



# ANNUAL REPORT 2024

## Planning and Transport Research Centre

May 2025

FINAL





## **ANNUAL REPORT 2024**

Planning and Transport Research Centre

### **Prepared by**

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### **Version control**

FINAL

### **About PATREC**

The Planning and Transport Research Centre (PATREC) is a collaboration between the Government of Western Australia and local universities, constituted to conduct collaborative, applied research and teaching in support of policy in the connected spaces of transport and land use planning. The collaborating parties are: The University of Western Australia, Curtin University, Department of Transport, Main Roads Western Australia, Western Australian Planning Commission and the Western Australian Local Government Association.

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## KEY ACHIEVEMENTS IN 2024

**Stakeholder satisfaction** indicator of **93%** achieved

### 4 core projects completed with high impact

- Planning for a sustainable last kilometre freight delivery system for the food and beverage sector
- Transport environment and kids... 15 years on
- Realtime model to estimate delay at traffic signals
- Machine learning models for road maintenance investment decision making

### 4 climate action projects completed

- Feasibility of battery-electric buses for regional school bus services Stage 1
- Accounting for carbon in the planning for new residential suburbs Stage 1
- Mapping the circular economy of WA: monitoring the contributions of circularity towards achieving Net Zero Stage 1
- Biofuels - evaluation of Hydrotreated Vegetable Oil (HVO) renewable diesel trial pilot Stage 1

### 4 external projects completed

- AI-assisted model calibration for real-time traffic simulation
- Improved roundabout modelling using drone video analytics including Stage 1
- Developing a low-powered edge camera system for pedestrian and cyclist surveys
- Optimising video analytics for traffic data collection and calibration incorporating fixed camera videos

### 3 core projects commenced

- Assessing the efficacy of video analytics for comprehensive active transport monitoring
- Roundabout safety review
- Automated intersection parameter measurement using aerial photography and computer vision – pilot

### 5 core projects substantially progressed

- Impacts of e-rideables on the transport task
- Micromobility and freight – exploring opportunities
- Transport mode choice development using PATHS data
- Evaluation of road safety treatments
- Feasibility of battery-electric buses for regional school bus services Stage 2

**PATREC Director appointed Chair of the AURIN Scientific Advisory Committee for 3 years**

### 2 external projects substantially progressed

- Potential for carbon capture and reduced GHG emissions through innovative asphalt pavement design – use of bio char waste
- Freight route priority trial evaluation

### 3 external grant applications, successful

- ARC Linkage Infrastructure, Equipment and Facilities 2024: National Cycling Data and Analysis Platform
- ARC Industrial Transformation Training Centre for Automated Vehicles in Rural and Remote Regions

### New external project grant application submitted

- National Critical Research Infrastructure Strategy (NCRIS), AURIN WA Node to support climate action in transport and land use planning research (successful 2025)
- Safe paths – enhancing active transport infrastructure through video analytics and community reporting (successful 2025)
- RoadSense Analytics – AI-enabled traffic intelligence

**7 news articles published**, mostly in conjunction with iMOVE CRC and AURIN

**7 peer-reviewed journal articles published**, related to PATREC research

**11 presentations made at PATREC connection events and conferences**

**1 PhD graduated**, 1 commenced, 3 in progress

**Academic return on investment (ROI, 2021-25, project-only):** 3.2 (UWA: 3.7; Curtin: 2.6)

**Research income** (excl. core subscriptions): \$1,740,303

**9 impact statements** for completed projects returned, including (selected quotes):

- involved a wide range of stakeholders, contributing to the success of the project
- well managed ... with close communications with project team to ensure milestone deliverables
- delivers a high-quality solution...tool will fill a gap within Main Roads
- appreciate the efforts to clarify the report for a layman such as myself
- led to interest from several government agencies to be involved in use cases for the next stage of the research
- final report was ... of high standard, [with] clear interpretation, and contextualisation of findings... recommendations were targeted and well-grounded
- quality of outputs is actually quite good, considering difficulties and limitations in accessing third party data

# 1. PURPOSE

The primary purpose of this report is to provide an update of activities conducted in 2024 with a focus on outputs and outcomes achieved. After providing a summary of completed research projects, the report on progress achieved in relation to commencing and current projects core and external projects, highlighting the newly commenced climate action in transport and land use planning projects. Knowledge transfer activities are then reported focussing on research outputs, communication at connection opportunities and events, teaching and training and research impact. Operational aspects of staffing, resources and governance needed to undertake the research is covered next with the report culminating with a summary table of key performance indicators.

## 2. RESEARCH PROJECT ACTIVITY

### 2.1. Projects completed

A record eleven projects were completed in 2024.

Four **core** projects (traditional program) completed:

- Machine learning models for road maintenance investment decision making
- Planning for a Sustainable Last Kilometre Freight Delivery System for the Food and Beverage Sector in Greater Perth
- Transport Environment and Kids... 15 Years On
- Realtime model to estimate delay at traffic signals

Four foundation **climate action** projects completed:

- Feasibility of battery-electric buses for regional school bus services, Stage 1
- Mapping the Circular Economy of WA: Monitoring the contributions of circularity towards achieving Net Zero: Stage 1
- Accounting for carbon in the planning for new residential suburbs, Stage 1
- Biofuels - Evaluation of Hydrotreated Vegetable Oil (HVO) renewable diesel trial - independent evaluation of pilot project, Stage 1

Four **external** projects completed:

- AI-assisted Model Calibration for Real-time Traffic Simulation (Lead; Chao Sun; iMOVE, MRWA, Aimsun, UWA, \$400k)
- Improved Roundabout Modelling using Drone Video analytics including extension (Lead: Chao Sun; iMOVE, MRWA, UWA, Aimsun) (\$392k)
- Developing a low-powered edge camera system for pedestrian and cyclist surveys (Innovation Connection/Metrocount (Lead: Chao Sun) (\$100k)
- Optimising video analytics for traffic data collection and calibration incorporating fixed camera videos (Lead: Chao Sun; MRWA, iMOVE, UWA, \$200k)

Key findings of the completed projects are summarised next.

## Machine learning models for road maintenance investment decision making

PATREC Project (\$149,000; January 2022 – December 2024; Main Roads, UWA)

To developed, test and demonstrate two approaches to enhance road maintenance investment decision-making which currently relies on tacit knowledge of domain experts, creating risks of knowledge loss, lack of objective methods, and potentially suboptimal outcomes:

- Multi-objective optimisation
- Machine learning prediction of expert decisions

### Key findings:

Both approaches reduce the risk of knowledge loss, improving documentation of decision processes, and potentially identifying more optimal solutions.

- Multi-objective approach successfully identified optimal solutions corresponding to different possible trade-offs between cost and satisfaction
- Regional differences in maintenance needs and potential satisfaction improvements were clearly visualised
- Machine learning models achieved limited success in predicting expert decisions, highlighting data gaps

A combination of both approaches has the potential to significantly enhance the efficiency, transparency, and robustness of road maintenance investment decisions for Main Roads' extensive regional road network.

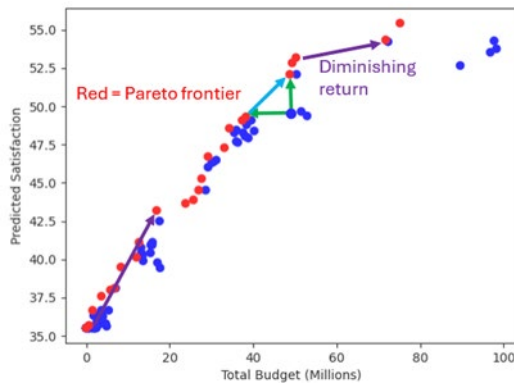


Figure 6: Regional trade-off dashboard demo.

## Planning for a sustainable last kilometre freight delivery system for the food and beverage sector in Greater Perth

*PATREC-iMOVE Core Project (\$88,000; Feb 2024 – Dec 2024; iMOVE, UWA, Main Roads, DPLH)*

- To determine the last kilometre freight challenges with a specific focus on the Food and Beverage (F&B) sector
- To identify opportunities to address the last kilometre freight challenges with a specific focus on the F&B sector
- To explore policy implications and alignments of the identified challenges and strategies to the existing relevant planning policies and make recommendations on future actions

Literature including academic studies and grey literature from around the world was reviewed to identify the last KM freight challenges and opportunities for the F&B sector, and more generally since there are likely to be commonalities across industries. The review explored how e-commerce, home delivery, new mobility modes, the built environment, and land use interact and create the current circumstance of the last KM freight system for the F&B sector. The review also explored the last KM solutions implemented in other states and countries.

Land-Use and Employment Survey (LUES) data and dwelling data were collected. The datasets were spatially analysed to identify geographical locations where the F&B last KM freight challenges are likely to exist in Greater Perth. Satellite and street view images of the identified locations were then reviewed to further narrow down the locations and the last KM challenges that exist.

Stakeholder consultations were undertaken to seek feedback from stakeholders on the findings and implications of the literature review and spatial analysis in the Perth context. They also revealed other issues that were not identified in the review and the analysis (e.g. practical issues).

The findings of the spatial analysis, the literature review and the consultations were combined to develop a composite picture of the last KM freight challenges and opportunities in Greater Perth. Policy implications and alignment with existing relevant planning policies (e.g. State Planning Policies and Planning Guidelines) of the identified challenges and opportunities were explored and recommendations were developed.

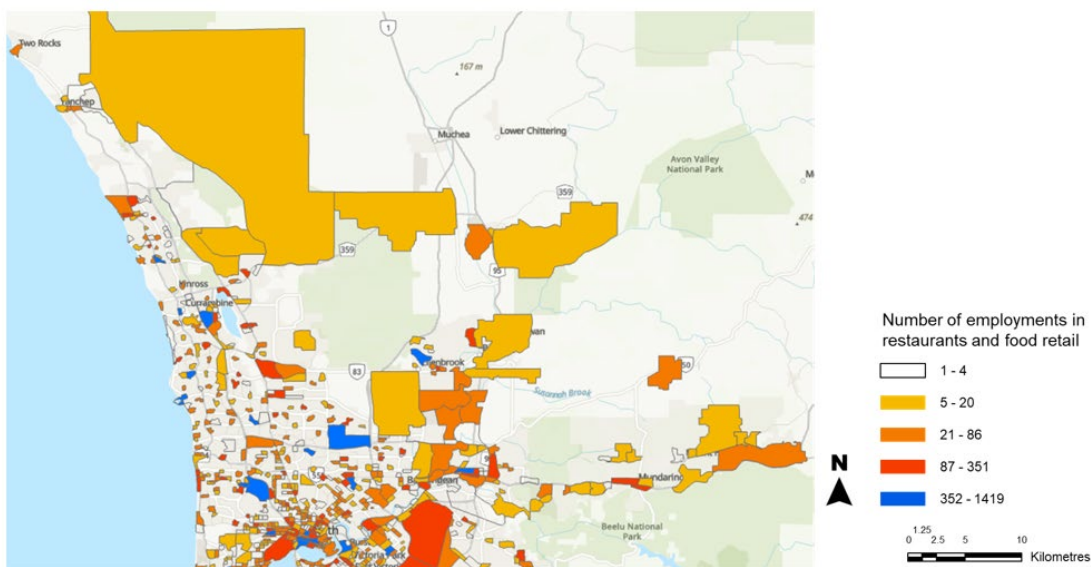


Figure 10 Number of employments in other F&B business types retail in Greater Perth – North (mesh block) (generated by authors based on the LUES data)

Recommendation were made in relation to: managing demand (managing travel demand due to F&B last KM freight), resolving modal/space conflicts (which mode should be prioritised where), managing challenges consistently across Perth, and encouraging collaboration among government agencies and the private sector.

### Transport environment and kids... 15 years on

*PATREC-iMOVE Core Project (\$100,000; Nov 2021 – July 2024; iMOVE, DoT, UWA)*

To create an evidence base to inform targeted interventions to increase active school transport (AST) in primary and secondary school students in Perth:

- Review current international evidence on AST interventions and their effectiveness
- Assess the walkability of the immediate environment surrounding schools
- Investigate prevalence, latent demand, barriers, enablers and attitudes and changes since a similar 2007 study results
- Determine what behavioural and infrastructure-based interventions are needed to increase AST

In 2007:

- primary school students predominantly travelled by car despite living close to school
- safety concerns were high among both students and parents, with fears of traffic and stranger danger
- while most parents believed their children could travel independently by foot or bike, actual willingness to let them do so was much lower, reflecting a gap between confidence and practice

By 2023:

- the patterns persisted, but with even higher car usage among primary school students
- safety concerns remained a major issue, now partly mitigated by the widespread use of mobile phones among students, enhancing perceived safety
- Secondary school data mirrored concerns about traffic and personal safety
- Parents' fears about their children's safety along the journey to school remained substantial across both time points and educational levels, influencing the demand for improved infrastructure such as safer crossings and dedicated paths

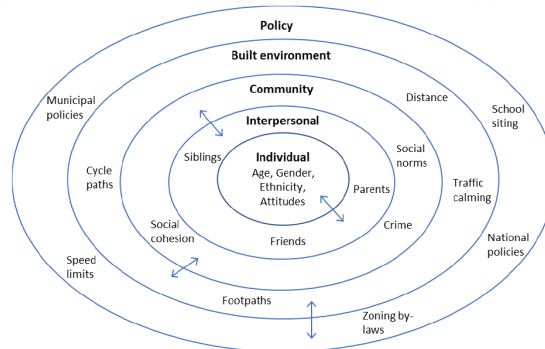
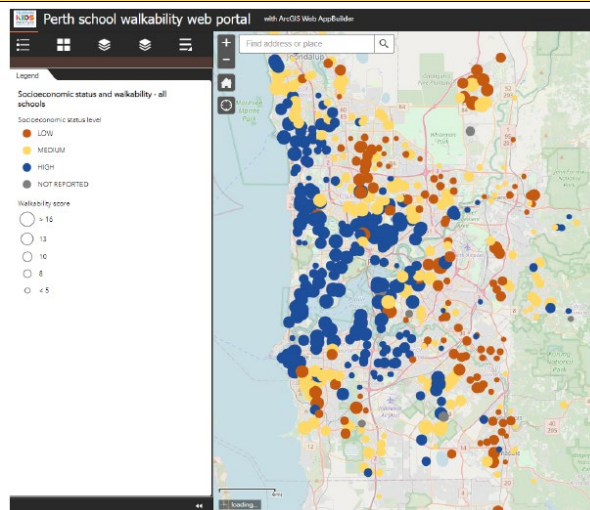


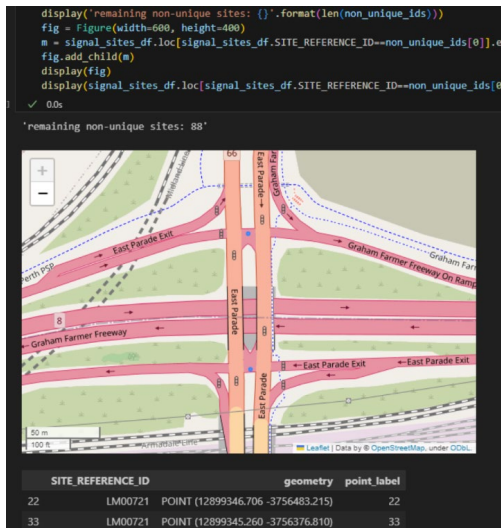
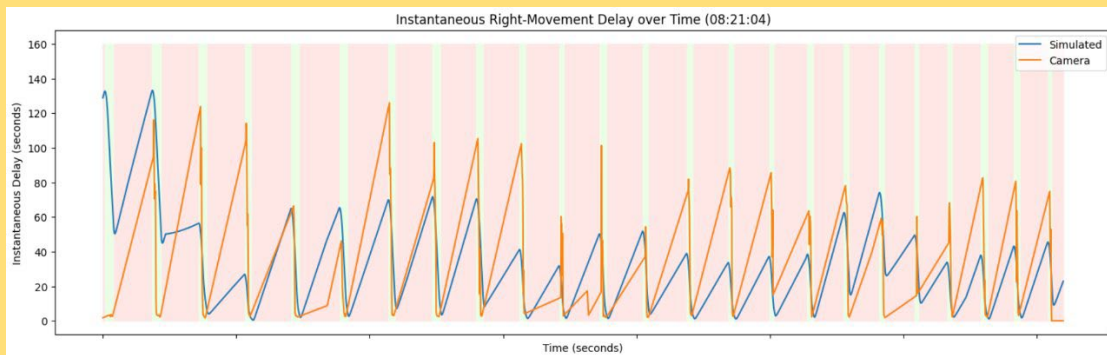
Figure 2. Ecological model showing factors influencing AST (36)

### Realtime model to estimate delay at traffic signals

*PATREC-iMOVE Core Project (\$106,000; Nov 2021 – July 2024; iMOVE, Main Roads, UWA)*

To develop a pilot model that utilises secondary datasets within Main Roads (e.g. signal timing data) to estimate overall delay at intersections in real-time, allowing Main Roads to measure the delay at a network, intersection, or approach level, while not requiring any additional expense in data licensing agreements:

- Determine the best analysis and modelling methods to use given available datasets.
- Use existing data to develop a mathematical or data-driven (including machine learning) model for an area of Perth employing agile development principles involving rapid prototyping and fast iteration to arrive at a pilot model from a range of preliminary models
- Validate the accuracy of the models using observed delay time data gathered from traffic surveys or Main Roads existing traffic cameras



A model based on queuing theory was developed to predict real time turning movement delays at signalised intersections. The model could not be sufficiently calibrated due to the lack of enough accurate and detailed data availability.

Instead, one of the tools developed as part of the data preparation process (for internal use), was further developed for direct use by Main Roads, as a sophisticated geospatial data extraction and transform tool.

### Climate action: Feasibility of battery-electric buses for regional school bus services in Western Australia

*PATREC-iMOVE Core Project (\$230,000; May 2023 – June 2024; iMOVE, DoT, PTA, UWA)*

To assess the technical feasibility of replacing diesel buses with electric buses on regional WA school bus routes:

- Availability and cost of electric buses that are suitable for regional school bus operations
- Minimum sizes and availability of appropriate electric school bus charging stations
- Electricity network’s capacity to supply the power needed for small and large depots
- Electric school bus charging load and how it impacts peak electricity demand and power quality
- Advantages of reductions in diesel use and greenhouse gas emissions

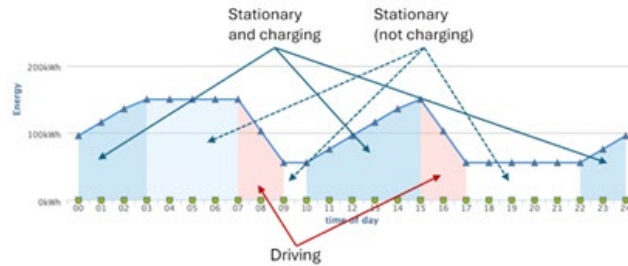


Figure 8-1 E-bus planning diagrams

It was found that there is no economic or technical barrier to transition to a 100% electric school bus fleet in WA:

- The introduction of electric school buses and corresponding charging stations is technically feasible, economically viable for all case studies investigated
- 73% of all 544 school bus depots (with 64% of all 935 school buses) can supply electricity sufficient to charge onsite without a grid upgrade
- For many of the sites with insufficient grid capacity, charging will be possible at the corresponding schools. Only a very small percentage of sites require either a grid upgrade or local generation
- E-bus emissions are expected to reduce to just 3,000 tons of CO<sub>2</sub> -e by 2030 (85% less than diesel) due to WA’s emission reduction target for the grid
- Making e-bus chargers available to the public (residents and tourists) on weekends and school holidays would generate substantial income.

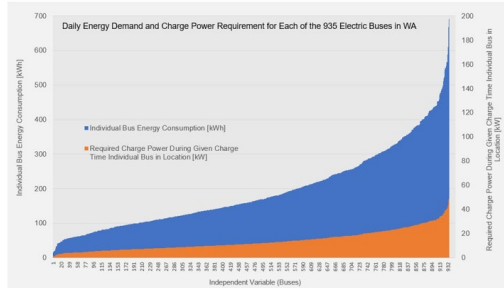


Figure 5-1 Individual Bus Energy and Charge Power Demand for 935 School E-Buses in Western Australia (2023)



Figure 3-2 Ciao purpose built electric school bus, Escolar, Brazil<sup>4</sup>

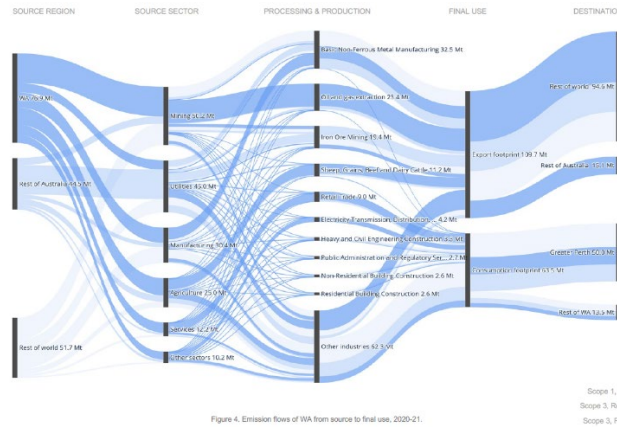


**Climate action: Mapping the circular economy of WA - monitoring the contributions of circularity towards achieving Net Zero: Stage 1**

*PATREC-iMOVE Core Project (\$300,000; July 2023 – December 2024; iMOVE, DoT, Curtin)*

To measure the materials footprint linked to final consumption in Greater Perth, quantifying the resource inflow and waste outflow and related energy use and greenhouse gas (GHG) emissions and provide an overview of the socioeconomic metabolism of Greater Perth, and the wider WA economy:

- Determine the state of play in circular economy research and policy internationally and locally
- Quantify and visualise the resource inflows and waste outflows linked to intermediate and final computation demands across WA and Greater Perth, and case study regions
- Estimate, map and visualise the material stocks and flows within the administrative boundaries of WA and Greater Perth

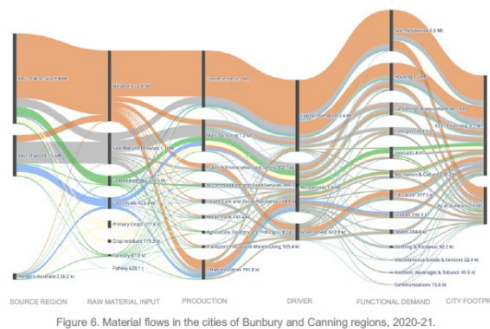
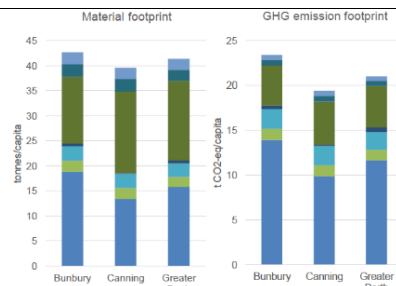


This research provided the first comprehensive assessment of the state of circularity in WA, providing insights into:

- Material footprints, and resulting emission flows including
  - resource inflows
  - waste outflows
- Built stocks - quantify
  - in-use built stock - amount of materials in existing buildings and infrastructure
  - net addition to built stock - amount of materials added, minus that removed through demolition and deconstruction

Recommendations made relating to:

- Lifecycle-focused policy
- Economic instruments that make circular strategies more competitive
- Integrating circular economy strategies with net zero policies
- Accessible state-wide materials accounts
- Increase visibility of opportunities for closing material loops
- Track material stocks in the built environment
- Monitor circular performance
- Integrate circular economy efforts towards a unified WA circular economy framework



### Climate action: Evaluation of an HVO renewable diesel trial pilot

*PATREC Core Project (\$38,694; March 2024 – November 2024; DoT, Curtin)*

To evaluate the trial of the use of HVO100 in the construction of the Byford Rail Extension (Metronet) to provide a third-party review of the suitability of HVO as a fuel source to achieve low carbon outcomes in the construction stages of the asset lifecycle and create increased confidence in the market to use the renewable diesel:

- Review the international experience in the use of HVO and other biofuels
- Analyse environmental benefits and economic viability of biofuels
- Establish an evaluation framework to measure the trial outcomes
- Collect on-site telematics data to understand the benefits and provide confidence in the fuel

#### Key achievements:

- Assessed technical and economic feasibility of HVO100 as a renewable alternative to fossil diesel
- Investigated relevant governing legislative and policy frameworks
- Gained insights from international case studies of successful implementations of low-carbon and zero-emission construction practices in cities like Oslo, Copenhagen, Helsinki, and London

There were difficulties in accessing telematics data from the machines, which was the preference, thus manual data was collected each day, however it proved too unreliable as a data source. This part of the research was paused until better on-site data is available, also potentially from Fremantle Ports.



Figure 16. A Kobelco excavator used in the Byford rail extension project.

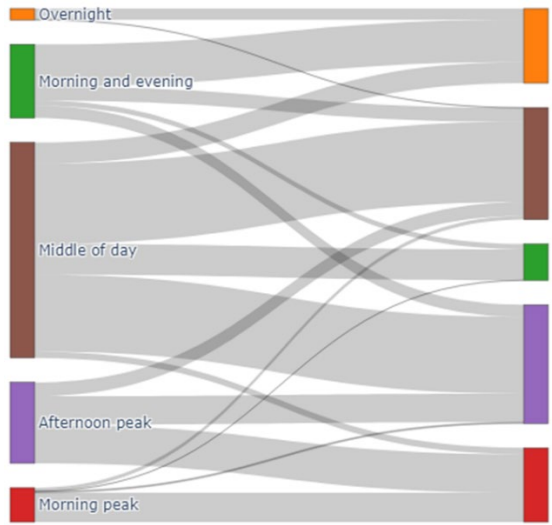
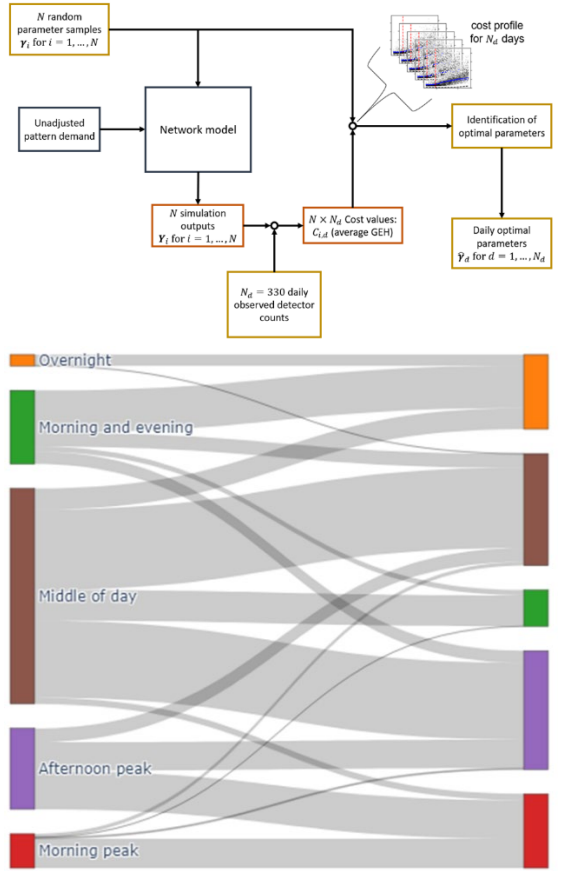
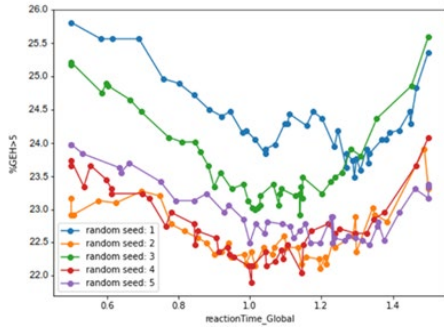
## AI-assisted model calibration for real-time traffic simulation

*External Project (\$382,000; June 2021 – June 2024; iMOVE, Aimsun, Main Roads, UWA)*

To improve the accuracy of the Perth Live Aimsun model by developing methods for the automatic calibration of the driver behaviour and supply-side parameters, e.g., reaction time and jam density, excluding the demand side inputs and parameters related to OD metrics and route choice.

**Key achievements:**

- Developed methods for offline calibration of the model, reducing computational resources
- Identified patterns in both traffic volume and optimal model parameters using hierarchical clustering techniques to improve performance
- Developed a systematic methodology for calibrating driver behaviour and supply-side parameters, although the specific patterns found are limited to the Perth Aimsun Live model and 2019 data.
- Identified best quality metrics for evaluating the quality of the model prediction, important in model calibration to quantify the model's goodness-of-fit.



## Improved roundabout modelling using drone video analytics (with extension)

External Project (\$481,322; April 2022 – December 2024; iMOVE, Main Roads, Aimsun, UWA)

To develop evidence-based parameter estimation methods to improve model results of traffic dynamics at roundabouts, thus roundabout design quality, by accounting for local conditions and driver behaviour:

- Collect and process video analytics data for selected roundabouts and pair with other types of data reflecting local physical conditions (including geometry, topography, location type (residential, industrial, rural etc.), traffic mix, and seasonality)
- Identify relationships between roundabout characteristics and their corresponding calibrated model parameters in SIDRA INTERSECTION, to develop an automatic calibration tool to assist engineers in designing new and modified roundabouts
- Enhance Aimsun Next's roundabout modelling capabilities by identifying behavioural relationships in a substantial dataset of roundabout trajectory data and developing additional models and functions for the core software at the micro-, meso- and macroscopic levels

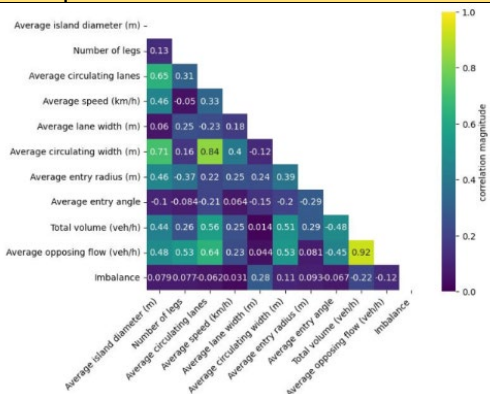


Figure 14: Cross-correlation between roundabout features. Colour indicates the magnitude of the correlation with the values shown numerically.

### SIDRA INTERSECTION enhancements

- Extracted traffic data from drone videos such as vehicle origin and destination (OD) matrices, speeds, trajectories, delay time, and approach lane capacity
- Developed and validated a robust model calibration methodology, combining capacity and delay measurements
- Created an automatic model calibration tool that predicts the Environment Factor parameter, based on readily available roundabout characteristics such as geometry and expected traffic volumes, producing significantly more accurate results than default parameter values and with quantifiable error estimates to help engineers understand prediction reliability

The findings are expected to inform updates to Main Roads Western Australia's Operational Modelling Guidelines, potentially improving roundabout modelling practices across the region.

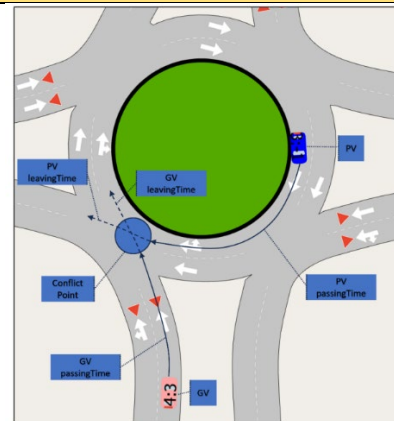


Figure 7: Microscopic giveaway model variable diagram

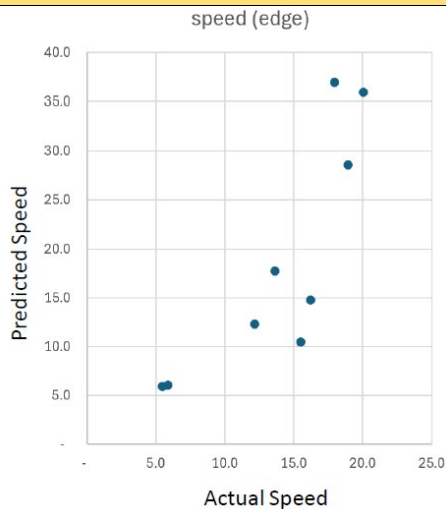
**Aimsun Next** enhancements through the integration of real-world driver behaviour data:

- Enhanced realism of simulated driver behaviours
- Improved consistency across micro- and meso- modelling scales
- Macroscopic junction delay functions provide a foundation based on observational data where little existed before
- Enhanced origin-destination lane choice model addresses a critical gap in accurately representing legal lane selections at complex multi-lane roundabouts
- Application of node speed formulas to curved sections improves overall accuracy of roundabout simulations

## Developing a low-powered edge camera system for pedestrian and cyclist surveys

*External Project (\$100,000; August 2022 – August 2024; Innovation Connection (Dept. Industry, Science, Energy and Resources), Metronet, UWA)*

To develop a vision-based, low powered, edge device for traffic survey purposes. Although there are already some commercial products for pedestrian detection, most need to be powered by the grid. Meanwhile, MetroCount's customer feedback shows a potentially large market demand for an off-the-grid device for pedestrian counting. This gap is addressed by combining expertise in hardware (MetroCount) with the research team's computer vision software development expertise.



- Pedestrian and cyclist detection/tracking software code developed, including to:
  - Detect and track people
  - Count numbers, by direction, mode
  - Track multiple objects simultaneously
  - Estimate speed
- System developments included:
  - Automatic reboot after system crash
  - Consume low power
  - Easy set up and calibration (if any) via the USB connection
  - High hardware reliability
  - Data uploading via wireless communication connections
  - Over-the-air (OTA) software update via wireless communication connections
  - ML model optimised for camera height of around 3 metres
- Use case - bi-directional shared path with clear delineation of directions and linear traffic movement, unit operating 24/7/365
  - test low-light and infrared cameras for dark environments
- Used breadboard to develop a working prototype

## Optimising video analytics for traffic data collection and calibration incorporating fixed camera videos

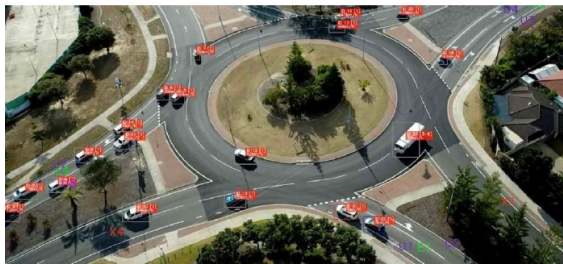
*External Project (\$200,000; January 2022 – December 2024; iMOVE, Main Roads, UWA)*

To implement a system for Main Roads to process videos recorded by fixed cameras which can complement or replace drones in areas with flight restrictions or severe occlusions caused by the environment and record videos for much longer:

- Optimise processing speed and test the possibility of real-time processing of VA software
- Recalibrate analytics modules for fixed cameras, which include delay time estimation, volume, speed, saturation flow, queue length
- Improve detection tracking for fixed cameras and under occlusion
- Improve vehicle classification
- Further develop Graphical User Interface (GUI)

### Achievements:

- Software development:
  - Delay time estimation module
  - Recalibrated and validated analytics modules
  - Retrained deep learning models for improved tracking under occlusion
  - Vehicle classification module
- Updated the GUI, API script and GUI User Manual

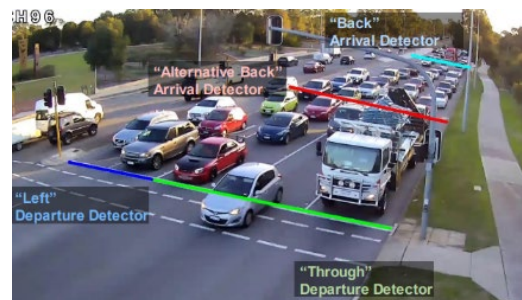
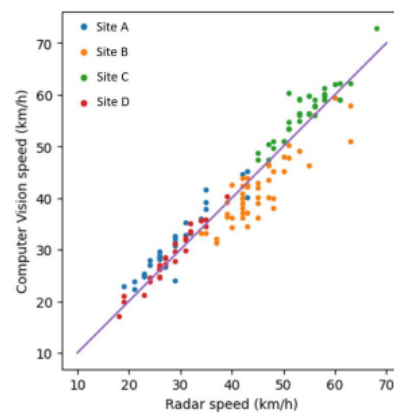


### Video Analytics GUI

### Documentation

A quick guide on how to use the GUI to process survey videos for vehicle trajectory data.

Last updated: 30/01/2025



## 2.2. Core projects progressed – traditional program

- Agreed to four, fast-track projects as part of the 2025-27 program of research, with two progressing to agreement finalisation as iMOVE projects and two, subsequently withdrawn:
  - Assessing the efficacy of video analytics for comprehensive active transport monitoring (agreement stage)
  - The effectiveness and efficiency of the container rail subsidy (subsequently withdrawn)
  - Decarbonisation of infrastructure in practice (subsequently withdrawn)
  - Roundabout safety review (agreement stage)
- 2023-25 program
  - Commenced - Automated intersection parameter measurement using aerial photography and computer vision - pilot
  - Substantially progressed:
    - Evaluation of road safety treatments - road safety trial design and evaluation using video analytics
    - Impacts of e-rideables on the transport task
    - Micromobility and freight – exploring opportunities in WA
    - Transport mode choice development using PATHS data

Status of progressed projects is summarised in Table 1.

**Table 1: Status of core projects in 2024 (19-21, 21-23 and 23-25 programs of research)**

Project Title	Key Agency	Uni/s	Progress as at 31 December 2024
<b>2021-23 core program of research</b>			
Transport Environment and Kids... 15 Years On	DoT/DPLH	UWA	Completed
Freight network to support NW freight task	DoT/DPLH	ECU	Withdrawn
Realtime model to estimate delay at traffic signals	Main Roads	UWA	Completed
Machine learning models for road maintenance investment decision making	Main Roads	UWA	Completed
<b>2019-21 core program of research</b>			
Enhanced vehicle detection at Traffic Signals and Smart Freeways	Main Roads	UWA	On hold until sensor installation completed by Main Roads
<b>2023-25 core program of research</b>			
Automated intersection parameter measurement using aerial photography and computer vision - pilot	Main Roads	UWA	Commenced
Improving roundabout modelling using drone video analytics Stage 2	Main Roads	UWA	Extension commenced

Evaluation of road safety treatments - road safety trial design and evaluation using video analytics	Main Roads	UWA	40% complete
Impacts of e-rideables on the transport task	DoT	UWA, Curtin	70% complete
Micromobility and freight – exploring opportunities in WA	DoT	Curtin	60% complete
Transport mode choice development using PATHS data	DoT; MR	UWA	60% complete
Sustainable last km freight and parcel delivery system - retail and parcel delivery	DPLH; MR	ECU	Withdrawn
Sustainable last km food and beverage delivery system - food and beverages	DPLH; MR	UWA	Completed

### 2.3. Core projects progress - climate action program

All four climate action projects were essentially completed in 2024 (Table 2) with some final reports still being under review by steering committees into 2025. As part of the fast-track (25-27 program) projects agreement progress, it was agreed that all four climate action projects could continue through to Stage 2 in 2025.

**Table 2: Status of Stage 1 climate action projects in 2024**

Climate action project	Progress as at 31 December 2024
Feasibility of battery-electric buses for regional school bus services Stage 1 (iMOVE, UWA (\$230k; Electrical Engineering, DoT, PTA)	Completed
Accounting for carbon in the planning for new residential suburbs Stage 1 (\$150k; iMOVE, UWA (AUDRC), DoT, DPLH)	Completed
Mapping the Circular Economy of WA: Monitoring the contributions of circularity towards achieving Net Zero – Stage 1 (\$300k; iMOVE, Curtin, DoT)	Completed
Evaluation of Hydrotreated vegetable oil (HVO) renewable diesel trial Stage 1 (\$40k; Curtin (Engineering), DoT, Metronet)	Completed

## 2.4. External projects progress

Significant progress was made on external projects which are those which do not received any core funding (Table 3).

**Table 3: Summary of status of external projects for 2024**

<b>External projects</b>			
AI-assisted model calibration for real-time traffic simulation	Main Roads	UWA	Completed.
Optimising video analytics for traffic data collection and calibration incorporating fixed camera videos	Main Roads	UWA	Completed.
Developing a low-powered edge camera system for pedestrian and cyclist surveys	(Innovation Connection/ Metrocount	UWA	Completed.
Improved roundabout modelling using drone video analytics Stage 1	Main Roads	UWA	Completed.
Application of biochar waste in pavement design	Main Roads	UWA	60% complete.
Freight route priority trial evaluation	Main Roads	Curtin	70% complete.
National Cycling Data and Analysis Platform (NCDAP)	ARC Linkage Infrastructure Equipment and Facilities	UWA, Curtin	Agreement executed, commenced
AURIN WA Node to support climate action in transport and land use planning research	National Critical Research Infrastructure Strategy (NCRIS)/JTSI	UWA, Curtin	Proposals submitted
Safe paths – enhancing active transport infrastructure through video analytics and community reporting	National Road Safety Action Grants Program, Main Roads, City of Stirling	UWA	Proposal submitted
RoadSense Analytics – AI-enabled traffic intelligence (Chao Sun, Main Roads	Australia's Economic Accelerator (AEA) Innovate, Main Roads, Surveytech, Stech cameras	UWA	Proposal submitted

## 3. KNOWLEDGE TRANSFER

### 3.1. Research outputs

The focus of PATREC's research outputs in 2024 was on the publication of technical reports for completed projects (Table 4). However, two software products were also delivered as primary project outputs.

Seven peer-reviewed journal papers were published in 2024 (Table 4) with five journal papers progressed (submitted, re-submitted or accepted for publication) (Table 5). Eleven seminar/webinar/conference presentations were given by PATREC associates at PATREC and other industry-organised events (Table 6). Nine news articles on PATREC-research were published on the iMOVE website with links provided from the PATREC website (Table 4).

**Table 4: Research publication outputs in 2024**

Publication Title	Authors	Date
<b>RESEARCH PROJECT TECHNICAL REPORTS COMPLETED</b>		
Planning for a sustainable last kilometre freight delivery system for the food and beverage sector in Greater Perth	Sae Chi	Dec 2024
TREK2 school study: transport environment and kids... 15 years on	Anna Gannett, Paula Hooper, Julie Saunders, Gina Trapp	July 2024
Transport Predictive Solution – Stage 2 – R&D – WA Node: AI-assisted Model Calibration for Real-time Traffic Simulation	Tom Lymburn, Liam Cummins, Thomas Stemler and Chao Sun	June 2024
Improved roundabout modelling using drone video analytics Stage 1: Final report for Aimsun	Liam Cummins, Lara Posel, Max Davidson, Sergio Banchemo, Tom Lymburn, Chao Sun	Aug 2024
Feasibility of battery-electric buses for regional school bus services in WA Stage 1	Thomas Bräunl, David Harries, Mark P McHenry, Guido Wager, Sharon Biermann	June 2024
Mapping the Circular Economy of Western Australia: Towards a Science-based Circular Observatory (1.0). Curtin University Sustainability Policy (CUSP) Institute, Curtin University. <a href="https://doi.org/10.25917/05QQ-8F09">https://doi.org/10.25917/05QQ-8F09</a>	Hopkins, J., Wood, R., Minunno, R., Marinova, D., Stephan, A., Vargas Contreras, P., Zaman, A., Fry, J., & Gruner, R.	2024
State of Circularity in Western Australia: A Summary Report. Curtin University Sustainability Policy (CUSP) Institute, Curtin University. <a href="https://doi.org/10.5281/zenodo.14808064">https://doi.org/10.5281/zenodo.14808064</a>	Hopkins, J., Wood, R., Minunno, R., Marinova, D., Pablo, V. C., Stephan, A., Zaman, A., Fry, J., & Gruner, R.	2025
Accounting for carbon in the planning for new residential suburbs, Final Report: Summary and recommendations	Bill Grace, Julian Bolleter, Chris Lund	March 2025

Machine Learning and Multi-Objective Optimisation Models for Enhanced Road Maintenance Investment Decision Making	Tom Lymburn, Sergio Banchero, Daniel Demiris, Chao Sun	March 2025
<b>SOFTWARE CODE DELIVERED</b>		
Video analytics Graphical User Interface Documentation: A quick guide on how to use the GUI to process survey videos for vehicle trajectory data (online manual) (main deliverable was software code)	Sergio Banchero and Chao Sun	Dec 2024
Realtime model to estimate delay at traffic signals: Automatic TomTom query generation – programming script with user guide	Tom Lymburn and Chao Sun	Sept 2024
A low-powered edge camera system for pedestrian and cyclist surveys	Tom Lymburn and Chao Sun	June 2024
<b>PEER-REVIEWED JOURNAL PAPERS PUBLISHED</b>		
Gannett A, Hooper P, Saunders J, Trapp GSA (2024). Investigating the walkability of primary, secondary and K-12 schools across metropolitan Perth, Western Australia, <i>GeoJournal</i> .		
Vazquez Melendez, Bergy, P and Smith, B (2024) Blockchain Technology for Supply Chain Provenance: Increasing Supply Chain Efficiency and Consumer Trust, <i>Supply Chain Management: an International Journal</i>		
Ting, S, Lymburn, T, Stemler, T, Sun, Y & Small, M (2024). Parameter Estimation for Gipps' Car Following Model in a Bayesian Framework, <i>Physica A: Statistical Mechanics and its Applications</i>		
Ruoso, A.C., Duarte Ribeiro, J.L., Oлару, D. (2024). Electric vehicles' impact on energy balance: Three-country comparison, <i>Renewable and Sustainable Energy Reviews</i> , 203, <a href="https://doi.org/10.1016/j.rser.2024.114768">https://doi.org/10.1016/j.rser.2024.114768</a>		
Sun, Y., Cummins L., Ji, Y., Stemler, T., Pritchard, N. (2024). Modelling Uncertainties for Automated and Connected Vehicles in Mixed Traffic, <i>Journal of Advanced Transportation</i> , 2024(1), p.2406230		
Curtis, C., Oлару, D., Smith, B., Reed, T. W., Knight, C., Biermann, S. (2024). Sustainable urban mobility transition through working from home. <i>Travel Behaviour and Society</i> Volume 39, April 2025, 100953		
Curtis, C. (2023) Employer perspectives on working from home: how Covid-19 is changing the patterns and flows in metropolitan Perth. <i>Urban Policy and Research</i> (missed in 2023 KPIs)		
<b>PATREC PERSPECTIVES, BULLETINS, ARTICLES, VIDEOS PUBLISHED</b>		
<a href="https://imoveaustralia.com/project/sustainable-last-kilometre-food-and-beverage-delivery-perth/">https://imoveaustralia.com/project/sustainable-last-kilometre-food-and-beverage-delivery-perth/</a>		
<a href="https://imoveaustralia.com/project/impacts-of-erideables-on-the-transport-task-in-wa/">https://imoveaustralia.com/project/impacts-of-erideables-on-the-transport-task-in-wa/</a>		
<a href="https://imoveaustralia.com/education/phd-student-profile/samson-ting/">https://imoveaustralia.com/education/phd-student-profile/samson-ting/</a>		
<a href="https://imoveaustralia.com/project/project-outcomes/electric-school-buses-regional-wa-challenges-solutions/">https://imoveaustralia.com/project/project-outcomes/electric-school-buses-regional-wa-challenges-solutions/</a>		
<a href="https://imoveaustralia.com/project/project-outcomes/implementing-perimeter-controls-perth-cbd/">https://imoveaustralia.com/project/project-outcomes/implementing-perimeter-controls-perth-cbd/</a>		
<a href="https://aurin.org.au/announcing-the-aurin-wa-node-advancing-climate-action-and-sustainable-planning-in-western-australia/">https://aurin.org.au/announcing-the-aurin-wa-node-advancing-climate-action-and-sustainable-planning-in-western-australia/</a>		
<a href="https://imoveaustralia.com/project/roundabout-safety-review-using-drone-video-analytics/">https://imoveaustralia.com/project/roundabout-safety-review-using-drone-video-analytics/</a>		

**Table 5: Journal papers in-progress in 2024 (Submitted, Re-submitted, Under Review or Accepted for Publication)**

Journal Papers in progress
Cummins, L., Sun, Y., Reynolds, M., Intelligent Pick-up and Drop-off System for Passenger vehicles, <i>Journal of Urban Technology</i> .
Lin, X., Hu, Y., Leek, C., Sun, Y., Sarker, P. Fatigue and Rutting Resistance of Asphalt Mix Modified by Recycled Soft Plastics and Recovered Toner. <i>Construction and Building Materials</i> .
Knight, C., Olaru, D., Lee, J., & Parker, S. K. Hybrid work design profiles: antecedents and wellbeing outcomes. Resubmitted to <i>Journal of Vocational Behaviour</i> .
P. Hooper, N. Edwards, F. S and J. Bolleter. Do fears become reality? Evaluating community experiences before and after a higher density infill development. <i>Journal of Housing and the Built Environment</i> .
Ting, S, Lymburn, T, Stemler, T, Sun, Y & Small, M. Estimating Gap Acceptance Parameters with a Bayesian Approach. <i>Transportation Research Part B: Methodological</i> .

**Table 6: Seminar, online webinar and conference presentations**

SEMINAR/WEBINAR/CONFERENCE PRESENTATIONS
Hopkins, J, Minunno, R, Marinova, D, Wood, R, Zaman, A, Gruner, R, Stephan, A & Vargas, P (2024) WATCH: Pioneering Digital Solutions for Circular Economy Metrics in Western Australia: Stage 1, poster presented at ERICA's (Energy Research Institutes Council for Australia) State of Energy Research Conference, Perth, 14-16 February
Olaru, D., Smith, B., Reed, T. & Biermann, S. (2024). Travel and satisfaction changes in response to working from home (WFH) in Perth, WA, 17th International Conference on Travel Behaviour Research (IATBR), July 14-18, Vienna, Austria
Hopkins et al. (2024) Towards a Science-based Circular Observatory: The Case for WA. American Geophysical Union Conference "Bridging the Gap: How Can Scientific Research Catalyze and Inform Real-World Change in Industry and Civil Society?", Washington, DC. 9–13.
WA Geography Seminar Series, 17 September 2024. Sharon Biermann and Jayne Bryant. From congestion-busting to net zero: climate action in land use and transport planning
Accounting for carbon presentations <ul style="list-style-type: none"> <li>• Julian Bolleter, Transition Town Vincent, December 2024</li> <li>• Julian Bolleter, Bill Grace, Development WA briefing, September 2024</li> <li>• Julian Bolleter, Bill Grace, Planning Institute of Australia state conference, 6 September 2024</li> <li>• Julian Bolleter, Bill Grace, Department of Planning Lands and Heritage, Liveable Neighbourhoods review team, July 2024</li> </ul>
Wu, C. Big data and AI in Urban Mobility. Australian Data Science Network Conference, 22 November 2024
Gannett A, Hooper P, Saunders J, Trapp GSA. Exploring student and parent preferences for active school transport interventions, Environmental Design Research Association Conference, Portland, USA, June 2024.
Gannett A, Hooper P, Saunders J, Trapp GSA. Exploring student and parent preferences for active school transport interventions, Australasian Society for Behavioural Health and Medicine, Adelaide, February 2024.

## 3.2. PATREC connection opportunities and events

PATREC arranged six events in 2024:

- 2024 John Taplin Memorial Lecture: Hagerstrand Meets Big Data: Time-Geography in the Age of Mobility Analytics, Professor Antonio Paez, McMaster University, 21 March 3.30, University Club of WA
- 20 June 2024 Public Lecture: Hosted by Institute of Advanced Studies and PATREC; Elisabetta Cherchi is Professor at the School of Engineering, Future Mobility Group, Newcastle University; New methods to understand and forecast travel demand for innovative transport systems. Case study: AV
- 15 October 2024. A/Prof Dr. Mohsin Malik Seminar Invitation - Impactful Theorising: A digital transformation playbook to harness the full potential of digital technologies
- CA researcher workshop, 30 October 2024, Curtin to identify research capacity and capability as well as research project ideas to support the CA Strategic Plan. More than 60 people attended and the inputs collated and summarised as part of the CA strategic plan
- Sae Chi – as part of role on ATRF Inc Executive committee, contributed to arranging 2 ATRF economics webinars – open to PATREC (invitation circulated to stakeholders)
  - ATRF Transport Economics Webinar 2024 #1: Emerging Approaches in Measuring Social Value; 26 June 2024, 50 attendees; Speaker: Lee Jollow, National Lead of Investment and Economics at Etheus
  - ATRF Transport Economics Webinar 2024 #2: Estimation of values of car travel time, reliability and safety from the ATAP WTP national survey; 19 August 2024; Speaker: Dr Mark Harvey, Adviser at the Bureau of Infrastructure and Transport Research Economics (BITRE)

Media opportunities:

- Tristan Reed
  - Interview with Isaac Mulcrone – “Drive with Isaac” on Youth Jam Radio (online streaming radio - youthjam.com.au) regarding free PT in Queensland
- Caroline Knight and Tristan Reed
  - Interviewed by the Brisbane Times/Australian Science Media Centre on how cities will change due to WFH/hybrid work
- Caroline Knight
  - Interviewed for HRM The news site of the Australian HR Institute: Armstrong, P. (28th May 2024). 3 new workplace psychosocial risks HR should be aware of. HRM online
  - Interviewed by Meakins, T. (7th November 2024). Work from home: How often Aussies 'should go into office' after claim 'lazy' approach will cost you. Yahoo! Finance.

## 3.3. Teaching and training

- Tristan Reed PATREC Research Fellow (ex-Curtin, now UWA Business School Lecturer), attained his PhD
  - Reed, T. W. Improving Search and Discovery of Geospatial Information in Australia and New Zealand using Semantic Web Techniques. PhD Thesis. Published. <https://espace.curtin.edu.au/handle/20.500.11937/95040>
- Director appointed external reviewer for a University of South Australia PhD thesis
- New PhD student commenced, supervised by Doina Olaru and Chao Sun – Hugo Nilssen

- PATREC co-supervised 4 PhD students (Chao Sun, Sharon Biermann):
  - In progress (Chao Sun co-supervisor):
    - Samson Ting (PhD) co-supervised with Thomas Stemler - data-driven approach to improve intersection modelling (PATREC and iMOVE top-up scholarships) – completing in 2025
    - Liam Cummins (PhD) co-supervised with Mark Reynolds - smart pick-up and drop off solution
    - Xiaoyu Lin (PhD) co-supervised with Yuxia Hu from Civil engineering - recycled soft plastics in pavement
- CA Program Leader presented 3X one-hour lectures at Curtin:
  - Sustainability leadership on the 22nd July
  - Leadership in Sustainability unit on the 26th - creativity in sustainability leadership
  - Climate Policy Masters unit 22nd August - local government and Climate Action – opportunity for PATREC collaborators to attend
- Sae Chi delivered a teaching unit – Business School, UWA - INMT5503 Logistics and Supply Chain Management (0.2 FTE paid by UWA BS)
  - 22 July – 18 October 2024 (Semester 2)
  - 73 students enrolled
  - Core unit for Master of Business Information and Logistics Management (postgrad)
  - 12 x 2-hour lectures and 24 x 1 hour tutorials
- Sae Chi delivered a lecture to Curtin Architecture students (for Prof Reena Tiwari) on Transport Disadvantage on 3 Oct

## 3.4. Research impact

### 3.4.1. Research project feedback

For completed projects, steering committee chairs/representatives are asked to provide feedback on the output quality and value for policy formulation via a close-out report. Key statements have been captured from these close-out reports to summarise research impacts achieved.

#### **Feasibility of battery-electric buses for regional school bus services in WA**

*(Extract from Project Close-out Report, 25 July 2024, completed by Steve Beyer and Ying Huang, DoT)*

- useful information to support government funded regional school buses transitioning to battery electric technology... findings will be considered by PTA when preparing their agency emission reduction plan... advice will be provided to the Government on the findings of the project and the implications of progressing with this transition
- contributes to the ambition of reducing transport sector emissions, and related consideration of decarbonisation pathways for different services and sectors
- involved a wide range of stakeholders including energy sector, school bus operators, bus drivers, regional schools and Department of Education... project team effectively engaged with the stakeholders for data inquiry, interviews and consultations, which contributed to the success of project
- well managed ... with close communications with project team to ensure the milestone deliverables.

#### **AI-assisted model calibration for real-time traffic simulation**

Formal feedback is in process. Informal email feedback provided as follows:

- Mohammad Saifuzzaman, Aimsun, email dated 22 April 2024: “It is well a documented report. Well done”
- Ferran Torrent, Aimsun, email dated 10 April 2024: “All good from my side. Good job”
- Bruce Ling, Acting Operational Modelling & Visualisation Coordinator, Traffic and Road Network Performance, Network Operations Directorate, Main Roads, email dated 17 June 2024: “Good job team and I appreciate the efforts to clarify the report for a layman such as myself”

### **Identifying opportunities to address transport disadvantage in Perth**

*Extract from Project close-out report, 22 February 2024, completed by Leonie Gibbons, Senior Policy Officer, Urban Mobility, Department of Transport)*

- The final report was ... of high standard, [with] clear interpretation, and contextualisation of findings... recommendations were targeted and well-grounded
- TD risk score in Excel format was very useful, allowing sorting and filtering of SA2/data enquiries
- Use of the TD score to build narrative around strategic decision making is the key application of this work
- The TD score is an important step in identifying locations and at-risk populations in Greater Perth. Further work could inform development of more equitable transport policy, greater public transport optimisation, increased uptake of active transport and improved access to essential services

### **Transport Environment and Kids...15 years on**

*(Extract from Project Close-out Report, 17 Jan 2025, completed by David Wake, A/ Research and Evaluation Coordinator, Urban Mobility, DoT)*

- Online interactive map provides a way to engage with data from the walkability assessment to consider regional patterns and school level measures. This has already been useful - for a budget bid to fund school connectivity improvements, and has been shared with stakeholders
- Delivered an evidence platform for further development of our active travel to school initiatives and consideration of new strategies, especially around infrastructure to enhance walkability and safety in school catchments and strengthening positive attitudes towards active travel options
- Generated evidence to inform program development and funding bids to address current issues affecting student active travel.
- Tackling barriers to active school travel involves many stakeholders... findings used to foster discussion with stakeholders and build collaboration
- Based on finding, looking at integrating infrastructure changes with school-based activities and developing a communications campaign to promote positive social norms towards active travel

### **Realtime model to estimate delay at traffic signals**

*(Extract from Project Close-out Report, 12 Dec 2024, completed by Graham Jacoby, Network Operations Analysis Manager, Traffic and Road Network Performance, Network Operations Directorate, Main Roads Western Australia)*

- Team delivered several reports and presentations related to the queue theory model
- Key deliverable was a tool (python script) to extract, transform and present vehicle turning movement data from the TomTom trafficstats API
- Team delivers a high-quality solution

- Turning movement data extraction tool will fill a gap within Main Roads as many signalised intersections do not have vehicle detectors installed at all turning movements. Understanding turning movement volumes and delays is critical for Network Operations Directorate, Traffic Signal Timing Improvement Programme (TSTIP)
- Improved data for TSTIP means traffic signals can be better optimised and provide benefits for our customers (WA road users)
- There was a turnover of key stakeholders within Main Roads during the project which resulted in some confusion and a change in objective. Despite the disruption the project team was able to adapt and still provide a useful output for Main Roads WA.

### **Mapping the Circular Economy of WA: Monitoring the contributions of circularity towards achieving Net Zero: Stage 1**

*(Extract from Project Close-out Report, 16 Dec 2024, completed by Susie Page, Manager Sustainability Policy and Strategy, Transport Sustainability and Strategic Projects, DoT)*

- A presentation of the findings and report were the outputs of the stage 1 research which was delivered to key stakeholders across government to support and gain interest in stage 2... led to interest from several government agencies to be involved in use cases for the next stage of the research
- Identifying opportunities for circular economy approaches is a priority for the Transport Portfolio with sustainable resource use and emissions reduction being two of the material topics in the Transport Portfolio ESG Framework and Sustainable Infrastructure Policy. Understanding the material flows across the economy is a key foundational baseline to have to inform policy and opportunities for material reuse and recycling
- With material shortages and price increases impacting the construction sector in recent years and set to continue in coming years, being able to maximise the circular economy through current and future forecasting of material supply and demand will be critical with a strong pipeline of work due to growth in population and freight task

### **Planning for a Sustainable Last Kilometre Freight Delivery System for the Food and Beverage Sector in Greater Perth**

*(Extract from Project Close-out Report, 6 Feb 2025, completed by Markus Botte, Manager Statutory Road Planning, Road Planning, Planning and Technical Services Directorate, Main Roads WA and Jason Gordon, Planning Director, Infrastructure Planning and Policy, Strategy and Engagement, Department of Planning, Lands and Heritage)*

- Quality of outputs met expectations, especially when considering the difficulties and limitations in obtaining and accessing third party data (or lack thereof), the quality of the outputs is actually really good
- Outputs provide an excellent analysis on last km freight for food and beverage in metropolitan Perth and solid basis for further investigation on these issues from a government policy perspective
- Research focussed on areas of interest to agencies where policy can influence outcomes for food and beverage activities
- Overall, the collaboration, sharing of information and ideas between academia and state government partner agencies as part of this research worked really well
- ... serve as a guide in the development of policies and guidelines, such as Liveable Neighbourhoods and Planning Policy...provides DPLH with basis to consider these issues in precinct planning and neighbourhood design policy development
- Better informed decision making and planning for understanding local traffic and amenity implications associated with last km F&B delivery. Consideration of F&B last

km delivery challenges when assessing statutory referrals and in developing planning guidance and policy

- Highlighted a potential gap in the current (local) planning framework(s). F&B delivery offerings are added to permissible land uses but are not adequately captured as requiring planning consideration and approval. Also, traffic and urban amenity, broader environmental/community health and social implications of home delivery requires further consideration
- Identifies opportunity for better road and street design outcomes to cater for increasing food and beverage pick-up and delivery and for improved built form design, particularly in medium-higher density locations.

### **Biofuels - Evaluation of Hydrotreated Vegetable Oil (HVO) renewable diesel trial - independent evaluation of pilot project**

*(Extract from Project Close-out Report, 16 Dec 2024, completed by Susie Page, Manager Sustainability Policy and Strategy, Transport Sustainability and Strategic Projects, DoT)*

- The purpose of the trial was to provide evidence and data that HVO renewable diesel is a drop-in replacement for standard diesel with a 90% reduction in CO2 emissions, and a cleaner more efficient burning fuel
- Due to data access and quality issues, the report has not been finalised and will be revisited in early 2025 with any further data from METRONET and the Fremantle ports trial.

### **Developing a low-powered edge camera system for pedestrian and cyclist surveys**

*(Extract from the Innovation Connect Final Report as completed by the Industry beneficiary: Metrocount, 28 February 2024)*

- Highly satisfied - overall satisfaction with research project outcomes (e.g. your experience with the PFRO, the results, the timeframes, your expectations)?
- Although delays occurred due to Covid travel restrictions and supply constraints, the overall project result was good
- Highly satisfied with the researcher(s) that worked on this research project in meeting your expectations
- Both Sergio and Dr Chao Sun impressed us with their expertise and AI and Vision ML subject knowledge depth
- A prototype low-power pedestrian and bicycle detection edge processing device was demonstrated that will now be refined into a new product
- We are continuing with an ongoing relationship with both research and consultancy to better refine the product in terms of packaging, testing and reliability

### **3.4.2. Awards**

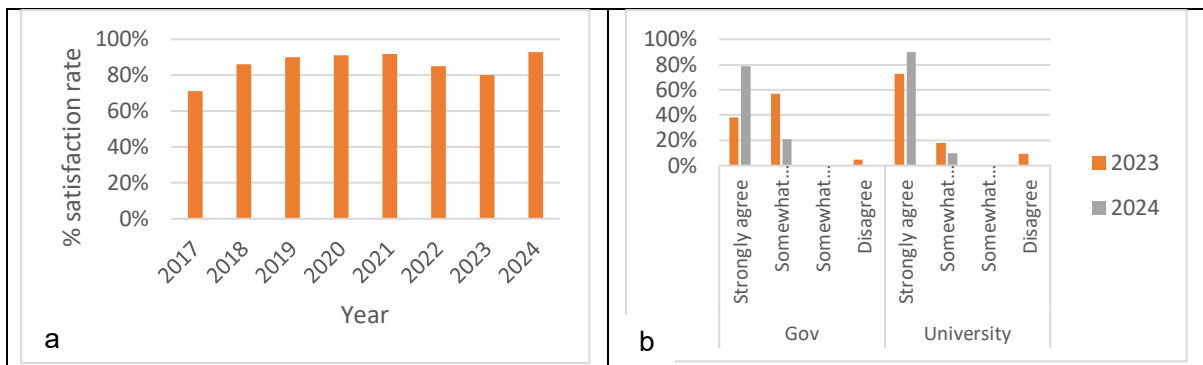
Director accepted the invitation to Chair the **AURIN Scientific Advisory Committee (SAC)** with other members: Marie Truelove (CSIRO Data61), Prof Matt Duckham (RMIT, Director, Information in Society EIP), Prof Jonathan Corcoran (UQ, Director, QLD Centre for Population Research), Lisa Bush (Geoscience Australia, Head, NLI Branch), Prof Chris Pettit (UNSW, Director, City Futures Research Centre), Isabel Ceron (ASSA, Project Lead, Decadal Plan 2023-32), Sean Copley (ABS, Ass. Director, Geospatial Solutions), Ellie Torabi (DITRDCA, Director, Research and Evaluation).

### **3.4.3. Stakeholder satisfaction survey results**

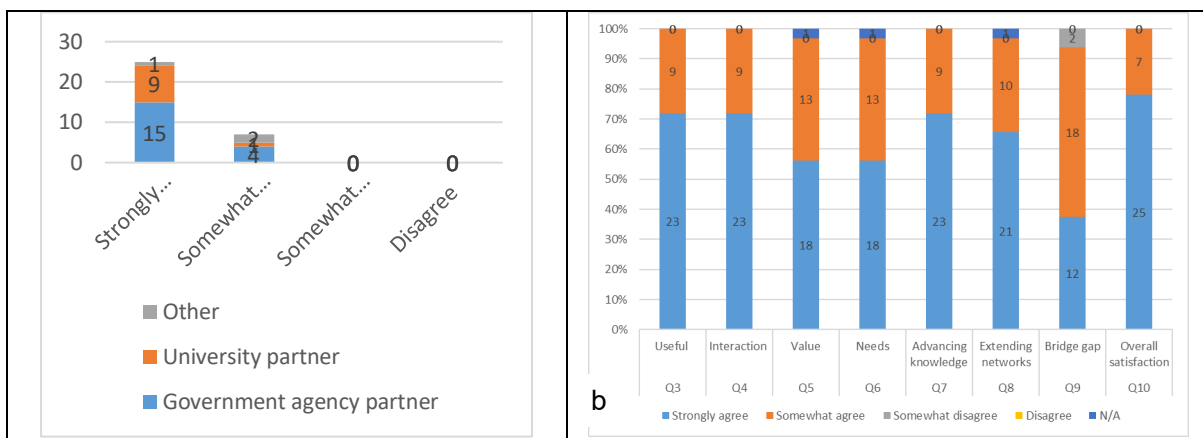
The satisfaction survey for 2024, was conducted in March 2025, circulated to 145 stakeholders directly involved in PATREC research during 2024, with a response rate of 22% (n=32).

University partners comprised 31% of respondents, with 60% government respondents and 9% “other” (Figure 1a). A percentage overall satisfaction rate of 93% was achieved. This is up 13% on the 2023 score and the highest score ever received (Figure 1a). The difference from 2023 is largely driven by a shift of around 40% of government responses from ‘somewhat agree’ to ‘strongly agree’, a reversal from the 2022 results (Figure 1b).

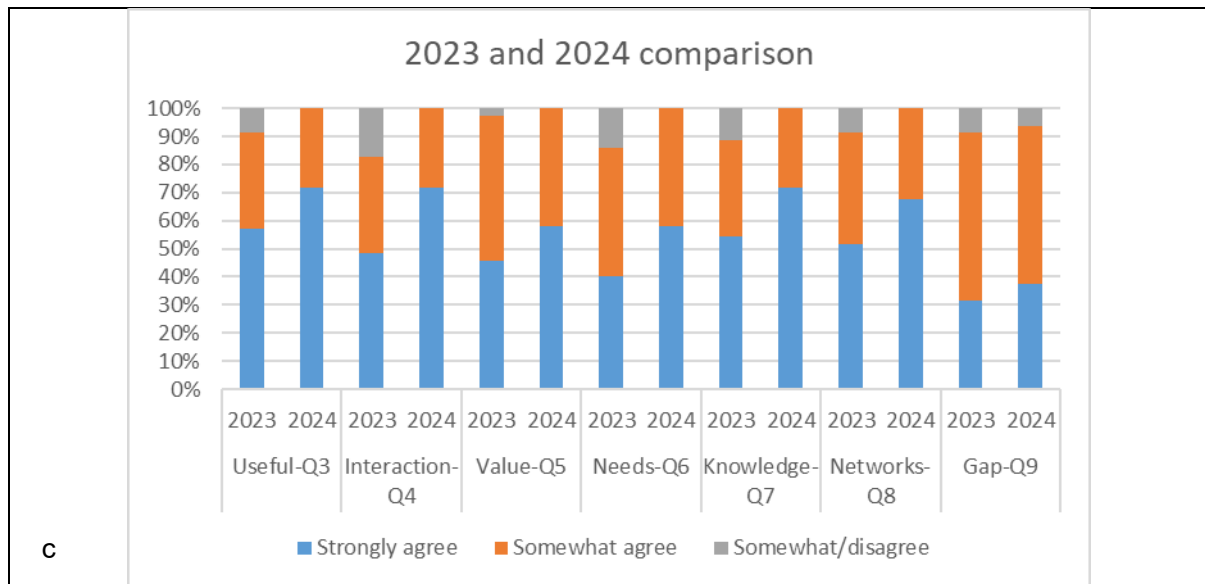
88% of all respondents ‘strongly agree’ they are satisfied with PATREC performance and the remaining 22% ‘somewhat agree’ (Figure 2a). Highest satisfaction (‘strongly agree’) was in relation to usefulness (Q1), interactions (Q4) and advancing knowledge (Q7) (Figure 2b). As in past surveys, lowest levels of ‘strongly agree’ relate to bridging the gap between research and policy (Q9), the only question with more ‘somewhat agree’ responses than “strongly agree’. Understanding each other’s needs (Q6) and value for money (Q5) also had lower levels of ‘strongly agree’ responses, although Q6 also showed the greatest increase in the percentage of those responding “strongly agree’ since 2023 together with interactions (Q4), and advancing knowledge (Q7) (Figure 2c). More detailed results for each question are provided in Figure 3.



**Figure 1: Trends in overall satisfaction with PATREC’s performance**



a



c

**Figure 2: 2024 PATREC satisfaction survey response by group (a) and question (b) and a comparison between 2023 and 2024 (c)**

Suggestions provided by respondents:

- More engagement with industry to inform policy recommendations (Other)
- Better communication and promotion of PATREC activities and achievements (i.e. within government agencies to raise awareness and demonstrate value) (Government)
- Greater focus on applied research and Industry engagement would be valued (Government)
- Make funding opportunities more accessible to partners (University).

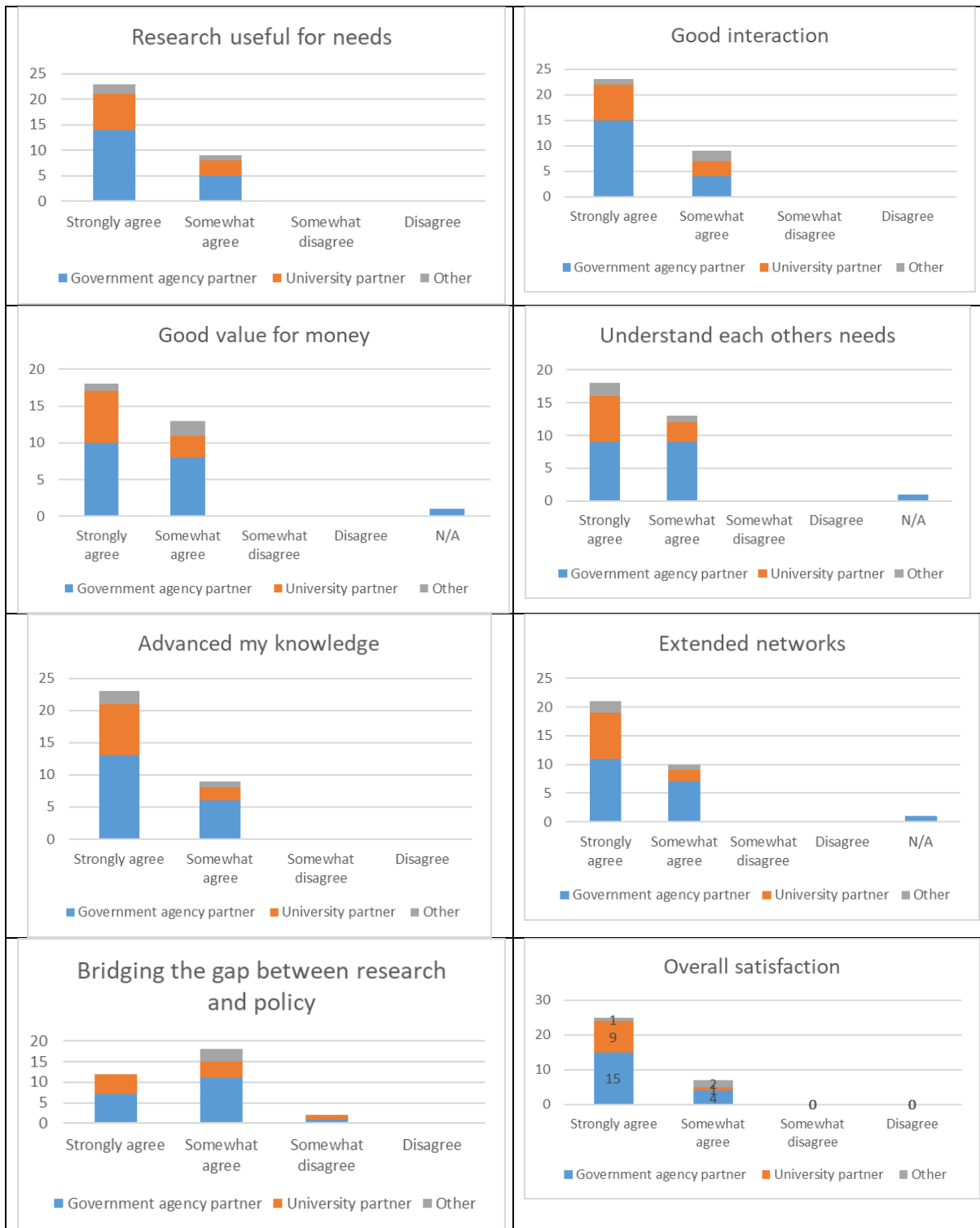


Figure 3: Individual question results

## 4. PEOPLE AND RESOURCES

### 4.1. Staffing

With leadership, administration and coordination by a small PATREC core team, a much wider team of PATREC project research associates from across partner universities and with some support from adjuncts, consultants and PhD students, were involved in conducting policy-informing, applied research in 2024.

The research team was broadly consistent with that presented in the Strategic Plan and Business Plan 2024 with extensions to expiring fixed-term and casual contracts taking place to ensure resourcing is secured to deliver on concluding and commencing core and external projects (Table 7). The new climate action program has broadened the range of expertise included in the PATREC team. Casual contract staff play a vital role in delivering on the research, usually in the role of research assistants.

In addition to the PATREC-funded core team, PATREC involves a number of academics who are employed full time by partner universities but who participate on an in-kind basis to conceptualise and manage projects, direct research assistants, undertake research and identify opportunities (Table 7). Limited use is also made of consultants where relevant expertise is not available within the partner universities.

**Table 7: PATREC project researchers**

Sharon Biermann	PATREC office - Director
Charise Baker	PATREC office - Senior Administrative Officer
Jayne Bryant	PATREC Climate Action program leader, CUSP, Curtin
Yuchao Sun	PATREC Senior Research Fellow (traffic engineering); 1.0 FTE
Sae Chi	PATREC Research Fellow (transport economics); 1.0 FTE
Sergio Banchemo	PATREC Research Assistant to Chao Sun
Demiris Daniel	PATREC Research Assistant to Chao Sun
Liam Cummins	PATREC Research Assistant to Chao Sun
Tom Lymburn	PATREC Research Assistant to Chao Sun
Max Davidson	PATREC Research Assistant to Chao Sun
Samson Ting	PATREC/iMOVE PhD scholarship, research assistant
Padraig Lamont	PATREC Research Assistant
Lara Posel	PATREC Research Assistant
Erica Oertlinger	PATREC Research Assistant
Marcos Magalhaes	PATREC Research Assistant
Doina Olaru	Research Associate, UWA Business School
Tristan Reed	Research Associate, UWA Business School
Lillian Wu	Research Associate, UWA School of Engineering
Miguel Loyola	Research Associate, UWA Business School
Brett Smith	Research Associate, UWA Business School
Richard Gruner	Research Associate, UWA Business School
Thomas Stemler	Research Associate, UWA Mathematics
Michael Small	Research Associate, UWA Mathematics and Statistics
Mark Reynolds	Research Associate, UWA Physics, Mathematics, Computing
Yuxia Hu	Research Associate, UWA Civil, Environmental and Mining Engineering
Colin Leek	Research Associate, UWA Civil, Environmental and Mining Engineering
Lynn Meuleners	Research Associate, WA Centre for Road Safety Research, UWA
Teresa Senserrick	Research Associate, WA Centre for Road Safety Research, UWA
Paul Roberts	Research Associate, WA Centre for Road Safety Research, UWA

Matthew Albrecht	Research Associate, WA Centre for Road Safety Research, UWA
Gina Trapp	Research Associate, Telethon Kids, UWA
Anna Gannett	Research Assistant and PhD candidate, Population and Global Health, UWA
Julian Bolleter	Research Associate, AUDRC, UWA
Bill Grace	Research Associate, Adjunct, AUDRC, UWA
Chris Lund	Research Associate, Adjunct, AUDRC, UWA
Thomas Braunl	Research Associate, Electrical, Electronic and Computer Engineering, UWA
David Harries	Adjunct Associate, Electrical, Electronic and Computer Engineering, UWA
Mark McHenry	Adjunct Research Associate, Murdoch University
Guido Wager	Research Associate, Electrical, Electronic and Computer Engineering UWA
Julie Saunders	Research Associate, Population and Global Health, UWA
Tele Tan	Research Associate, Electrical Engineering, Computing and Mathematical Sciences, Curtin
Zhen Peng	Research Assistant, Civil and Mechanical Engineering, Curtin
Ritu Gupta	Research Associate, Electrical Engineering, Computing and Mathematical Sciences, Curtin
Andrew Grose	Research Associate, Electrical Engineering, Computing and Mathematical Sciences, Curtin
Ryan Loxton	Director Curtin Centre for Optimisation and Decision Science, Curtin
Himanshu Agrawal	Research Associate, Electrical Engineering, Computing and Mathematical Sciences, Curtin
Carey Curtis	Research Associate, Adjunct, UWA, Curtin
Courtney Babb	Research Associate, Design and Built Environment, Curtin
Parisa Izadpanahi	Research Associate, Design and Built Environment, Curtin
Dora Marinova	Research Associate, CUSP, Curtin
Josh Hopkins	Research Associate, CUSP, Curtin
Roberto Minunno	Research Associate, CUSP, Curtin
David McMeekin	Research Associate, Electrical Engineering, Computing and Mathematical Sciences, Curtin
Yun Yu	Research Associate, Chemical Engineering, Curtin

## 4.2. Finances

The closing balance at the end of the 2024 financial year was \$9,601, as a result of ending the year with \$150,000 less revenue than budgeted and expenditure which was \$456k more than budgeted (Table 7.1), significantly clearing the balance brought forward from 2023.

**Table 8: Financial summary for 2024**

<b>PATREC Income and Expenditure 2024</b>	<b>YTD as at 31 Dec 2024</b>	<b>Budget 2024</b>	<b>Variance Budget vs YTD Actual</b>
<b>INCOME</b>			
WA Government Grants (core subscriptions - trad.)	300,968	300,968	0
Universities Sponsorship (core subscriptions- trad.)	193,480	217,127	-23,647
iMOVE/PATREC core project (traditional)	250,000	300,000	-50,000
External Research Grants & Contracts (trad.)	808,234	950,000	-141,766
Climate action (WA gov core)	290,000	290,000	0
Climate action (WA uni core)	72,500	72,500	0
Climate action project (iMOVE/external)	300,000	255,000	45,000
ATRF conference	-28,797	0	-28,797
Interest balance	48,366	0	48,366
<b>Total Income</b>	<b>2,234,751</b>	<b>2,385,594</b>	<b>-150,843</b>
<b>EXPENDITURE</b>			
PATREC OFFICE	<b>287,256</b>	<b>298,327</b>	<b>-11,071</b>
RESEARCH PROJECTS	<b>2,610,887</b>	<b>2,192,505</b>	<b>418,382</b>
ATRF CONFERENCE	<b>48,412</b>	<b>0</b>	<b>48,412</b>
<b>Total Expenditure</b>	<b>2,946,555</b>	<b>2,490,832</b>	<b>455,723</b>
<b>YTD BALANCE</b>	<b>-711,804</b>	<b>-105,237</b>	<b>-606,566</b>
<b>Balance Brought Forward from 2023</b>	<b>721,405</b>	<b>721,405</b>	<b>0</b>
<b>CLOSING BALANCE (incl Balance B/F)</b>	<b>9,601</b>	<b>616,168</b>	<b>-606,566</b>

## 5. GOVERNANCE

### 5.1. Board members

The PATREC Board comprises a senior representative of each of the collaborating parties and a Chair who is independent of all Parties. Reece Waldock continued as the Independent Chair of the Board. Board membership in 2024 remained relatively stable (Table 9). The PATREC Director is an ex officio member of the Board. The PRAC Chair and PTA are also invited to Board meetings. With ECU withdrawal from PATREC in 2024, there is no longer an ECU member of the Board. At the end of 2024, it was agreed that Alan Colegate would replace Peter Woronzow as Main Roads member and the new Chair of the WAPC would replace David Caddy in 2025.

**Table 9: PATREC Board members 2024**

2024 Board members
Adjunct Prof Reece Waldock AM, Independent Chair
Adjunct Prof David Caddy, Chair, Western Australian Planning Commission
Mr Peter Woronzow, Director General Transport, Western Australia
Mr Steve Beyer, Director, Transport Sustainability and Strategic Projects, Department of Transport
Prof Dora Marinova, Professor of Sustainability, Curtin University
Prof Amanda Davies, Head, School of Social Sciences, The University of Western Australia
Mr Ian Duncan, Executive Manager, Infrastructure, WALGA

### 5.2. Research Advisory Committees

Two PATREC Research Advisory Committees (RAC) provide oversight of core project selection and progress monitoring, ensuring research is aligned with policy needs. The PRAC provides oversight of the 'traditional' program of PATREC research, with a separate advisory committee established in 2023 to advise the Board on the Climate Action program (CARAC).

Comprising two senior representatives from each partner organisation, chaired by a nominated representative of one of the government partners, elected by the Board, the objectives of RACs are to:

- maintain an element of formality and rigour to the research project identification, selection, support, monitoring and dissemination process;
- enhance communication amongst partners; and
- advise the Board on project level matters, allowing the Board to focus on strategic matters.

RACs meetings were held three times a year, 2 - 3 weeks in advance of Board meetings.

#### 5.2.1. PATREC Research Advisory Committee (PRAC)

During 2024, Steve Atkinson (Main Roads member and Chair) took up a secondment position and Ryan Falconer took up the position of Chair. Steve Atkinson agreed to return to the position of Deputy Chair on completion of his secondment, with Georgina Gibbs, acting for

Steve Atkinson during his secondment, taking on the role of acting Deputy Chair (Table 10). Also well into 2024, Sue Hellyer replaced Mark Woods (DoT), Andrew Wilkinson replaced John Chortis (DPLH), Tanvir Asgar replaced Damien Martin (DPLH) and ECU representation was no longer necessary on withdrawal of ECU from PATREC. Kerry Job, Rail Planning Manager, Infrastructure Planning & Land Services, Public Transport Authority, joined the PRAC.

**Table 10: PATREC Research Advisory Committee (PRAC) members 2024**

Name	Organisation
Ryan Falconer (Chair)	Department of Transport
Georgina Gibbs, acting for Steve Atkinson (Deputy Chair)	Main Roads WA
Sue Hellyer	Department of Transport
Cory Ross	Main Roads WA
Tanvir Asgar	Department of Planning, Land & Heritage
Andrew Wilkinson	Department of Planning, Land & Heritage
Martin White	Public Transport Authority
Tele Tan	Curtin University
Courtney Babb	Curtin University
Doina Olaru	The University of Western Australia
Brett Smith	The University of Western Australia
Negar Nili	WALGA
Kerry Job	PTA

### 5.2.2. Climate Action Research Advisory Board (CARAC)

Chaired by Steve Beyer from the Department of Transport, with Susie Page as the deputy chair, members are drawn from a wider field of stakeholders across government agencies, given the wider ambit of climate action research, although the focus remains on transport and land use planning. During the course of 2024, Louis Bettini replaced Qindong Li and Gemma Habens, Melinda Payne. Andrea Down joined from the Public Transport Authority.

**Table 11: Climate Action Research Advisory Committee (CARAC) members 2024**

Member	Position/Organisation
Steve Beyer (Chair)	Director Transport Sustainability and Strategic Projects, Department of Transport
Susie Page (Deputy Chair)	Manager Sustainability Policy and Strategy, Transport Sustainability and Strategic Projects, Department of Transport
Sam Wilkinson	Principal Policy Officer, State EV Strategy, Climate Change Division, Strategic Policy, Department of Water and Environmental Regulation
Helen McGettigan	Director Planning and Strategy (Energy, Climate Change and Sustainability), Infrastructure WA
John Clifton	Manager Strategy and Innovation, DevelopmentWA
Louis Bettini	Principal Advisor Sustainability, Strategy and Communications Directorate, Main Roads WA

Ryan Falconer	Director Transport Insights, Urban Mobility, Department of Transport
Gemma Habens	Climate Policy Manager, Strategy and Engagement, Department of Planning, Lands and Heritage
Andrea Down	Rail Planning Coordinator, Infrastructure Planning and Land Services, Public Transport Authority
Dora Marinova	Professor of Sustainability, Curtin University Sustainability Policy Institute, Curtin University
Bill Grace	Adjunct Professor, Australian Urban Design Research Centre, UWA

### 5.3. Project steering committees

All PATREC core and most external projects are led by steering committees, comprising key researchers as well as government stakeholders and chaired by a government agency representative (Table 12). The iMOVE Programs Manager is automatically invited to each meeting. Steering committees have oversight on progress, provide access to information and data and review and accept key outputs. Steering committees are established in the process of project development and agreement execution and provide significant value in ensuring research is relevant to policy objectives and delivers impact.

**Table 12: Project steering committee participation in 2024**

Project title	Government	Research
Transport environment and kids... 15 years on	Chair: Michelle Prior, David Wake (DOT); Jason Gordon (DPLH); Sharnie Stuart (Education) Max Bushell (WALGA)	Gina Trapp, Anna Gannett (Telethon Kids, UWA)
Machine learning models for road maintenance investment decision making	Chair: Qindong Li, Lalinda Karunaratne (Main Roads)	Chao Sun (PATREC)
Model for estimating delays at traffic signals	Chair: Graham Jacoby (Main Roads)	Chao Sun (PATREC)
Evaluation of road safety treatments - road safety trial design and evaluation using video analytics	Chair: Adrian Bonner, Lucas Viljoen, Edward Rose, Steve Atkinson (Main Roads)	Chao Sun, Sergio Banchemo, Paul Roberts, Matt Albrecht (UWA)
Impacts of e-rideables on the transport task in WA	Chair: Michelle Prior, David Wake, Liza Picton (DOT)	Doina Olaru, Brett Smith, Tristan Reed (UWA); Courtney Babb, Parisa Izadpanahi (Curtin)
Micromobility and freight – exploring opportunities in WA	Chair: Sarah Court, Claire Thompson, Chris Grame (DOT); Max Bushell (WALGA); Anita McCracken (RAC); Wayne Bradshaw (West Cycle)	Courtney Babb, S Zaung Nau, Hui Xie, Carey Curtis (Curtin)
Transport mode choice development using PATHS data	Renlong Han, Sharif Siddique (DOT); Wes Soet (Main Roads)	Brett Smith, Doina Olaru, Tristan Reed (UWA)
Sustainable last km freight and parcel delivery system - retail and parcel delivery	Chair: Jason Gordon (DPLH); Markus Botte (Main Roads)	Sae Chi, Sharon Biermann (UWA)
Feasibility of battery-electric buses for regional school bus services	Chair: Steve Beyer, Ying Huang (DOT); John Bailly (PTA); David Edwards (Horizon Power); Sam	Thomas Braunl, David Harries, Guido Wager UWA); Mark McHenry (Murdoch)

	Wilkinson (DWER); Sam Leong, Anthony Erickson (Western Power)	
Accounting for carbon in the planning for new residential suburbs	Chair: Steve Beyer, Callie Cummings, Ryan Falconer (DOT); Melina Payne (DPLH); Greg Ryan (DevWA)	Julian Bolleter, Bill Grace (AUDRC, UWA); Chris Lund (Murdoch)
Mapping the Circular Economy of WA: Monitoring the contributions of circularity towards achieving Net Zero – Stage 1	Chair: Steve Beyer, Susie Page (DOT); Cara Francis, Ariadne McLeod (DWER); Julie Brockman (City of Canning); Jesse McDonald (SWDC), Hayley Rolfe (GHD); Helen McGettigan (IWA)	Dora Marinova, Josh Hopkins, Roberto Minunno, (Curtin)
Improved Roundabout Modelling using Drone Video analytics	Chair: Scott Aitken (Aimsun); TK Kim (Main Roads),	Chao Sun
AI-assisted Model Calibration for Real-time Traffic Simulation	Chair: Scott Aitken, Mohammad Saifuzzaman (Aimsun); Rafael Carvajal, Raj Shah, Miaad Khayatian, Steve Atkinson (Main Roads)	Chao Sun
Optimising video analytics for traffic data collection and calibration incorporating fixed camera videos	Chair: TK Kim, Raj Shah, Miaad Khayatian, Steve Atkinson (Main Roads)	Chao Sun
Freight route priority trial evaluation	Chair: Cory Ross, Ziad Boufajreldin (Main Roads)	Tele Tan, Andrew Grose, Ritu Gupta
Application of Biochar Waste in Pavement Design	Chair: Chris Skantzios, Steve Atkinson (Main Roads)	Yuxia Hu, Colin Leek, Chao Sun (UWA)
Automated intersection parameter measurement using aerial photography and computer vision - pilot		Chao Sun (UWA)

## 6. PERFORMANCE AGAINST KPIS AND TARGETS

Broad key performance indicators set for PATREC relate directly to the value-add role or purpose for which PATREC was established. The university collaborators require an increase in research profile and performance while the government partners require better evidence on which to base policy and investment and development spending decisions. Performance indicators comprise essential academic and policy impact indicators with a focus on outputs and outcomes. Performance for the year against 2024 targets as set in the Annual Business Plan 2024, is summarised in Table 13. An academic ROI indicator (project only, excluding overheads) and qualitative statement of impact have been included for the first time.

**Table 13: Key performance indicator targets and achievements (2024)**

Performance Indicator	Target 2024	Achieved as at 31 Dec 24
<b>Academic Performance Indicators</b>		
Number of journal papers published	10	7 (as per Annual Report 2024)
Number of peer-reviewed conference papers published in proceedings	0	0
Number of post graduate research students attracted, retained and/or graduated)	8	3 (retained) 1 new attracted PhD 1 awarded (Tristan Reed) (Section 3.3)
Value (\$) of research funding secured [all income except for traditional core] Note: 2025 target to also except CA core so as to reflect all income earned beyond core	\$1,867,500	\$1,740,303 (excl CA core - \$1,377,803)
Annual academic project ROI (5-yr 2021 - 2025)	3.0	3.2 (UWA: 3.7; Curtin: 2.6)
<b>Policy Impact Performance Indicators</b>		
Number of high impact, policy-informing projects/sub-projects completed	12	12 (Tables 1, 2 and 3)
Number of substantive Technical Reports/Software Systems accepted/published/delivered	12	12 (Table 4)
Number of PATREC Perspectives/iMOVE news articles published on PATREC/iMOVE websites	5	7 (Table 4)
Number of presentations at PATREC and other connection events (including conference presentations not published)	10	11 (Table 6)
Number of connection events arranged and held	3	6 (Section 3.2)
Number of short courses, unit contributions presented	0	5 (Section 3.3)
Impact statements – completed projects*		9 (Section 3.4.1)
<b>Stakeholder (academic and policy) satisfaction indicator</b>	85%	93%