VEHICULAR EMISSION TRAJECTORIES IN SRI LANKA: A SCENARIO-BASED ANALYSIS

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Master of Science Dissertation

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Supervised by: Dr. Varuna Adikariwattage and Dr. Thusitha Sugathapala

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

Shasthri Sankha Jayawardhana Date:15.10.2025

The above candidate has carried out research for the Masters dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Dr. Varuna Adikariwattage Date: 16/10/2025

Dr. Thusitha Sugathapala Date: 24/10/2025

DEDICATION

To my supervisors, Dr. Varuna Adikariwattage and Dr. Thusitha Sugathapala, your collective expertise in transportation, emissions, and most importantly, in the discipline of research, has guided me not just through this thesis but also in shaping the way I approach inquiry and evidence.

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To my parents and my brother, whose faith in me never faltered, and to Sachinthi, for her unwavering love and support through every high and low. I dedicate this thesis to you.

ABSTRACT

This study presents a novel, data-driven framework for estimating and forecasting vehicular emissions in Sri Lanka, addressing a critical gap in disaggregated emissions modelling on a national scale. While current estimations rely on a top-down methodology, this research introduces a bottom-up approach utilising vehicle-level data from the national Vehicle Emissions Test (VET) programme, spanning 2016–2024. The study focuses on internal combustion engine (ICE) passenger cars, and processes raw VET data through cleaning, mileage estimation, and integration of vehicle technology/category classifications and emission factors as per EMEP/EEA Tier 02 guidelines. A Long Short-Term Memory (LSTM) neural network is developed to forecast average annual mileage using time-series data, including fleet composition, economic indicators, and disruption events. The model achieved a MAE of 121.81 km and an R-squared value of 0.85 during validation, showing strong predictive accuracy and a good fit. The trained model is used to predict two scenarios, with Scenario 01 being the continuation of the national vehicle import ban and Scenario 02 being the lifting of the ban, allowing for modernisation with Euro 6-compliant vehicles. Using the predicted annual spanning mileage, annual spanning emissions of CO, NMVOC, NO_x, N_2O, NH_3, and PM are estimated by multiplying by matched emission factors. Results indicate a divergence with Scenario 02 having higher total annual spanning emissions with an increase of 1.34% (CO), 3.68% (NMVOC), 1.62% (NO_x), 10.5% (N_2O), 6.33% (NH_3) and 6.92% (PM), at the end of the prediction horizon, reflecting the impact of increased vehicle activity despite cleaner technologies. This study demonstrates the potential of regulatory datasets for predictive modelling in low-resource environments and supports evidence-based air quality policy planning through a scalable methodology.

Keywords: Vehicular Emissions, Emission Factors, LSTM Prediction, Scenario Analysis

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LIST OF ABBREVIATIONS

ANN	Artificial Neural Network
ARIMA	Autoregressive Integrated Moving Average
BPTT	Backpropagation Through Time
CEC	Constant Error Carousel
CO	Carbon Monoxide
COPERT	Computer Programme to Calculate Emissions for Road Transport
CO_2	Carbon Dioxide
DMT	Department of Motor Traffic
EMFAC	Emission Factors (Model)
EF	Emission Factor
EMEP/EEA	European Monitoring and Evaluation Program/ European Environment Agency
FFNN	Feed Forward Neural Network
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GRU	Gated Recurrent Unit
ICAP	Indian Clean Air Programme
ICE	Internal Combustion Engine
IPCC	Intergovernmental Panel on Climate Change
LSTM	Long Short-Term Memory
MAE	Mean Absolute Error
MRV	Monitoring, Reporting and Verification
MSE	Mean Square Error
N_2O	Nitrous Oxide
NH_3	Ammonia
NMVOC	Non-Methane Volatile Organic Compounds
NO_x	Nitrogen Oxides
PEMS	Portable Emission Measurement System
PM	Particulate Matter
RNN	Recurrent Neural Network
RTRL	Real-Time Recurrent Learning
SVR	Support Vector Regression
UNFCCC	United Nations Framework Convention on Climate Change
VET	Vehicle Emissions Test
VKT	Vehicle Kilometres Traveled
VSP	Vehicle-Specific Power
WLTC	World Harmonised Light Duty Vehicle Test Cycle
YOM	Year of Manufacture