DEVELOPMENT OF DRIVING CYCLES AND A MATHEMATICAL MODEL FOR FUEL ECONOMY CHARACTERIZATION OF LIGHT DUTY VEHICLES IN SRI LANKA

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DECLARATION

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ABSTRACT

Estimating the fuel consumption of vehicles under varying driving patterns is challenging and lacks a clear theoretical base. The study aims to provide a scientific basis for a better understanding of driving patterns and their influence on the fuel economy performance of in-use light duty vehicles in Sri Lanka. The study encompasses two specific objectives: the development of driving cycles to represent the local driving conditions of selected vehicle types and the development of a mathematical model capable of estimating fuel economy values of different light duty vehicle types under varying driving patterns. The methodology adopted during the study comprises the theoretical development of two local driving cycles: one specifying both 2W and 3W and the other specifying the characteristics of 4W and the development of a mathematical model that can estimate fuel economy values under varying driving conditions. The main findings of the study portray the characteristics of the two driving cycles developed for the Colombo Metropolitan Area: one cycle spans a period of 1499s which is developed to mimic the driving behavior of 4W whereas the other cycle spans a period of 1215s which is dedicated for 2W and 3W. When developing the said two cycles, data has been acquired from 19 major routes comprising 72 route links within the Colombo Metropolitan region. The micro-trip-based method is opted when developing driving cycles. Krigging spatial interpolation has been utilized as the classification technique for micro-trip generation. The mathematical model developed for the fuel economy characterization is undergone two-way validation, i.e., simulation-based validation and the validation based on manufacturer's data. When validated, the estimation accuracy of the model gets converged to a band between 89.61% to 92.78%. Conclusively, it can be stated that the developed and validated theoretical model can be utilized as a tool to estimate the fuel consumption of different vehicle types under varying driving conditions. Furthermore, it is recommended to refer to the local driving cycles developed to mimic the local driving behavior when using the theoretical model for localized fuel consumption estimations.

DEDICATION

To my beloved parents, Dr. Damayantha Gajanayake and Dr. (Mrs.) Geethani Gajanayake and to my beloved brother, Dr. Sarith Gajanayake.

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Abbreviations	**Definition**
2W	Two-wheelers
3W	Three-wheelers
4W	Four-wheelers
AADT	Average Annual Daily Traffic
A/C	Air Conditioning
ADR	Australian Design Rules
ADT	Annual Daily Traffic
ADVISOR	ADvanced VehIcle SimulatOR
AFR	Air-Fuel Ratio
AMT	Automated Manual Transmission
AP	Afternoon Peak
API	Application Programming Interface
ARTEMIS	Assessment and Reliability of Transport Emission Models and Inventory Systems
ASHRAE	American Society of Heating Refrigerating and Air-conditioning Engineers
AT	Automatic Transmission
BEV	Battery Electric Vehicle
BS	Bharat Standards
BSFC	Brake Specific Fuel Consumption
CADC	Common Artemis Driving Cycle
CAI	Controlled Autoignition
CC	Cylinder Capacity
CDA	Cylinder Deactivation
CDC	Colombo Driving Cycle
CI	Compression-Ignition
CMA	Colombo Metropolitan Area
CMDC	Colombo Metropolitan Driving Cycle

CP	Characteristic Parameter
CR	Compression Ratio
CSI	Cumulative Similarity Index
CUEDC	Composite Urban Emission Driving Cycle
CVT	Continuously Variable Transmission
DC	Driving Cycle
DSD	Divisional Secretariat Division
EOP	Evening Off Peak
EP	Evening Peak
EPA	Environmental Protection Agency
EPAS	Electronic Power Assisted Steering
EU	European Union
EV	Electric Vehicles
FC	Fuel Consumption
FT	Fixed Transmission
FTP	Federal Test Procedure
FWD	Front Wheel Drive
GFEI	Global Fuel Economy Initiative
GHG	Green House Gas
GIS	Geographic Information Software
GPS	Global Positioning System
GVWR	Gross Vehicle Weight Rating
HEV	Hybrid Electric Vehicle
HPAS	Hydraulic Power Assisted Steering
HWFET	High Way Fuel Economy Test
IC	Internal Combustion
ICE	Internal Combustion Engine
IEA	International Energy Agency
IMDC	Indian Motorcycle Driving Cycle
IMMA	International Motorcycle Manufacturers' Association
ISFC	Indicative Specific Fuel Consumption

ISO	International Standardization Organization
JP	Japanese Driving Cycle
LA01	Los Angeles 01 driving cycle
LA92	Los Angeles 92 driving cycle
LDV	Light Duty Vehicle
LoS	Level of Service
METI	Ministry of Economics, Trade and Industry
MOP	Morning Off Peak
MT	Manual Transmission
NEDC	New European Driving Cycle
NREL	National Renewable Energy Laboratory
OBD	On Board Diagnostic
PKE	Positive Kinetic Energy
PV	Performance Value
RH	Relative Humidity
RMS	Root Mean Square
RPM	Revolutions Per Minute
RWD	Rear Wheel Drive
SAE	Society of Automobile Engineers
SAFD	Speed Acceleration Frequency Distribution
SAPD	Speed Acceleration Probability Distribution
SC03	Supplemental Federal Test Procedure with A/C system turned on.
SDG	Sustainable Development Goals
SFC	Specific Fuel Consumption
SFTP	Supplemental Federal Test Procedure
SI	Spark Ignition
SL	Sri Lanka
SSD	Sum Square Difference
TPES	Total Primary Energy Supply
UNEP	United Nations Environmental Program
US	United States

US06	The United States Supplemental Federal Test Procedure
USCAFE	The United States Corporate Average Fuel Economy
USFTP	The United States Federal Test Procedure
WLTC	World Harmonized Light Vehicle Test Cycle
WLTP	World Harmonized Light Vehicle Test Procedure
WMTC	World Motorcycle Test Cycle