

A Study on Vehicle Noise Emission Modelling: Correlation with Air Pollutant Emissions, Impact of Kinematic Variables and Critical Hotspots

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This work proposes a methodology suitable for analyzing the sound power levels (L_w), carbon dioxide (CO_2), and nitrogen oxides (NO_x) emissions along a trip, and consequentially assessing the related critical hotspots.

The estimation of noise and pollutant emissions from six vehicles (four diesel, one gasoline, and one hybrid-electric powered) driven along three different routes (one National Road and two highways) was conducted, in a combined way, through seven Noise Emissions Models – NEMs (namely, Lelong, Harmonoise, Nouvelle Méthode de Prevision du Bruit – NMPB, Common Noise aSSessment methOdS – CNOSSOS, SonRoad, Acoustical Society of Japan Road Traffic Noise Model – ASJ, and Vehicle Noise Specific Power model – VNSP) and the Vehicle Specific Power (VSP) methodology, respectively.

The inputs required by the models (vehicle speed and acceleration and road grade) were extrapolated from On-Board Diagnostic (OBD) system and GPS data recorded during monitoring campaigns. The specificities of each model were analyzed, and the role played by the kinematic variables in noise and exhaust emissions assessment was highlighted.

Results show that all the tested NEMs estimated higher noise levels on the highways, while VSP predicted higher emissions on the National Road. This happens because speed is the main input variable in NEMs, while acceleration has an impact on noise estimation in the low-speed range (below 50 km/h). For pollutant emissions evaluation, acceleration plays a fundamental role also at the high-speed range (above 50 km/h), where a transition from a cruising condition to an acceleration phase leads to significant variations in terms of VSP values. L_w values, estimated with NEMs that use acceleration correction terms, present a positive moderate-to-high correlation with VSP ones. Moreover, the models that neglect acceleration in noise estimation fail to recognize traffic control treatments as critical hotspots.

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FIGURE 1
Noise assessment results (with standard deviation values).

FIGURE 2
Exhaust emission assessment results (with standard deviation values) in terms of CO_2 per unit distance and NO_x per unit distance; V1 to V4 diesel-powered cars, V5 gasoline-powered car, and V6 hybrid-electric-powered car..

