Binary logistic regression (BLR) modeling of idle CO emissions in order to estimate predictors influences in old vehicle park

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This paper determines, by experiments, the CO emissions at idle running with 1,785 vehicles powered by spark ignition engine, in order to verify the correctness of emissions values with a representative sample of vehicles in Serbia. The permissible emissions limits were considered for three (3) fitted binary logistic regression models (BLR), and the key reason for such analysis is finding the predictors that can have a crucial influence on the accuracy of the estimation whether such vehicles have correct emissions or not. Having summarized the research results, we found out that vehicles produced in Serbia (hereinafter referred to as "domestic vehicles) cause more pollution than imported cars (hereinafter referred to as "foreign vehicles"), although domestic vehicles are of lower average age and mileage. Another trend was observed: low-power vehicles and vehicles produced before 1992 are potentially more serious polluters.

1. Introduction

Emissions from motor vehicles vary at different driving regimes [1]. One of the specific regimes is idle running, in which a vehicle may spend more than 25% of the operation time [2]. Testing of emissions at idle running was originally developed for vehicles that had very little or no emission control, which made it possible to detect the badly-tuned and/or defective engines. Such vehicles are usually equipped with a mechanical carburetor or fuel injection system where the ratio of air-fuel mixture at idle running corresponds to the ratio of air-fuel mixture under load. Therefore, measurements of CO emissions at idle running (e.g. 2500 rpm) provide a reasonable indication of emissions under normal operating conditions for vehicles with a mechanical system of fuel supply control. Such vehicles include technologically old-fashioned automobiles that are used mainly in developing countries, such as the Republic of Serbia. Large proportion of total emissions from modern vehicles equipped with emission control system is caused by a small percentage of vehicles with a defective emission control system. The research carried out by Guensler [3] proved that 5% of the vehicles cause up to 25% of total emissions, 15% of the vehicles cause up to 43%, and 20% of vehicles are responsible for 60% of emissions. If we want to consider emissions by type of harmful substances, Faiz et al. [4] demonstrated that 20% of vehicles cause 43% of the total CO emission.

The research indicated how the introduction of stricter limits of CO emissions at idle running is socially and politically acceptable [5]. CO idle concentrations were compared to international standards, and the tested vehicles were found to exhibit large failure rates, indicating the need of developing country-specific emissions standards. By measuring the actual distribution of emissions in the sample of Lebanese vehicles, the emissions standards were set so that a maximum of 20% of the vehicles would fail. Such failure rate would be considered socially and politically acceptable and is not expected to raise a significant public opposition to the program.

To identify the characteristics of vehicles that are significantly associated with emission test failures the most commonly used are multiple and logistic regression. Although in such cases the logistic regression is a more appropriate solution, in paper [6] is used multiple regression, which showed that engine size and type, age and