

Integration of Vehicle Operating Cost and Emissions Models

Research Presentation

October 2024 – NZ Transport Agency
Waka Kotahi
Sector Research Programme

 NZ TRANSPORT
AGENCY
WAKA KOTAHI

 NTRO NATIONAL
TRANSPORT
RESEARCH
ORGANISATION

A note to the audience

This presentation is based on Research Report 730 *Integration of vehicle operating cost and emission models (September 2024)*.

While NZ Transport Agency Waka Kotahi (NZTA) provided investment, the research was undertaken independently, and the resulting findings should not be regarded as being the opinion, responsibility or policy of NZTA or indeed of any NZ Government agency.

NZTA is established under the Land Transport Management Act 2003. The objective of NZTA is to undertake its functions in a way that contributes to an efficient, effective and safe land transport system in the public interest. NZTA funds innovative and relevant research that contributes to this objective.

People using this research should apply and rely on their own skill and judgement and, if necessary, they should seek appropriate legal or other expertise regarding its use.

Sector Research Programme Overview

- NZTA works with the sector to identify and address gaps in the sector's knowledge and understanding of the development, management and operation of the land transport system.
- We work alongside subject matter experts to:
 - develop a programme of research projects to address knowledge gaps, in consultation with the wider sector (including MoT and Local Government)
 - procure research providers to undertake and deliver the work,
 - provide project oversight and guidance, and
 - publish, promote and support the implementation of the resulting research outputs

Integration of Vehicle Operating Cost and Emission Models

Review of the NZVOC model and the VEPM

Introduction

Research Overview

Findings & Recommendations

Introduction

Background

Purpose

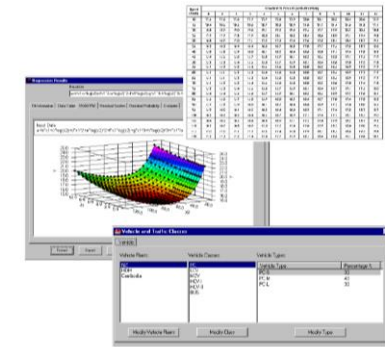
Background

Two models, with strengths & weaknesses

- New Zealand Vehicle Operating Cost (NZVOC) model estimates operating costing, including fuel use, for transport cost benefit analyses.
- Vehicle Emission Prediction Model (VEPM) uses a comprehensive fleet model to predict vehicle emissions.
- NZTA Waka Kotahi identified that there appears to be opportunities to combine aspects (inputs, outputs) of NZVOC and VEPM building on the strength of each and address their current limitations.

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Transfund

Using the NZVOC Model
To Prepare PEM Vehicle
Operating Costs

February 2003

Vehicle Emissions Prediction
Model:
VEPM 7.0 technical report

Jayne Metcalfe and Serge Peeters

Purpose

- Understand the opportunity to link, integrate or better align two separate models used in New Zealand for estimating vehicle operating costs and predicting vehicle emissions
- The project's key outcome is a recommendation for feasible changes to better integrate the inputs, outputs and updates of VOC and emissions models

Research overview

Research Team

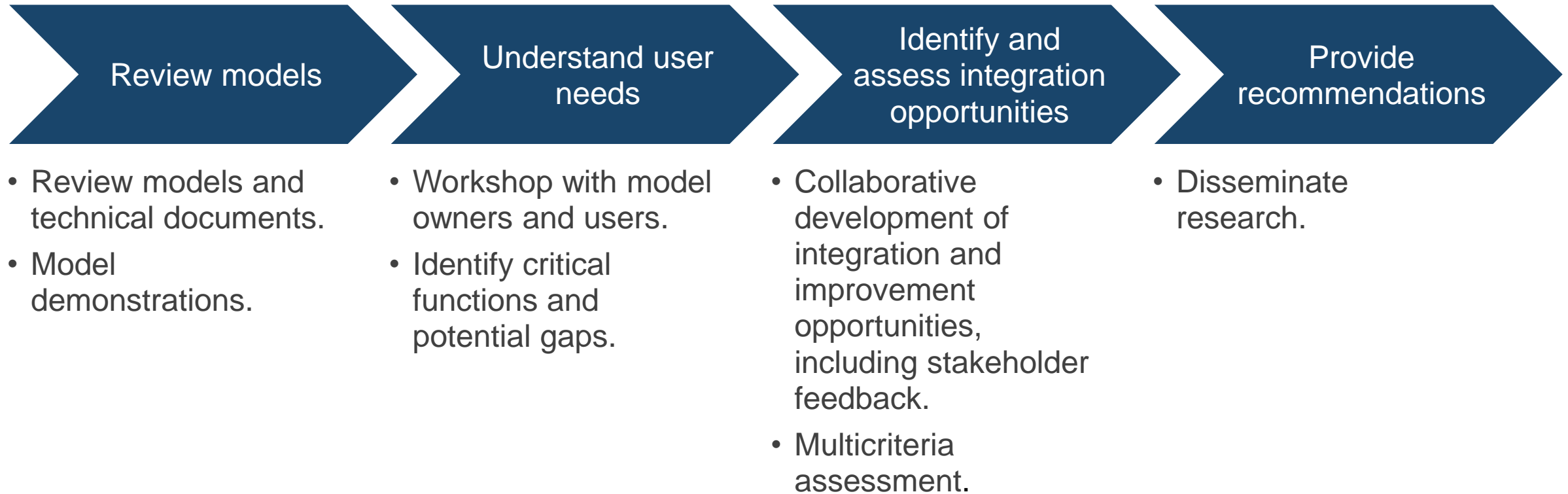
Method

Research Outputs

Project Team

- NZ Transport Agency Research Leaders
 - Sandy Fong & Sharon Atkins
- NTRO Researchers
 - Brook Hall, Tyrone Toole, Daniel Ainalis, Robert Kochhan, Jeremy van Dijk, Ian Greenwood (sub-consultant)
- Peer Reviewers
 - Chris Bennett, Robin Smit
- Project Steering Group
 - Representatives from NZTA, MoT, DTP Victoria

Method



Research Outputs

- A research report, inclusive of research approach, stakeholder engagement outcomes, analysis and recommendations.
- A detailed scope for model integration or updates for a potential implementation project in the future, included in Appendix A
- A 2-page summary
- A recorded presentation to share the research findings



Integration of vehicle operating cost and emission models

Review of the NZVOC model and the VEPM

September 2024

Brook Hall, National Transport Research Organisation, Melbourne, Australia
Daniel Ainalis, National Transport Research Organisation, Melbourne, Australia
Robert Kochhan, National Transport Research Organisation, Melbourne, Australia
Tyrone Toole, National Transport Research Organisation, Melbourne, Australia
Jeremy van Dijk, National Transport Research Organisation, Melbourne, Australia
Ian Greenwood, Greenwood Associates Infrastructure Consultants, Auckland, New Zealand

NZ Transport Agency Waka Kotahi research report 730
Contracted research organisation – National Transport Research Organisation

Findings & Recommendations

NZVOC model and the VEPM Overviews

Comparisons

Proposed Opportunities

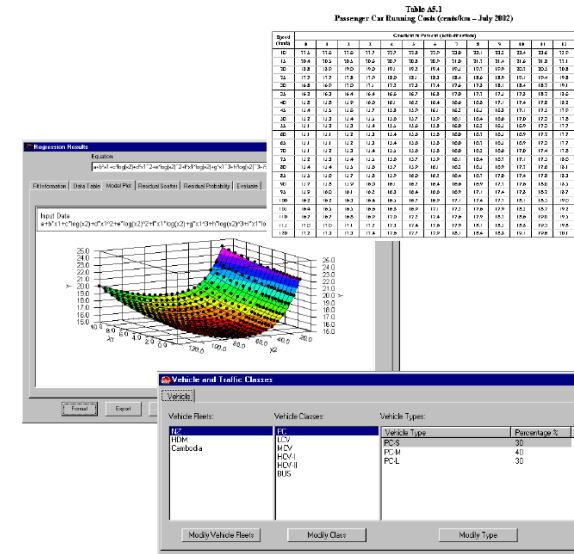
Recommendations

NZVOC

Predicts VOCs (including fuel use) for economic evaluations of transport-related projects

- Based on the World Bank's HDM-4 model, calibrated to NZ conditions
- Developed in 1980s. Last update 2015.
- Mechanistic model that predicts energy required to overcome physical forces (e.g. speed, gradient, roughness & congestion effects)
- Not widely available and is run infrequently to update regression models and data tables that are published in the MCBM

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VEPM

An average speed model that predicts fleet-weighted vehicle emissions under typical conditions

- Released in 2008. In Sep 2023, VEPM 7.0 transferred the model to an online web-based platform.
- GHG, air pollutant, and brake and tyre wear emission rates are available for various speeds, gradients and traffic compositions, and vehicle load, etc.
- Uses VFEM fleet data and forecasts to 2050
- VEPM is best suited to large-scale (national/regional) and generalised analyses but is often used on road project assessments

Vehicle Emissions Prediction Model: VEPM 7.0 technical report

Jayne Metcalfe and Serge Peeters

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emission:
impossible

Comparisons

Similar, but different

- Similar elements, but different structure, interface, inputs, assumptions, calculation methods, outputs & preferred use-cases.
- VEPM is well developed, regularly updated and understood. Meets specific and broad needs. Widely used.
- NZVOC has a particular use (i.e. updating MCBM regressions and parameter values). It is a specialists' model, but its outputs are widely applied.
- Developing a single, hybrid model to replace both is not feasible, nor desirable.

NZVOC

NZVOC fleet data

NZVOC

- Vehicle data
 - (Base) fuel consumption
- Road condition data
 - Roughness
 - Deflection
 - Texture
 - Gradient
- Traffic data
 - Congestion
 - Average speed
- Trip data
 - Average trip length
 - HV load
 - Cold starts
 - Degradation
- Environmental data
 - Ambient temperature
 - Emission factors (adapted from COPERT)

VEPM

Vehicle Fleet Emissions Model (VFEM)

VEPM fleet data

- Fleet composition
- VKT

VEPM

Emissions data

- Exhaust GHGs
- Exhaust harmful air pollutants
- Brake & tyre wear

Deighton Total Infrastructure Management System (dTIMS)

National Land Transport Programme (NLTP)

Monetised Benefits and Costs Manual (MBCM) Tables, charts & formulae

MBCM worksheets

Projects level (cost) analysis

Traffic Model Emissions Tool

Project Emissions Estimation Tool (PEET)

Vehicle Emission Mapping Tool (VEMT)

Health and Air Pollution in New Zealand (HAPiNZ)

National Emission Reporting

Simplified regression model of VEPM

Works based emissions

Alignment Opportunities

- Vehicle fleet data
- Speed/congestion input and effects
- Road gradient
- Model choice & usage

Improvement Opportunities

NZVOC

- More frequent updates and output publication
- Include LZEVs in vehicle fleet data
- Publication of resource consumption factors, incl. fuel use as interim VOC outputs

VEPM

- Improve emission estimates for free-flowing traffic in low-speed zones

Proposed Opportunities

Nine potential opportunities to improve and better align models

1. Using consistent vehicle classes and fleet proportions
2. Enabling the NZVOC model to recognise low and zero emission vehicles
3. Enabling the NZVOC model (or its outputs) to reflect changing vehicle fleets over time
4. Aligning the NZVOC model's emission outputs with the VEPM's emission outputs
5. Aligning speed drive cycles with average speed profiles
6. Enabling the VEPM to better reflect road condition and configuration effects
7. Developing use-case guidance and worked examples
8. Improving data collection and calculation transparency, and describing limitations
9. Improving the usability of the NZVOC model

Opportunity Assessment

Priorities for implementation

- Highest: Development opportunities (1 to 4)
 - High: Guidance opportunities (7 & 8)
 - Medium: Further research opportunities (5 and 6)
 - Low: Uncertain benefit opportunity (9)
-
- A research specification was developed for the Development and Guidance packages

Recommendations

Highest priorities for implementation

Development package

1. Using consistent vehicle classes and fleet proportions
2. Enabling the NZVOC model to recognise low and zero emission vehicles
3. Enabling the NZVOC model (or its outputs) to reflect changing vehicle fleets over time
4. Aligning the NZVOC model's emission outputs with the VEPM's emission outputs

Recommendations

High priorities for implementation

Guidance package

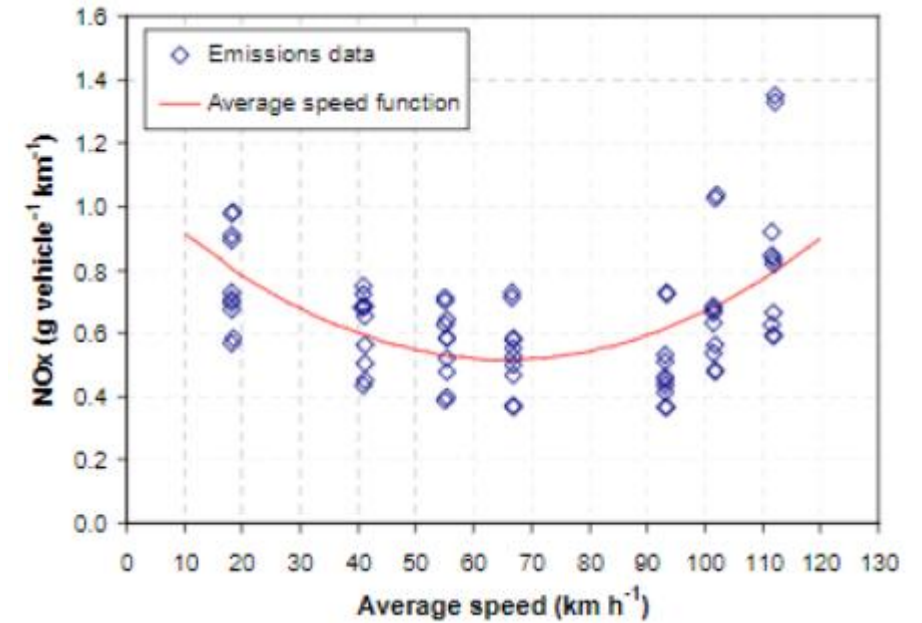
7. Developing use-case guidance and worked examples
8. Improving data collection and calculation transparency and describing limitations

Recommendations

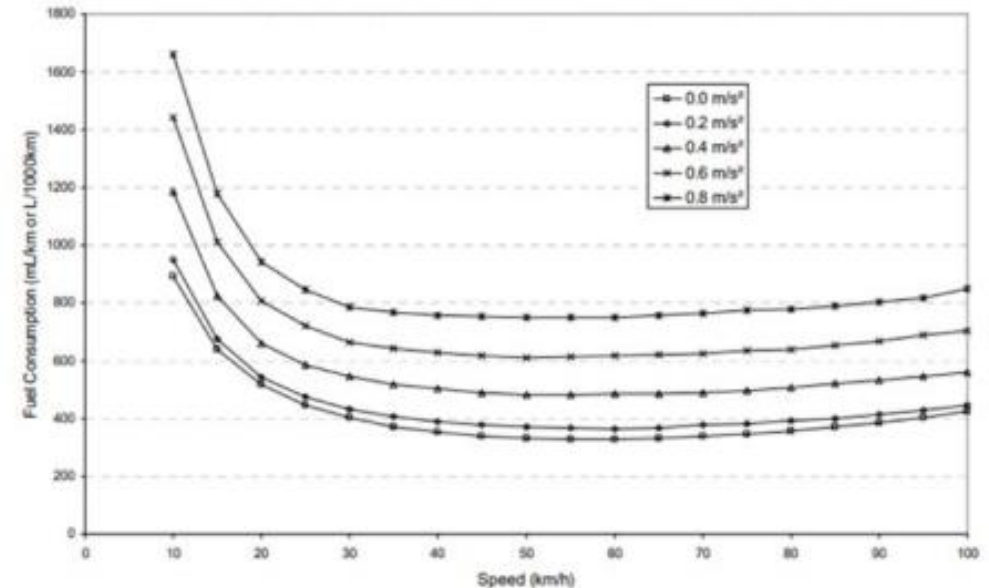
Medium priorities for implementation

Further research needed

5. Aligning speed drive cycles with average speed profiles to better distinguish between free and interrupted flow across different (average) speeds
6. Enabling the VEPM to better reflect road condition and configuration effects



Source: VEPM study (2023)



Source: ATAP study (2024)

Recommendations

Low priority for implementation

Further consideration needed

9. Improving the usability of the NZVOC model

For further information

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<https://www.nzta.govt.nz/planning-and-investment/learning-and-resources/research-programme/>

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<https://www.ntro.org.au/>

Full research report and 2-page summary:

<https://www.nzta.govt.nz/resources/research/reports/730/>

NZTA Response

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NZVOC

VEPM

