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

S. S. JAYAWARDHANA

248013V

Master of Science Dissertation



Department of Civil Engineering  
Faculty of Engineering

University of Moratuwa  
Sri Lanka

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

**Shasthri Sankha Jayawardhana**

248013V

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Department of Civil Engineering, University of Moratuwa  
in partial fulfilment of the requirements for the degree of Master of Science

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

Department of Civil Engineering  
Faculty of Engineering

University of Moratuwa  
Sri Lanka

October 2025

## **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.

To Prof. Saman Bandara and Dr. Loshaka Perera, for believing in my potential and selecting me as a Research Assistant for this impactful project under the Vehicle Emissions Test Trust Fund.

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To my parents and my brother, whose faith in me never faltered, and to Sachintha, 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<sub>x</sub>, N<sub>2</sub>O, NH<sub>3</sub>, 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<sub>x</sub>), 10.5% (N<sub>2</sub>O), 6.33% (NH<sub>3</sub>) 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 <sub>2</sub>  | Carbon Dioxide                                                             |
| DMT              | Department of Motor Traffic                                                |
| EMFAC            | Emission Factors (Model)                                                   |
| EF               | Emission Factor                                                            |
| EMEP/EEA         | European Monitoring and Evaluation Program/<br>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 <sub>2</sub> O | Nitrous Oxide                                                              |
| NH <sub>3</sub>  | Ammonia                                                                    |
| NMVOC            | Non-Methane Volatile Organic Compounds                                     |
| NO <sub>x</sub>  | 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                                                        |