An Economical GPS-Based Driving Cycle for 3-Wheelers: Establishing a Framework for Emission Studies

Sankha Jayawardhana[1,], Kushan Aponsu[1], Sajana Gamage[1] and Loshaka Perera[1]*

Abstract

The research presents a detailed approach to developing a driving cycle tailored for 3-wheelers in Sri Lanka, addressing the need for accurate emission estimation in the context of increasing vehicle populations with a significant proportion of 3-wheelers, and environmental concerns. Previous studies have highlighted the critical role of driving cycles in estimating emissions, particularly in urban environments where traffic patterns are complex and variable. It identifies two primary approaches to emissions modelling: fuel-based and travel-based models. While fuel-based models rely on fuel consumption data, travel-based models, including driving cycles, utilize real-world driving behaviour data to provide a more accurate representation of emissions. The review identifies a notable gap in the development of driving cycles for 3-wheelers in Sri Lanka, despite their prevalence in the transport sector. Therefore it is clear that a dedicated driving cycle is required, leading to enhanced emission inventory estimations through localized emission factors, and informed policy decisions aimed at reducing air pollution.

The study utilizes a micro-trip-based construction method to develop the driving cycle, which is particularly effective for capturing the stop-and-go nature of urban driving. The research involved a representative route selection, focusing on urban and suburban areas in Colombo and Matara, where 3-wheelers are commonly used. The selected routes were designed to reflect typical driving conditions, incorporating a mix of road types and traffic volumes. This careful selection process is crucial, as it ensures that the driving cycle accurately represents the diverse traffic behaviours in real-world scenarios. Data collection was conducted using an onboard GPS device, which recorded driving behaviour with high precision. This method was chosen over the chase car approach due to the unpredictable nature of driver behaviour in Sri Lanka, which can lead to incomplete data in congested traffic. The study gathered over a million data points from five drivers operating Bajaj 4-stroke petrol 3-wheelers, focusing on peak traffic hours to capture the most representative driving patterns. The data was then filtered and pre-processed using Python scripts to eliminate anomalies, ensuring the integrity of the dataset. The construction of the driving cycle involved categorizing driving data into micro-trips, which are segments of driving between stops. This approach allows for a detailed analysis of driving behaviour, capturing variations in speed, acceleration, and deceleration. The study utilized a systematic method to balance the representation of different driving conditions by binning micro-trips based on their average speeds. This technique ensured that the final driving cycle accurately reflected the average driving behaviour of 3-wheelers in the selected regions.

The results of the study revealed an average speed of 15.12 km/h, with significant time spent in acceleration (40.58%), deceleration (33.84%), and cruising or idling (25.58%). These findings highlight the frequent stop-and-go conditions of urban traffic, validating the effectiveness of the micro-trip-based method for driving cycle development. The adaptability of the developed

https://doi.org/10.31705/ ICAHETS.2024.1

driving cycle methodology across South Asia is emphasized, providing a framework that can be tailored to local conditions in other countries where 3-wheelers are prevalent.

In conclusion, this research not only fills a critical gap in the existing literature regarding driving cycles for 3-wheelers but also offers a methodology for emission estimation that can inform policy decisions aimed at improving air quality and public health in Sri Lanka and beyond. The study's findings advocate for the testing of the developed driving cycle on a chassis dynamometer to obtain precise emission data alongside emission factors, ultimately contributing to more sustainable urban transport solutions.

Keywords: *driving cycle, three wheelers, emission estimation*

Author details;

1. University of Moratuwa, Katubedda, Moratuwa 10400, Sri Lanka. jayawardhanass.24@uom.lk

2. University of Moratuwa, Katubedda, Moratuwa 10400, Sri Lanka. kushandil97@gmail.com

3. University of Moratuwa, Katubedda, Moratuwa 10400, Sri Lanka. sajanapeshitha@gmail.com

4. University of Moratuwa, Katubedda, Moratuwa 10400, Sri Lanka. loshakap@uom.lk