

APPLICATION OF MULTI-CRITERIA ASSESSMENT IN EVALUATION OF MOTOR VEHICLES' ENVIRONMENTAL PERFORMANCES

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Concern for environment is an important element and obligation in contemporary automobile manufacturing. This paper presents an approach to assess environmental performances of motor vehicles by the application of multi-criteria assessment tools. Within the first part of the paper the multi-criteria problem is presented, with special emphasis on selection of criteria for assessment of passenger vehicles' environmental performances. The second part of the paper describes the application of a multi-criteria assessment according to two approaches – VK Software and Compromise Programming (CP) method. The obtained results are compared and discussed.

Keywords: *environmental performance, motor vehicles, multi-criteria analysis, multi-criteria evaluation*

Primjena višekriterijske analize za vrednovanje ekoloških performansi kod motornih vozila

Izvorni znanstveni članak

Briga o zaštiti okoliša je bitan element i obveza u suvremenoj automobilskoj industriji. U ovom je radu predstavljen prikaz vrednovanja ekoloških performansi motornih vozila primjenom alata višekriterijskog ocjenjivanja. Prvi dio rada opisuje višekriterijski problem i izbor kriterija za vrednovanje ekoloških performansi motornih vozila. U drugom dijelu rada je opisana primjena višekriterijskog ocjenjivanja primjenom dva pristupa – VK Softvera i metode kompromisnog programiranja (CP), a dobiveni rezultati su uspoređeni i raspravljeni.

Ključne riječi: *ekološke performanse, motorna vozila, višekriterijska analiza, višekriterijsko vrednovanje*

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Introduction

Special attention in implementation of advanced technologies in design of new generations of passenger motor vehicles is focussed on reducing the impacts on environment. Automotive manufacturers are struggling to improve their products and to fulfil environmental protection regulations and standards by developing new solutions to decrease the fuel consumption, noise and toxic emissions, to increase the recyclability, etc. [20]. To meet each successive emissions regime, automotive companies have invested considerable research and development resources to create new combustion control technologies. These include items such as direct injection fuel systems, engine mapping software, and variable air intake systems. Consequently, vehicle manufacturers have to reconcile toxic emissions criteria including carbon monoxide (CO), hydrocarbons (HC) and nitrous oxide (NO_x). Recently, concerns have included the issue of (non-toxic) carbon dioxide (CO₂) emissions [3].

Assessment of automobiles' environmental performances is a multidisciplinary challenge that requires participation of experts from different fields (technical, economic and social) in order of assessment criteria grading as well as of evaluating different alternatives due to criteria. This is why the multi-criteria assessment (MCA) can be of help in achievement of the appointed goal [10]. The following section provides a short review of specific approaches in assessment of passenger vehicles' environmental performances by MCA.

Yousefi and Hadi-Vencheh [20] applied two MCA methods to evaluate improvement fields of Iran automobile manufacturing industry. Customers' criteria based on the research literature, experts, mechanics, sellers and customers' ideas were selected. Features which characterized main criteria were: technical features (engine specification, safety, speed, comfortableness and relaxation), aesthetic (internal design, external design,

colour and variety), manufacturer (manufacturer country, manufacturer company, brand), tools availability (availability of spare parts, availability of consumption tools), economical aspects (automobile price, fuel consumption, payment flexibility), social aspects (advertisement, society atmosphere, owners' satisfaction). The obtained results were compared and combined.

Bouwman and Moll [5] compared various Dutch passenger transportation systems by studying their complete life-cycle energy use. They used MCA to compare transportation systems according to their use of space, costs and travel time.

Each alternative scheme for treating a vehicle at its end of life has its own consequences from a social, environmental, economic and technical point of view. Disassembly, reuse, and recycling are a common way of treatment for waste electronic equipment [12], devices, and machines such as passenger vehicle at end of life. A specific MCA approach based on Preference Ranking Organization Method for Enrichment and Evaluations (PROMETHEE) method was proposed in [8] for selection of best compromise alternative scheme for treating vehicle at its end of life. PROMETHEE based preference ranking was also used in non-country specific study [3] where small set of motor vehicles was ranked based on constituents of their exhaust emissions. The alternative ranking analyses also considered different levels of importance associated with the four criteria (emissions) considered, namely, CO₂, CO, HC and NO_x.

In [11], a multi-criteria assessment model was developed to rank different road transportation fuel-based vehicles (both renewable and non-renewable) using a PROMETHEE method. Vehicles based on gasoline, gasoline-electric (hybrid), E85 ethanol, diesel, B100 biodiesel, and compressed natural gas (CNG) were considered as alternatives. These alternatives were ranked based on five criteria: vehicle cost, fuel cost, distance between refuelling stations, number of vehicle options available to the consumer, and greenhouse gas (GHG) emissions per unit distance travelled.

