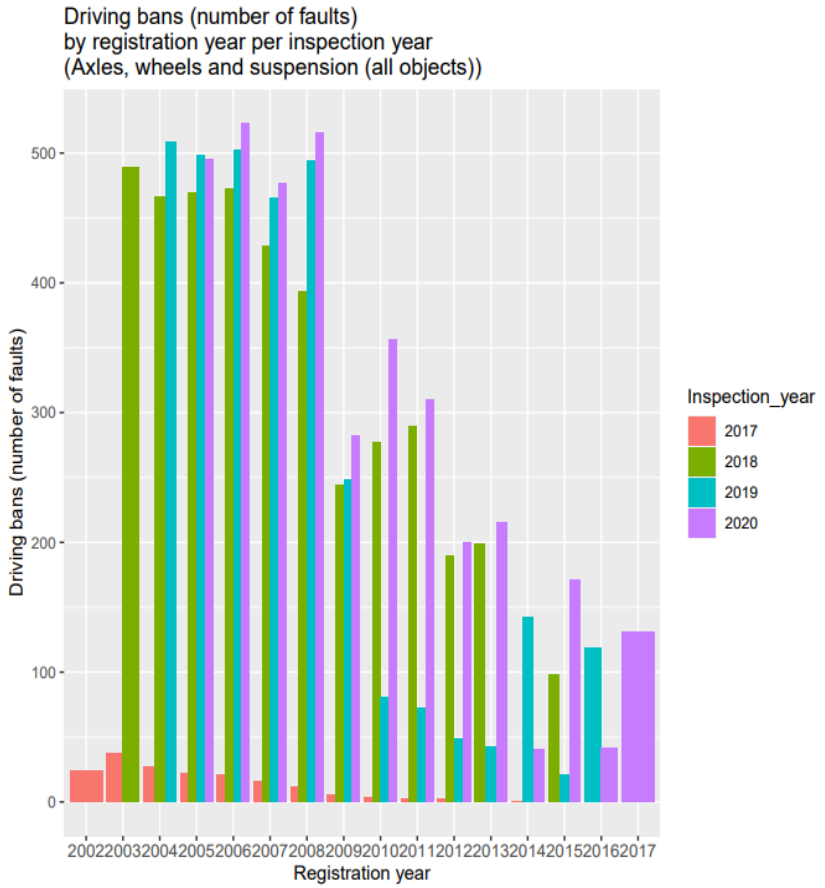


Turkey

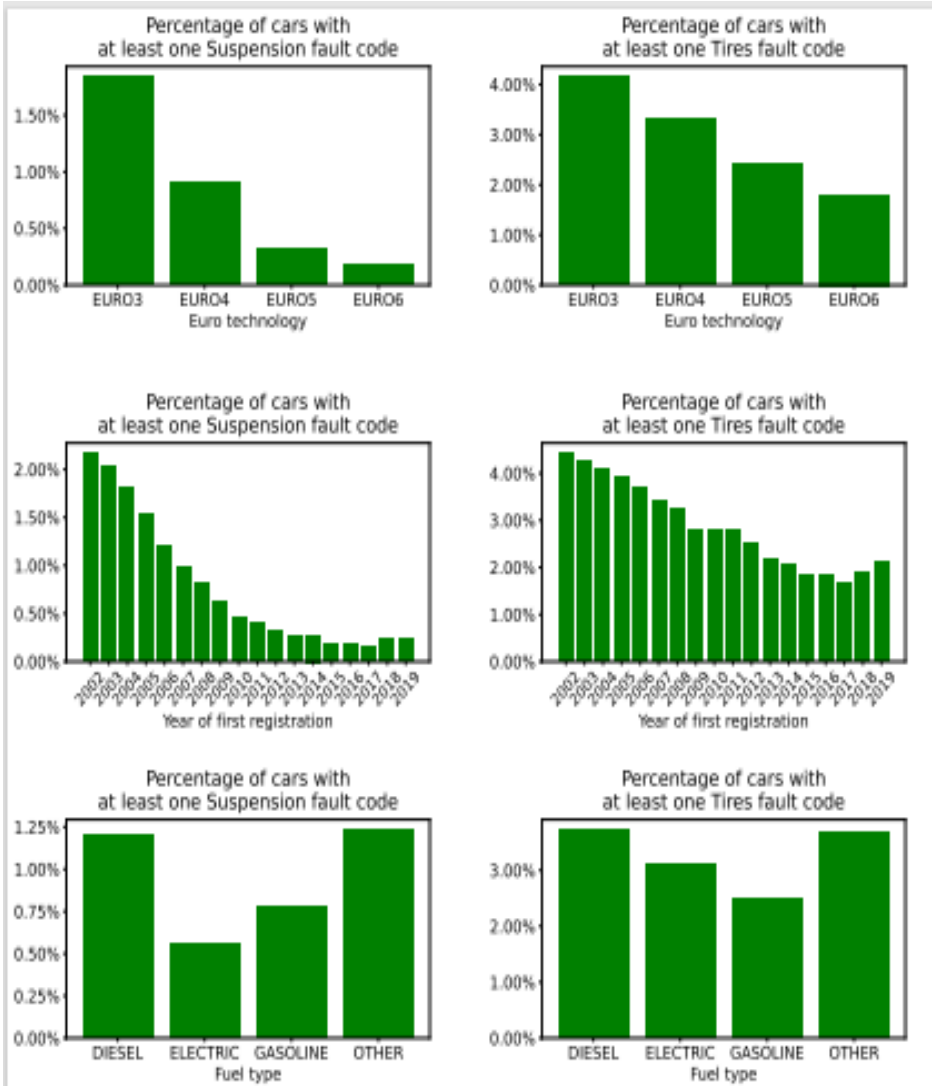


PTI results: Tyres & Axles

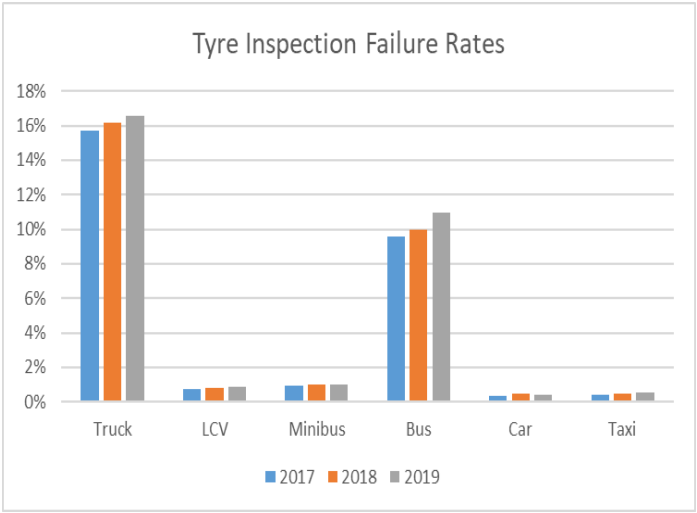
Finland



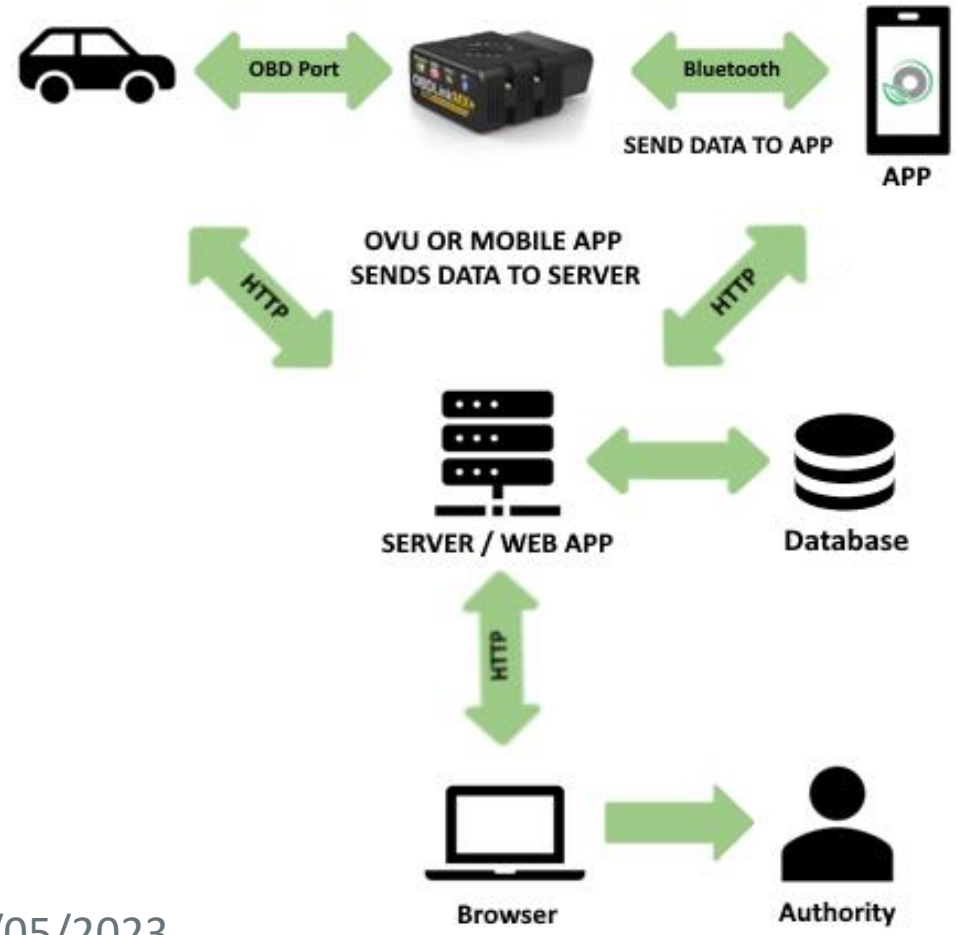
Spain



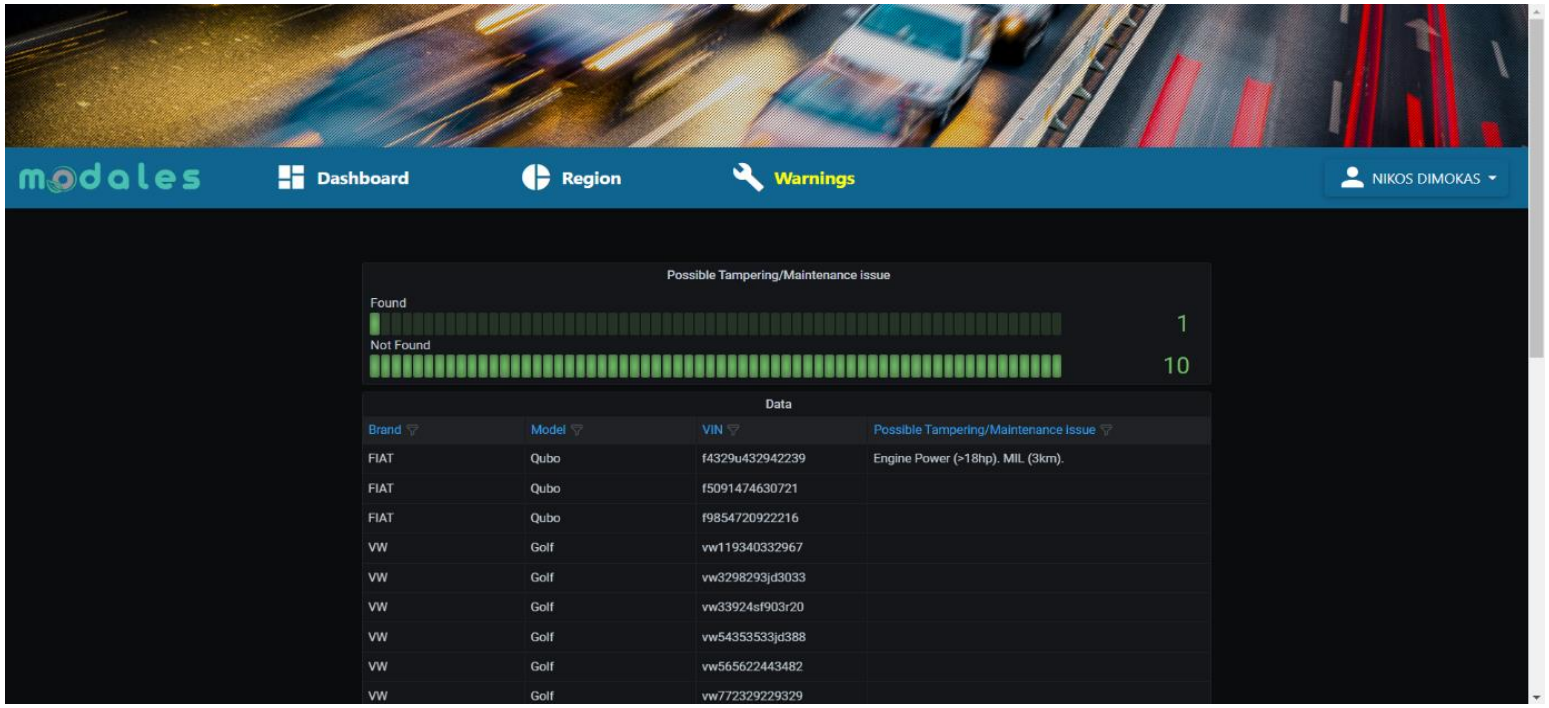
Turkey



Vehicle maintenance and tampering monitoring MODALES solution



Monitoring dashboard



Recommendation for improved PTI framework

- Digitalisation of vehicle registration documents;
- Improving the exchange of data between Member States;

as such it is an opportunity to improve administrative cross-border cooperation for inspection and enforcement bodies

- Use OBD information for evaluating the technical state of a vehicle (maintain a record per vehicle)

- Less pressure on PTI centres for vehicles with a millage of >160.000 km (manufacturers responsibility of emission type approval requirements) by revising the EC regulation

Assessment of the effect of tampering solutions on HDV tail-pipe emissions (1/2)

- The effect of different **Engine Aftertreatment System** (EATS) **tampering methods** and **reprogramming** (a.k.a remapping) of **engine control unit** (ECU) software in **heavy duty vehicle** (HDV) applications was studies.
- The aim was to study:
  - direct effect in respect to changes in
    - exhaust emissions and
    - vehicle performance
  - by testing typical tampering and ECU reprogramming methods
  - increase the knowledge of the potential gains and penalties obtained with respect to the different vehicle modifications.
- The data of this study was also analysed for improving the knowledge regarding detection of EATS tampering and ECU reprogramming

Assessment of the effect of tampering solutions on HDV tail-pipe emissions (2/2)

- Experimental tests on VTT HDV chassis dynamometer
  - Test matrix per configuration
    1. WHVC: 1x cold start + 2x hot starts
    2. Drivetrain power testing

- Emissions (focus on CO_2, CO, NO_X and particles), fuel consumption, vehicle performance

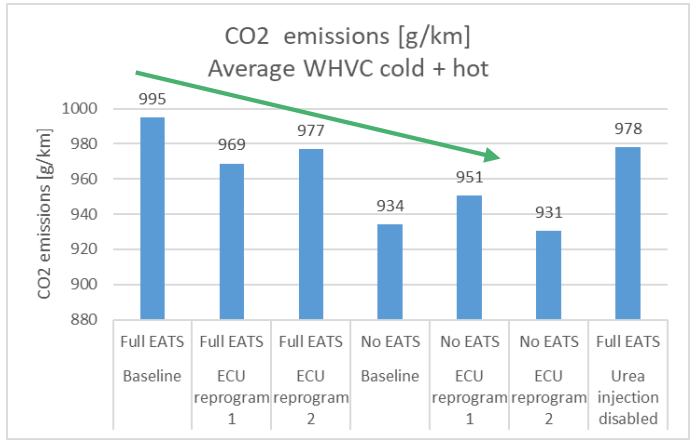
- Demonstrated the “gains & losses”, e.g. gain in fuel consumption in relation to change in emissions

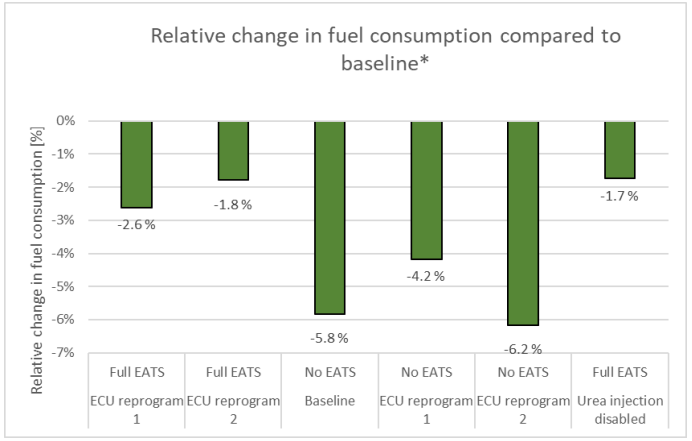
Test configuration

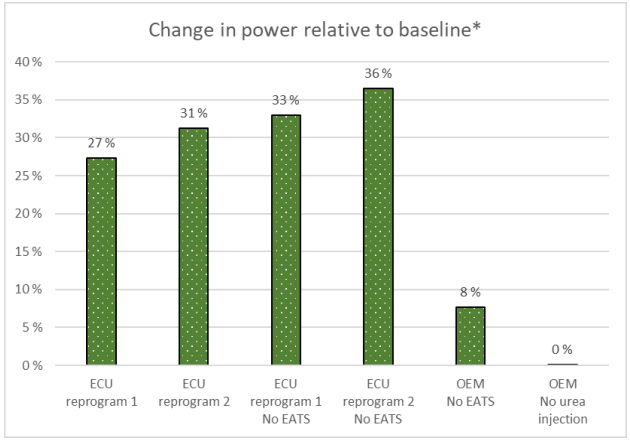
- VTT's city bus was used for simulating HDV emissions
  - 12 litre diesel engine (EEV)
  - EATS: DOC, DPF + SCR
    - EATS was a Proventia retrofit upgrade, similar to Euro VI
- A "local" tuning shop helped out with the tampering & re-configuring ECU software
  - This tuning shop was found during contacting tuning centres
- Test configurations:
    - Baseline: with OEM ECU software and full EATS
    - Software reprogramming 1 with full EATS
    - Software reprogramming 2 with full EATS
    - EATS tampering 1: with OEM ECU software and no EATS
    - EATS tampering 2: With ECU software reprogramming no.1 and no EATS
    - EATS tampering 3: With ECU software reprogramming no.2 and no EATS
    - EATS tampering 4: with OEM ECU software and full EATS but SCR deactivated

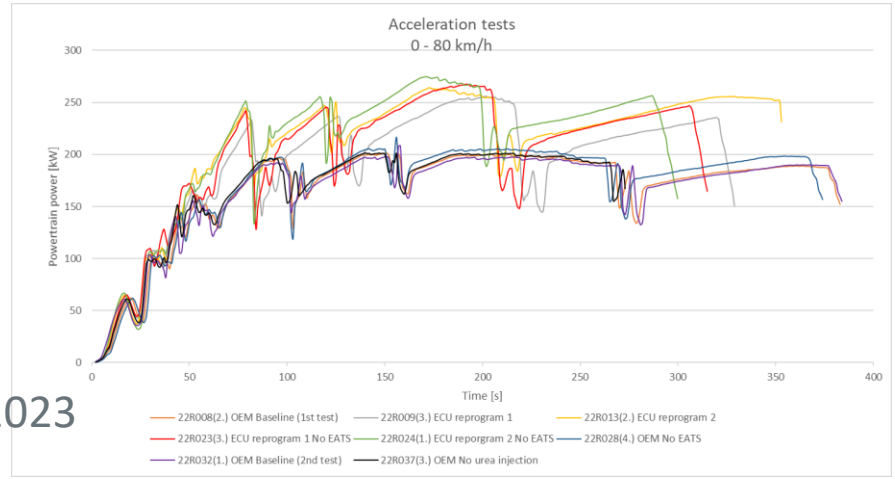
Examples of findings (1/2)

- ECU reprogramming alone reduced consumption (and thus CO_2) by some 2 – 3 %, further with EATS removed up to ca. - 6%
- Simultaneously increasing wheel power with ca 27 % to 36 % depending on configuration
  - By removing EATS, peak power increased by 8 %



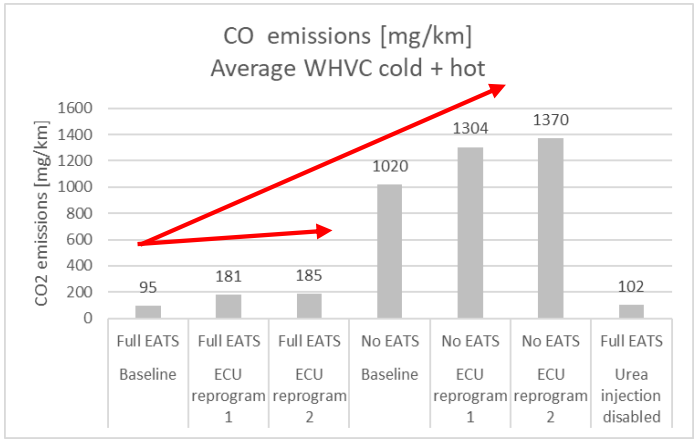


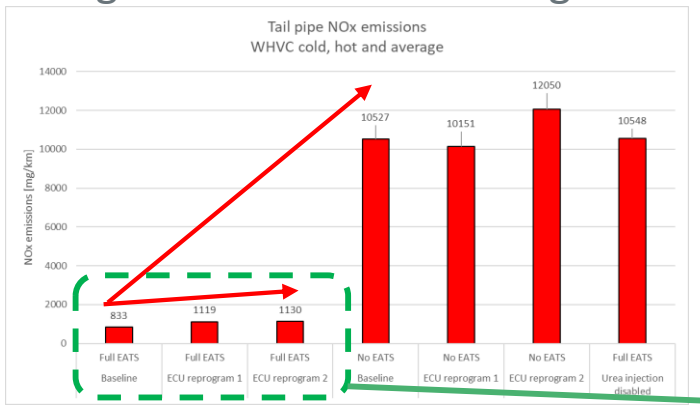


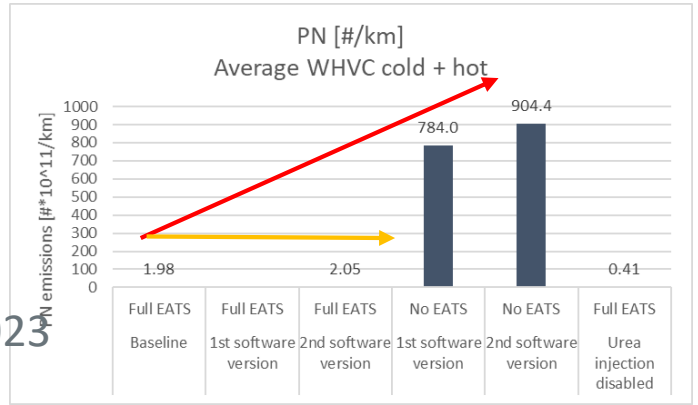


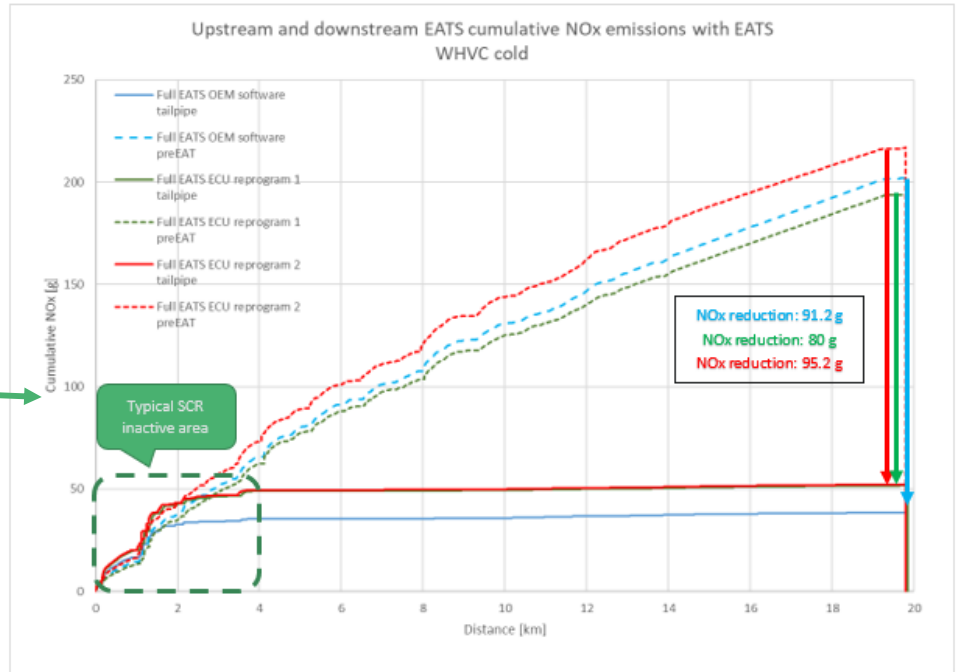
Examples of findings (2/2)

- ...with penalty of CO increasing by ca. 150 % and NOx increasing ca. 35 % in tail pipe with full EATS (DOC, DPF and SCR installed)
  - Due to effective DPFs, no significant increase in particulate emissions was found
  - This SCR system was designed to maintain a constant NOx reduction percentage, OEM systems may not behave as well in real situations (influence in tail pipe NOx may vary significantly depending on SCR calibrations)
- Greatest penalty on exhaust emissions are caused by EATS tampering, dramatically increasing the respective exhaust components corresponding engine raw exhaust emissions
- It was found that reprogramming alone might be difficult to distinguish based on emissions, but this is not the case of EATS tampering









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Legal aspects on vehicle tampering and recommendations

Esther Tenge – Spark Legal and Policy Consulting

MODALES Final Conference, Brussels, 12 May 2023

Research on the legal situation on vehicle tampering across EU Member States

Data collection

1. Legal desk research in 14 countries (13 EU Member States + UK) carried out by national legal experts
2. Stakeholder survey (EU Survey) sent out to more than 300 governmental and industry stakeholders as well as to associations

Comparative analysis aimed at identifying the commonalities and contrasts in legislation on vehicle tampering across EU Member States

Legal situation of tampering

Topics covered

- The EU legal framework regarding vehicle tampering
- The relevant national legal and regulatory frameworks on vehicle tampering
- The obligations placed on manufacturers under national law
- The national rules and requirements in place in relation to type approval
- The national rules and requirements regarding post-type approval rules on tampering
- The national legislation in place regarding periodic roadworthiness tests and technical roadside inspections
- National strategies and initiatives regarding vehicle tampering
- The effectiveness of the rules on tampering and the enforcement of these rules
- Relevant case law by national courts, bodies, or authorities relating to vehicle tampering

Examples of findings

- Vehicle tampering is prohibited under the national law in most Member States, but this prohibition most often is derived from legislation on type approval processes, rather than included as a specific legal provision.
- Some Member States provide for specific checks in order to identify tampered vehicles or parts in the national legal measures relating to periodic roadworthiness tests / technical roadside inspections.
- Issues related to the effectiveness of the enforcement of rules on tampering and recalls identified at national level mostly relate to the lack of severity of the sanctions.
- Most rulings identified did not rely on specific anti-tampering rules but rather on general consumer, contractual and/or criminal law (applying the concept of fraud or hidden defect).

Legal best practices and recommendations

Four categories

- The definition of tampering in the context of light duty vehicles
- Legal requirements placed on manufacturers
- Specific anti-tampering legislation
- Enforcement and penalties

For each category

- Background information
- Legal recommendations
- Best practices relating to or illustrating those recommendations

Examples legal best practices and recommendations

Adopting rules prohibiting vehicle tampering will enable authorities to apply anti-tampering measures outside of the context of the type approval process

Post-type approval rules in Slovakia prohibit making, procuring or giving to another person equipment or software for the purpose of unauthorised manipulation of parameters evaluated during technical control, emission control or control of originality.

Penalties going beyond fines may deter vehicle tampering; broadening the scope of applicability of sanctions may enable the punishing of other parties involved in tampering aside from the manufacturers.

In Belgium, different sanctions and prohibitions are available. These can range from prohibitions (such as the prohibition of sale if the certificate of conformity is found out to be incomplete and is therefore unvalidated), to criminal sanctions with imprisonment for up to 3 months, fines up to 10 000 EUR and/or damages.

Validation legal best practices and recommendations

- EUSurvey made available to the same stakeholders (more than 300) contacted for input during the legal data collection phase for verification of the recommendation
- For most of the recommendations (eight out of 13), the majority of stakeholders indicated a high priority level was appropriate
- For the remaining recommendations (five out of 13), the majority of stakeholders indicated a medium level of priority should be given
- In addition, there were almost no indications of low priority levels
- Thus, it was considered that all recommendations identified were validated through this stakeholder survey

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The MODALES dashboard and potential user for detecting anomalies in vehicle performance

Dimitri Margaritis – CERTH / HIT

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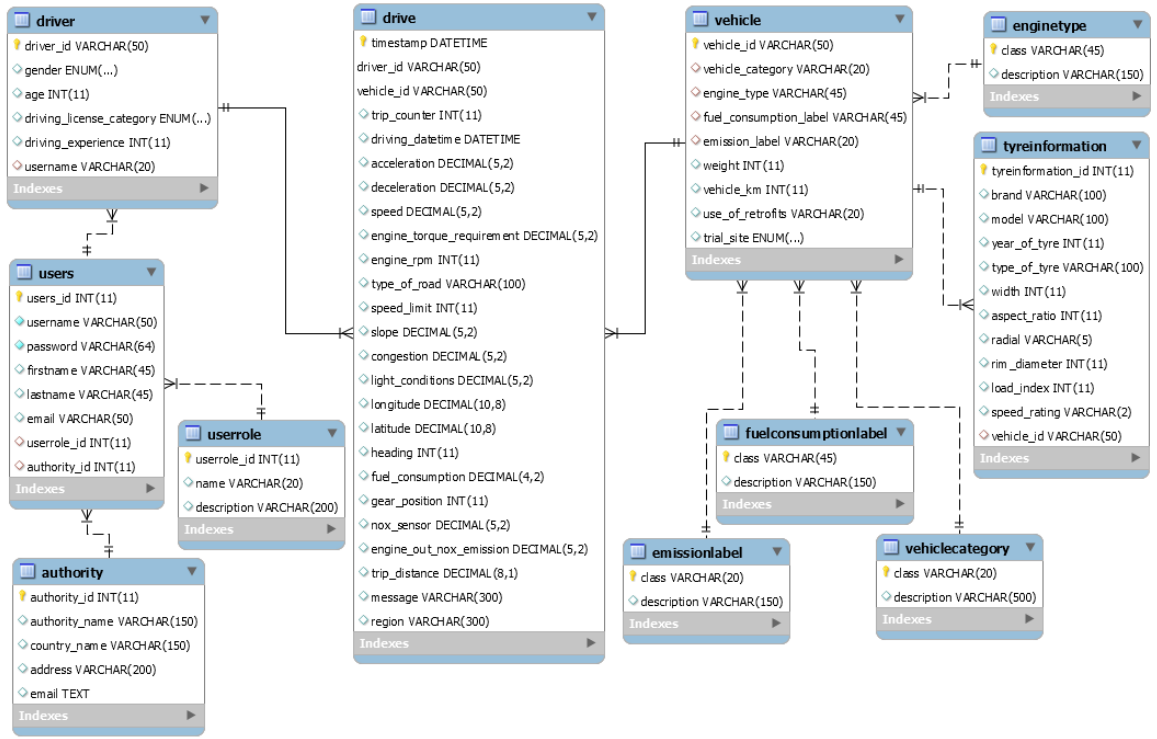
The Web dashboard

- For each app user, “anonymous” data are transmitted to a web dashboard to collect usage statistics and performance metrics
- The latter allows the authorities and potentially the public to understand the benefits of the mobile app and view statistics by region or type of user
- The web dashboard aggregates the data and presents them in various graphical representations to assist decision-making
- The Web dashboard application is based on the received data from the mobile sensors and OBD dongles and indicators derived from them
- The main indicators are vehicle emissions and fuel consumption. The two indicators are time-based. Thus, the dashboard could also present the performance evaluation based on time

Web dashboard architecture

- The dashboard application aggregates the data and present them in various graphical representations to assist the decision making
- It is based on some significant and indicative indicators
  - Vehicle emissions
  - Fuel Consumption
  - *Driver's low emission driving performance*



Web dashboard: login area

Login

Username

Password

LOGIN

Only authorized users can login.

Web dashboard: graphical presentation

Web dashboard: live demo

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www.modales-project.eu

LinkedIn MODALES project

Thank you

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