Formulation of noise isolation index for evaluating the interior acoustics level in vehicle cabin

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Abstract
This article proposes noise isolation index to assess the acoustical comfort level in the interior vehicle cabin. The noise isolation index is developed, validated, and compared for three local compact cars, namely, Axia, Myvi, and Viva which are most widely used vehicles in Malaysia and have not been yet studied. Toward this end, the interior and exterior sound signals are recorded on both stationary and non-stationary (highway, pavement, and urban) conditions and the trends of sound quality loudness (sone) and sharpness (acum) with respect to sound pressure level (Pa) are observed. The findings of this study indicate that the noise isolation index results are literally influenced by factors including type of road surface, engine transmissions, and vehicle design characteristics. The proposed index can be successfully extended by automotive researchers to assess the interior vehicle noise and can be significant factor in vehicle manufacturing process.

Keywords
Noise isolation index, acoustics, sound quality metrics, riding comfort, sound pressure level, experimental design

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Introduction
Acoustical comfort has recently become an essential factor that is considered by customers when purchasing a new car.¹,² Improving comfort level in vehicles plays a significant role in attracting customers to purchase a vehicle that meets their expectations and demands. Nowadays, with advancements in technology and improved socioeconomic conditions, the expectations of customers for a lighter and comfortable vehicle have increased, leading to stiffer competition among automotive manufacturers to improve the level of comfort in the interior vehicle cabin. Consequently, as automotive products become more competitive, substantial efforts and vigorous investments are constantly undertaken to develop methods to enable car manufacturers to adequately their products to the customers' demands.³,⁴ The acoustical comfort in the vehicle interior cabin is obviously influenced by a variety of factors such as airborne noise, structure-borne noise, engine, tire–road interactions, and interior space vibrating parts.⁵–⁷ In this regard, over the past decades, multiple studies have been done purposely to investigate and evaluate the level of comfort inside the car cabin and to estimate the effects of exposed noise vibration on the driver health and concentration.⁸–¹¹

Studying the acoustical comfort in vehicles is essential task in front of acoustics engineers when designing

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