PATREC

ANNUAL REPORT 2022

Planning and Transport Research Centre

April 2023

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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, Edith Cowan University, Department of Transport, Main Roads Western Australia, Western Australian Planning Commission and the Western Australian Local Government Association.

Publisher

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Contents

1. INTRODUCTION

1.1. Purpose

The primary purpose of this report is to provide an update of activities conducted in 2022 with a focus on outputs and outcomes achieved.

1.2. 2022 in Focus

Key achievements in 2022:

- Impacts of completed projects
    - Smart Transport Technologies Roadmap - informed RAC's future budget submissions (a key outcome of the project). "Many thanks to the team for the work done on the project. It has been an interesting one and we have enjoyed building stakeholder relationships and gaining a stronger understanding of how these technologies may be deployed in Perth. Until the report is published the findings are being applied within other submissions, as well as utilised on other projects. In particular, we will be continuing to explore the need for ITS architecture in WA (a critical barrier to deploying any smart tech in Perth and a priority item being addressed as part of MRWA's ITS Master Plan) (Fiona Goodbody, Manager Transport Policy, Social and Community Impact, RAC, email dated 24 January 2023)
    - Working from Home (WFH) - Changes in Transport Demand – "This project was a great example of how PATREC have responded to a pressing issue significantly impacting Australian transport systems. The original request through iMove meant that there could be coordination of similar research being conducted across the country. PATREC provided a local perspective to the Western Australian agencies involved and responded comprehensively to the scope providing insights relating to community behaviour, travel demand, modelling scenarios and policy recommendations. The work is being used to inform understanding of the impacts of the COVID-19 pandemic on the urban transport system with a particular emphasis on how strategic modelling reflects significant and unanticipated change" (Claire Thompson, email dated 24 February 2023). An iMOVE Report - Prospects for Working from Home: Assessing the evidence – was published on the iMOVE website. It comprises an overview of all the iMOVE research conducted on WFH including initial PATREC research https://imoveaustralia.com/wp-content/uploads/2022/05/Prospects-for-Working-from-Home-Assessing-the-evidence-FINAL.pdf
    - RAC Air pollution monitor independent review – "Thank you for your support to coordinate the independent review of the RAC Air Health Monitor Network. Gavin and the team from Curtin have completed their review and have been very helpful working through the recommendations with the RAC team and our partners (email Marion Morton, A/General Manager Social Impact, RAC, dated 4 November 2022). The review is acknowledged on the RAC website "Local air pollution and health experts led by Professor Gavin Pereira from Curtin School of Population Health, Curtin University and as part of the Planning and Transport Research Centre (PATREC) have provided support of the RAC Air Health Monitor through an independent review" https://rac.com.au/about-rac/advocating-change/initiatives/air-health-monitor/faqs
- New program established: Climate action in transport and land use planning program with three foundation projects agreed

- PATREC 2023-25 core research program agreed, comprising seven projects, commencing in the second half of 2023
- Substantially progressed made – six core research projects from the 2021-2023 core research program
- External projects completed
    - iMOVE Smart Transport Technology Roadmap Project (RAC, UWA) ($200k)
    - iMOVE Working from Home: Changes in Transport Demand (DOT, Main Roads, UWA, Curtin) ($240k)
    - RAC Air pollution health monitor independent review (RAC, Curtin)($18k)
- External project agreements executed and projects commenced
    - Perth Freight Route Priority System Trial Evaluation (iMOVE, Main Roads, Curtin) ($140k)
    - Improved Roundabout Modelling using Drone Video analytics (iMOVE, Main Roads, Aimsun, UWA) ($392k)
    - Innovation Connection (Metrocount) – Video analytics application (UWA, Main Roads) ($100k)
    - Optimising video analytics for traffic data collection and calibration incorporating fixed camera videos (iMOVE, Main Roads, UWA) ($200k)
- External projects substantially progressed – for completion in 2023/early 2024
    - AI-assisted Model Calibration for Real-time Traffic Simulation (iMOVE, Main Roads, Aimsun, UWA) ($400k) - progressed
    - Australian Transport Research Cloud, AURIN/Australian Research Data Commons (Uni Melbourne, UWA, Curtin) ($450k)
    - AURIN national transport domain specialist – Sae Chi 0.5 FTE appointment (Uni Melbourne) ($98k)
    - ARC Linkage participation - Map My Say (AUDRC, UWA)
- Consulting activity
    - WSP - PSP application of video analytics to cyclists and pedestrians – extension – South Perth Foreshore (Stage 2) - sub-contract to WSP (for Main Roads) ($25k) - completed
    - Collection and automatic identification of light pole assets using machine learning – application of methodology (Stage 2) (Main Roads) ($67,916k) – commenced
- New external projects under development
    - Potential for carbon capture and reduced GHG emissions through innovative asphalt pavement design – use of bio char waste (iMOVE, Main Roads, UWA) – draft agreement negotiated ($278k)
- Grant application submitted
    - ARC Industry Fellowship - Mid-career – application submitted for Chao Sun (with MRWA in-kind support and UWA cash): Evidence Based Road Design using Video Analytics Data ($1 million, 4 years) – outcome expected March/April 2023
- 9 peer-reviewed journal articles published
- Australasian Transport Research Forum (ATRF) conference – PATREC appointed to Chair and lead the local organizing committee
- Teaching and training
    - Post-graduate supervision:
        - PATREC-iMOVE PhD top-up scholarship awarded - Chao Sun successfully attracted a top-performing maths and computer science PhD student: Samson Ting (Topic: Using a data-driven approach to improve intersection modelling)
        - PATREC co-supervised (ongoing) 4 PhD students (Chao Sun,) and 2 Masters dissertations (Chao Sun, Sharon Biermann)

  - Xiaolin Tang – PhD thesis submitted for examination, supervised by Brett Smith and Sharon Biermann (Topic: Riding into the Future:
  - People's Willingness to Rideshare in Autonomous Vehicles)
- Stakeholder satisfaction indicator of 85% achieved (on target)

2. RESEARCH PROJECT ACTIVITY

2.1. Projects completed

Two major external iMOVE projects were completed:

- iMOVE Working from Home: Changes in Transport Demand (DOT, Main Roads, UWA, Curtin) ($240k), delivering seven substantive final reports:
    - Overview
    - Working from Home: Employee Perspectives - Travel and Values
    - Working from Home: Employee Perspectives – Work
    - Working from Home: Changes in Productivity
    - Working from Home: Employer Perspectives (completed in 2021)
    - Working from home: Transport infrastructure demand - scenario evaluation
    - Working from Home: Policy Response
- iMOVE Smart Transport Technology Roadmap Project (RAC, UWA) ($200k)

A small, but high impact, independent review project was undertaken for the RAC by Curtin's School of Population Health:

- RAC Air pollution health monitor independent review (RAC, Curtin)($18k)

A small extension to the consulting project for WSP was completed:

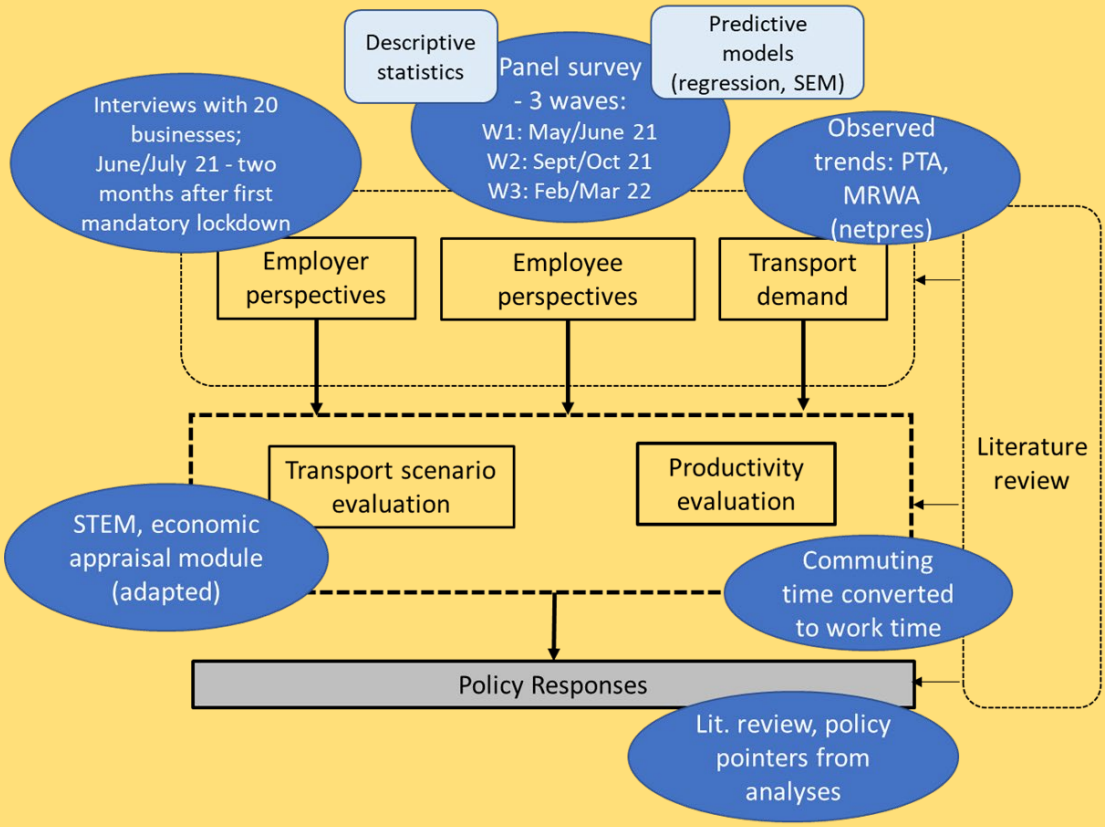
- Principal Shared Path (PSP) application of video analytics to cyclists and pedestrians – South Perth Foreshore (Stage 2) - sub-contract to WSP (for Main Roads) ($25k)

The key findings of the completed projects are summarised next.

Working from Home: Changes in Transport Demand – the Case of Greater Perth (completed)

PATREC-iMOVE Core/External Project ($240,000; November 2020 – November 2022; DPLH, Main Roads, DOT, UWA, Curtin)

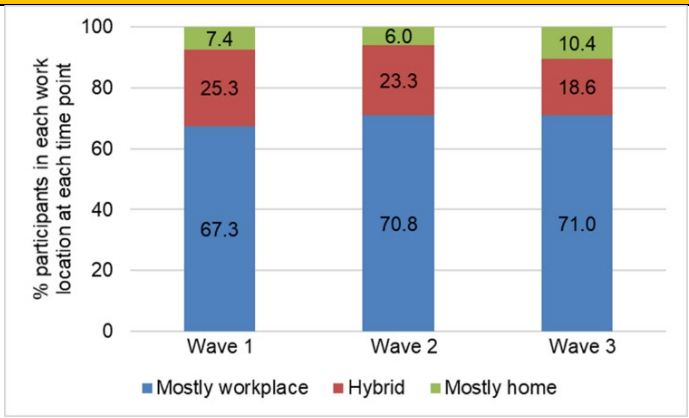
To ascertain the extent to which WFH has been undertaken and will continue to be; the productivity impact when WFH is compared to the workplace, from the perspectives of individuals, employers, and the economy at large; the proportion of reduced travel demand that is attributable to WFH; the utility of WFH as a future demand management tool for the mitigation of congestion on all transport networks; the potential for higher levels of WFH to enable expansions of the transport network to be deferred or avoided; and the facilitation steps that would be required if it became desirable to expand the level of WFH in the longer term.



Work from home, at office or a mix of both (hybrid)

- Most surveyed worked at workplace –increased between Wave 1 and 3
- Around a quarter worked hybrid – hybrid work decreased between Wave 1 and 3
- WFH - 6-10% - increased from Wave 1 to 3
- (only included those who worked >10 hours/week counted)

Panel survey - 3 waves: W1: May/June 21 W2: Sept/Oct 21 W3: Feb/Mar 22



Commuting rates, times and distance

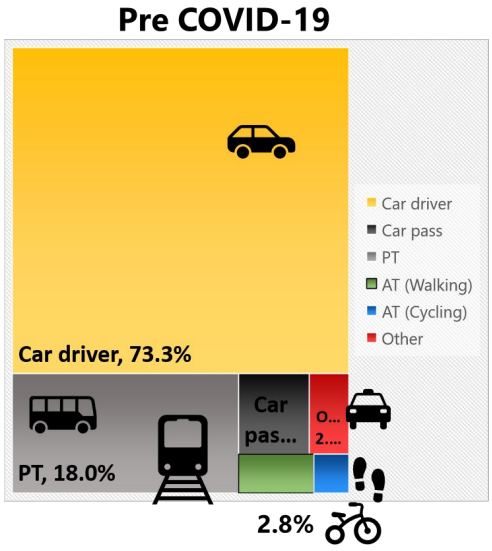
Variable	Statistic	Wave 1	Wave 2	Wave 3
Commute pre COVID-19 (trips/week)	Mean	4.36	4.31	4.38
	Std. dev.	1.54	1.50	1.48
Commute 'last week' (trips/week)	Mean	**3.93**	**4.00**	**3.80**
	Std. dev.	1.58	1.54	1.70

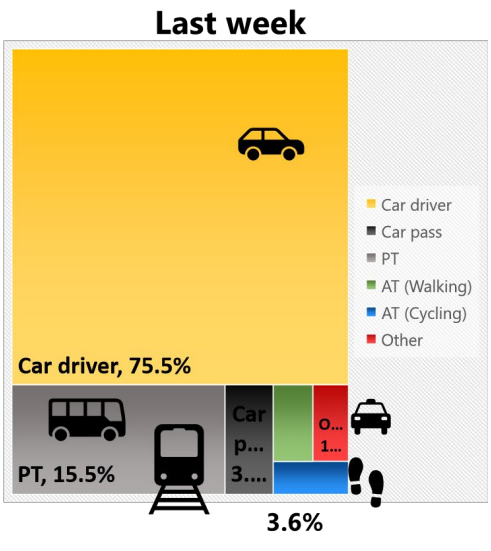
Variable	Statistic	Wave 1	Wave 2	Wave 3
Euclidean distance for commuting (km)	Mean	14.33	14.26	13.95
	Std. dev.	15.22	13.20	13.34
Time taken for commute to work (minutes)	Mean	33.06	**36.58**	**37.03**
	Std. dev.	20.58	22.43	23.82

Working from home - days of the week

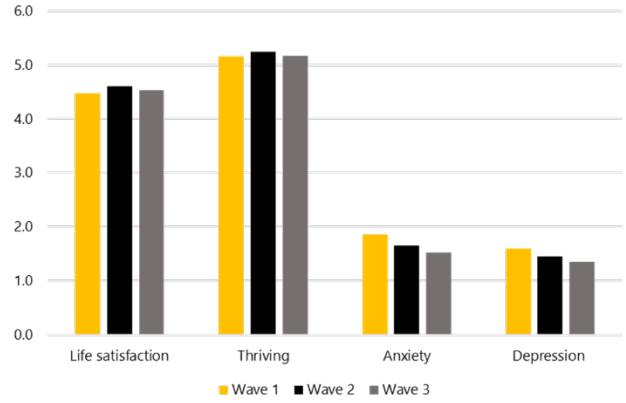
WFH only (non-commuting) %	Pre COVID-19	Wave 1	Wave 2	Wave 3
Mon	18.5	28.7	25.5	**30.6**
Tue	18.6	26.6	23.9	26.0
Wed	17.3	24.5	24.5	24.5
Thu	18.7	24.7	26.8	**30.9**
Fri	21.5	31.4	31.1	**35.5**
Sat	80.0	81.2	80.7	82.4
Sun	87.6	88.4	82.2	89.9

Mode share change





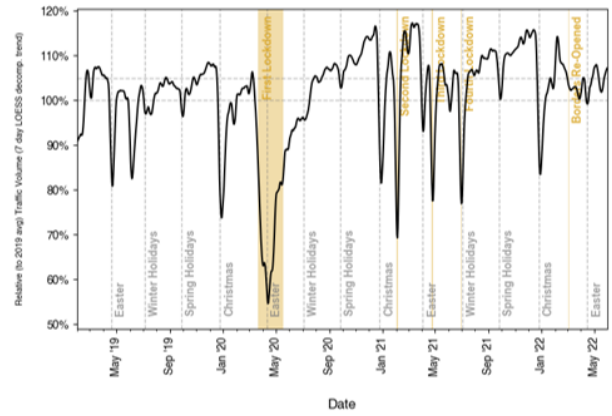
Employee work experience



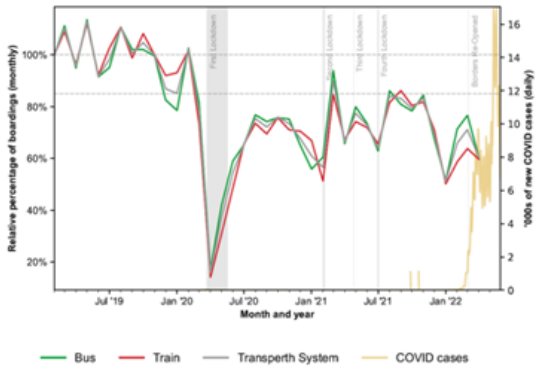
- Anxiety and depression significantly improved across time
- For hybrid workers:
  - autonomy and support drove wellbeing
  - close monitoring drove anxiety and depression

Observed change in travel patterns

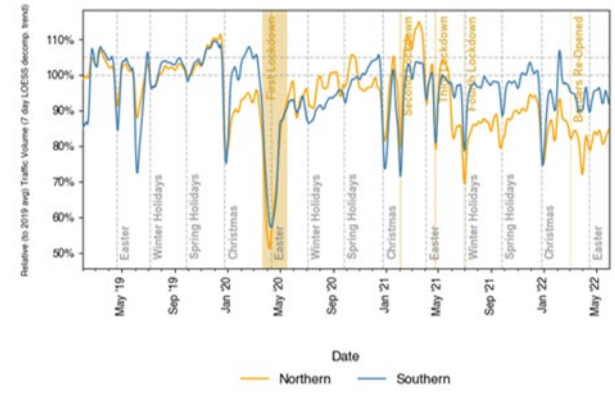
CBD CORDON TRAFFIC



PUBLIC TRANSPORT BOARDINGS



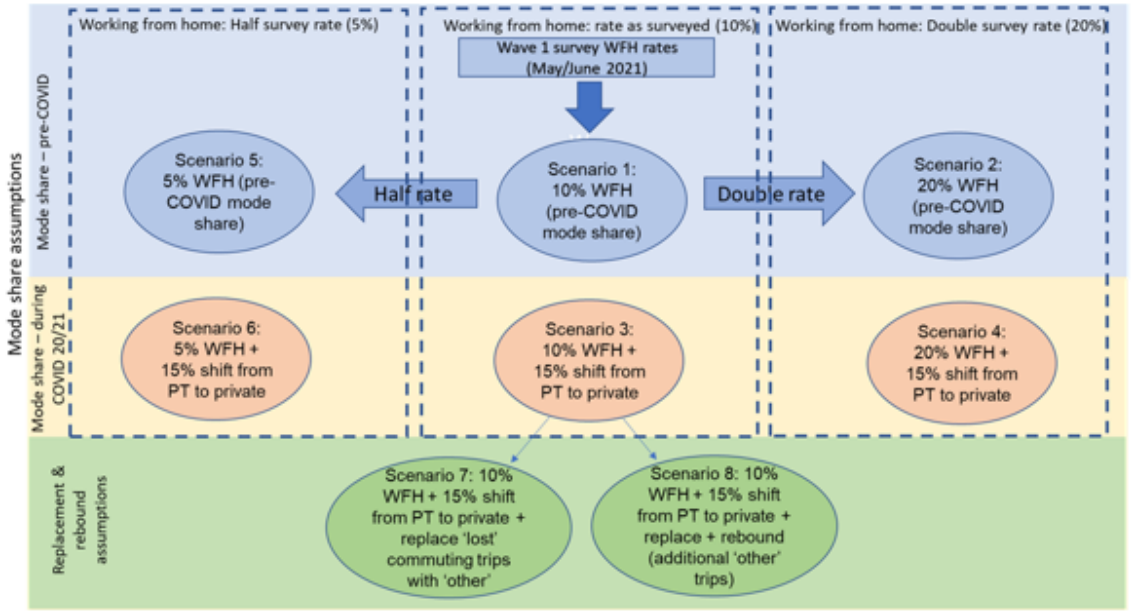
SUBURBAN TRAFFIC



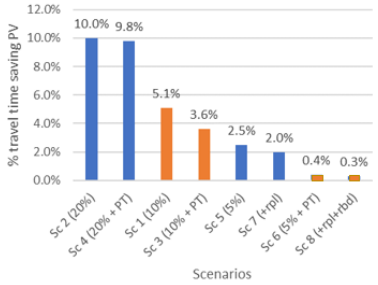
- COVID trends mapped against pre-COVID of 2019 (whole year) set at 100%
- Increase in road traffic in inner suburbs but not middle and outer suburbs
- Public transport patronage declined by 16% (at the lowest point) from pre-COVID (2019)

Transport demand network impacts for 8 scenarios

8 SCENARIOS – WFH RATE, MODE MIX, TRIP TYPE

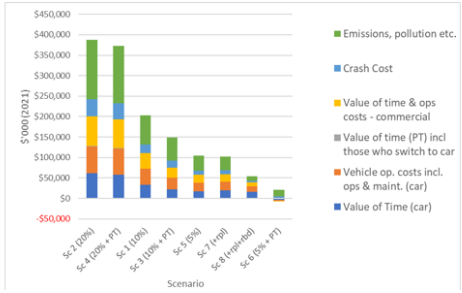


NETWORK TRAVEL TIME SAVINGS (PRIVATE)

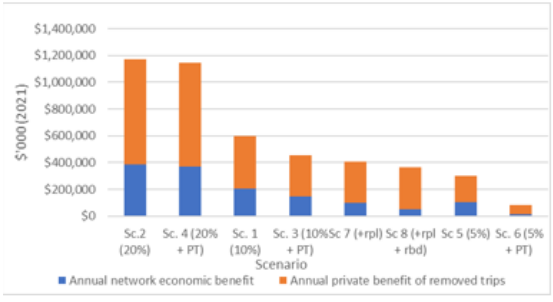


TRANSPORT NETWORK ECONOMIC BENEFITS

...accruing to travellers who remain on the network



TOTAL ECONOMIC BENEFIT



Removing 1 in 10 work commute trips (Sc 1):

- $204 million annual transport economic benefit for those remaining on the network (network benefits)
- $395 million annual transport economic benefit to those who commute less due to WFH (private benefits)

Productivity impacts

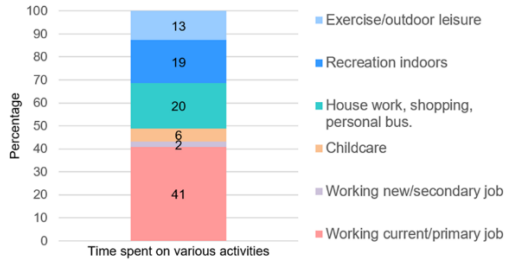


Figure E4 Percentage time saved by not commuting and spent in other activities

Average number of hours worked in last week by wave:
- Wave 1 – 32.3 hours
- Wave 2 - 34.9 hours
- Wave 3 – 35.3 hours

- Savings from commuting converted to paid and domestic work and recreation
- Productivity and well-being benefits
- Productivity gains
  - direct – more paid work
  - indirect - domestic or leisure activities
- Implied direct productivity gain
  - 1.84% for entire sample
  - 5.4% for only those respondents recording greater WFH

(wave 2 results used)

Policy recommendations

MONITOR and MODEL

- Monitoring
  - changes in WFH - frequency (days/ week), distance and modal shift
  - traffic volumes and PT patronage to
    - validate models
    - account for spatial and temporal dimensions (localised effects)
- Review current modelling practices:
  - refining trip generation rates in relation to blue and white collar workers – other categories?
  - changes in trip attractions, when WFH practices are changing
  - estimating mode choice models that acknowledge
    - changes in accessibility, perceived comfort and personal safety
    - changes in trip chaining behaviour
  - account for WFH-related productivity and wellbeing effects when estimating overall effects of WFH
  - examine the net effect of increased online deliveries, courier and express services
- More scenario analysis to
  - improve understanding of sensitivity of inputs to transport models, so can
  - focus on most relevant metrics without unnecessarily changing or complicating current models

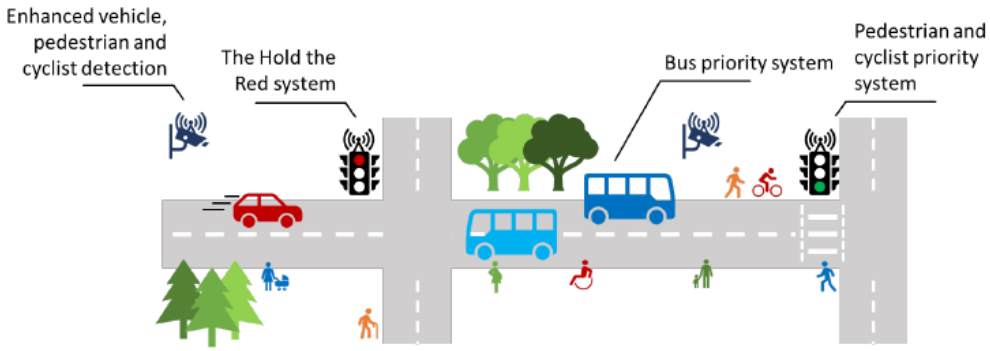
PROMOTE

- Benefits of WFH to support companies/ organisations to create flexible work policies
  - WFH across all days of the week
  - staggered start and finish times to spread peak travel
- Benefits of WFH to households through campaign led by transport professionals (similar to YourMove) with emphasis on
  - net cut in car travel
  - promoting benefits of multimodal transport (public transport, active travel and e-mobility)
- Commuter SmartRider incentives (for off-peak travel), bundles with bikes and scooters for
  - commuting
  - local travel on WFH days
- Cross-government advisory group to guide integrated action on the many policy initiatives which are interdependent

Smart Transport Technology Roadmap (completed)

PATREC-iMOVE External Project ($200,000; October 2020 – October 2022; RAC, iMOVE, UWA)

To identify promising technologies that can best address key transport and mobility challenges in Perth, Western Australia (WA) and outline a Smart Transport Technology Roadmap for the next three to five years



Preferred option: pedestrian and cyclist prioritisation and road safety improvement

Intersections with higher crash occurrences involving pedestrians and cyclists can benefit from the preferred option:

- Murray Street & Pier Street, Perth City
- Vahland Avenue & Tribute Street East, Shelley (unsignalised)
- Beechboro Road & Raleigh Road, Bayswater (unsignalised)
- Burke Drive & Honour Avenue, Attadale (unsignalised)
- Ranford Road & Brennan Avenue, Canning Vale (unsignalised)
- Brookton Highway & Solders Road, Roleystone (unsignalised)
- Horticulture Gardens & Echidna Street, Banksia Grove (unsignalised)

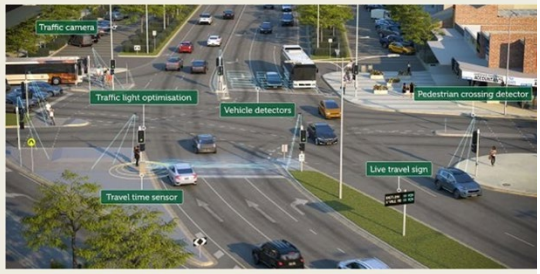


Figure 9 Smarter Roads Program (VicRoads, 2021)

- Preston Point Road & First Street, Bicton (unsignalised)
- Canning Highway & Preston Point Road, Melville (unsignalised)

Intersections with higher crash occurrences can benefit from HTR:

- Old Coast Road & Casuarina Drive, Erskine
- Ravenswood Drive & Mirrabooka Avenue, Mirrabooka
- Walcott Street & Alexander Drive, North Perth
- Tonkin Highway & Great Eastern Highway, Ascot
- Orrong Road & Francisco Street, Rivervale
- Willeri Drive & Hossack Avenue, Willetton (unsignalised)
- Alexander Drive & Gnangara, Landsdale
- Thomas Street & Roberts Road, West Perth
- Great Eastern Highway & Farrall Road, Midvale

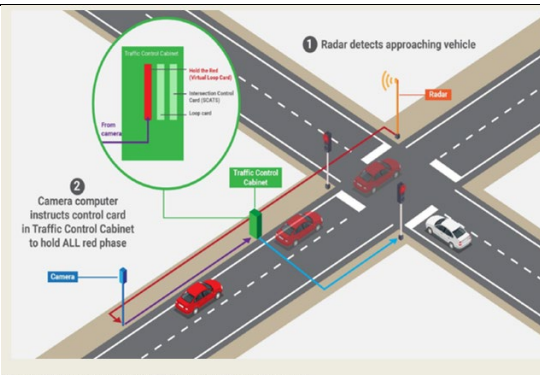


Figure 10 Hold the Red (HTR) system (Source: TMR)

- Ennis Avenue & Royal Palm Drive, Warnbro (unsignalised)
- Ranford Road & Wilfred Road, Canning Vale (unsignalised)

Bus corridors can benefit from the PT priority system:

- Canning Highway West Corridor
- CBD North-East corridor (William Street)
- CBD Western Corridor (access between Elizabeth Quay Bus Station and Mounts Bay Road)
- Stirling Highway Corridor
- CBD South-East Corridor (access between Elizabeth Quay Bus Station and St Georges Terrace)
- Wanneroo Road South Corridor
- Scarborough Beach Road Corridor
- Karrinyup and Cedric Street Corridor (approaches to Stirling Station)

Figure 4 Canning Highway West Corridor (PTA, 2018)

- Canning Highway East Corridor
- Beaufort Street Corridor

Use of automated video analytics on Principal Shared Paths – Stage 2: South Perth Foreshore (completed)

*PATREC **External** Project ($25,000; May – September 2022; WSP (for Main Roads), UWA)*

To extend the coverage of video surveys on Perth's Principal Shared Path (PSP) network to provide insights into how pedestrians and cyclists use PSPs (speed, volume, behaviour) to serve as a proof-of-concept for using video surveys as an alternative to pneumatic tubes

Figure 20 Heatmap of cyclist movements for Coode Street Crossing (Wednesday 21st March 2021)

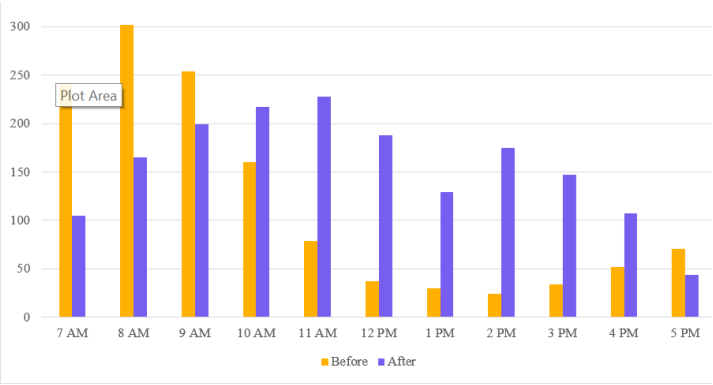


Figure 35 Cyclist Hourly Count Comparison for Coode Street Crossing (Weekend)

Comparon of behaviour before and after construction of cyclist priority crossings at 3 locations (Witcomb, Coode and Douglas)

Measured and identified:

- number of pedestrians and cyclists
- speeds of cyclists and vehicles
- conflicts between cyclists, pedestrians, vehicles
- give-way compliance
- incidence of crashes and near misses

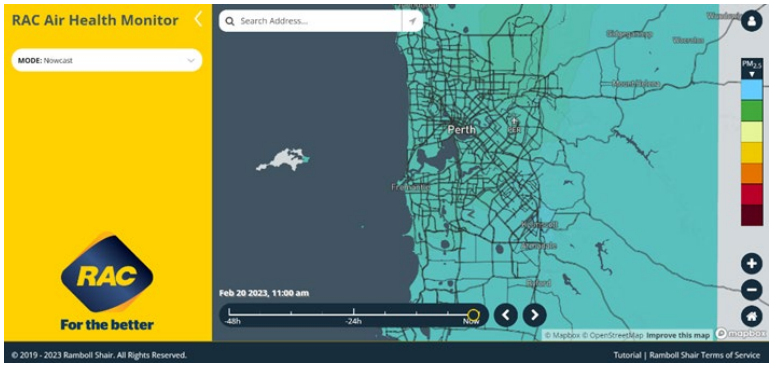
Observations:

- Cyclist speeds generally lower than observed in Stage 1 (station precincts) due to curved alignment of path
- Bollards not effective in maintaining lane discipline and could become an obstruction to path users
- Average speed of scooters and skateboards reasonable, some of the recorded maximum speeds are significantly higher than the legal speed limit
- Most vehicles followed the new priority rules after the modification, about 15-20% of them failed to give way
- Reduction in cyclist's speed after given priority is an interesting finding. Likely to be caused by cyclists slowing down to make sure vehicles are giving way to them before taking priority

RAC Air health monitor independent review (completed)

*PATREC **External** Project ($18,056.36); August – October 2022; RAC, Curtin)*

To undertake a high-level independent review ('sense check') of the RAC Air Health Monitor and its component parts. The intent is to ensure there are no obvious flaws, omissions or concerns. It is not intended to be a detailed peer review or data validation exercise and as such would be at the system and process level.



Category	$PM_{2.5}$ (ug/m³)	PM_{10} (ug/m³)	NO_2 (ppb)
Good (better than WHO threshold)	0-4	0-14	0-9
Moderate (not ideal, but better than WHO 24-hr average threshold)	5-14	15-44	10-24
Unhealthy for sensitive groups (worse than WHO threshold)	15-24	45-49	25-79
Unhealthy	25-49	50-99	80-119
Very unhealthy	50-99	100-199	120-179
Hazardous	100-299	200-599	180-239
Extreme	300+	600+	240+

- Air Quality Information representation – monitor to align with national initiatives to harmonise public air quality information
- Sensor calibration - compare performance between different seasons
- Modelling and heatmapping - undertake validation using independent data not used in model fusion
- Overall credibility and communication – promote the peer-reviewed methodology, expansive sensor network, multiple levels of modelling and inclusion of schools

2.2. Core research program 2021-23 progressed

Six projects comprising the program of core-funded research projects (2021-2023) progressed to the satisfaction of project steering committees, the PATREC Research Advisory Committee and the Board. Most projects were on-track and in cases where projects were running behind schedule, satisfactory plans were in place to get back on track (Table 1).

Table 1: Progress of core projects (2021-23 program of research)

Project Title	Key Agency	Research Lead	Uni/s	Budget ($)	Progress as at 9 March 2023
2021-23 core program of research					
Transport Environment and Kids… 15 Years On	DoT/DPLH	Gina Trapp	UWA	100,000	Back on track after an 11 months delay in obtaining approvals from the Dept of Education. Approval now received to survey at schools but scope had to be amended since approvals do not allow mapping component.
Identifying opportunities to address transport disadvantage	DoT (DoC)	Sae Chi	PATREC, UWA, Curtin	99,594	Potential concerns with quality of outputs. Satisfied that concerns being addressed at the project level as well as with the DOT PRAC member.
Freight network to support NW freight task	DoT/DPLH	Kerry Brown	*ECU*	84,930	On track. Draft Economic Changes and Outlook briefing paper prepared; grey literature reviewed for economic outlook and for NW region; literature collation and review to inform the interview and survey questionnaire; survey development; ethics approval granted.
Integrating AI and IoT based Bridge Health Monitoring	Main Roads	Jun Li	Curtin, UW	270,407	On track. Final milestone delivery expected 31 March 2023
Model of delay at traffic signals (Value Driver)	Main Roads	Chao Sun	PATREC/U	120,000	On track. Performance evaluation of preliminary models presented to the SC; further refinement to capacity and arrival flow rate for the queueing model; model performance checked against the turn by turn delay time sample data from MR.
ML models for road maintenance investment decision making	Main Roads	Chao Sun	PATREC	100,000	On track. Stakeholders have agreed two new objectives for this project: 1) Model experts' decision making on rehab, with a focus on rural roads because there's not much rehab work in metro and 2) incorporating customer satisfaction into investment decision making. Agreement timeframe and milestone delivery will be revised
2019-22 core program of research					
Enhanced vehicle detection at Traffic Signals and Smart Freeways	Main Roads	Mohammed Bennemoun	UWA	95,400	Behind schedule but procurement now nearing completion and preliminary construction pricing has removed reduced budgetary risks for Main Roads. A revised schedule will be provided when construction has been scheduled by Main Road's construction partner. Expected by end of March 23.

The last remaining core project of the 2019-21 research program: Enhanced vehicle detection at traffic signals and smart freeways, is yet to be concluded. Sensor deployment by Main Roads has been held up by significant delays in supply of materials due to COVID and global supply chain issues. Deployment of sensors is unlikely to be completed prior to 28/02/2023, in which case, the project would end in mid-2024.

2.3. External projects progressed

Significant progress was made on external projects which are those which do not received any core funding (Table 2).

Table 2: Summary of progress with external projects

External Project	Progress update as at 17 November 2022
AURIN – national transport domain specialist: Dr Sae Chi, $98k)	70% complete. Sae Chi appointed for 0.5FTE, 1 February 22 to 31 June 2023
Australian Transport Research Cloud (ATRC) (Lead: Sharon Biermann; Data Commons, AURIN, UWA, Curtin, 450k, 3 years, ends June 23)	70% complete - Accessibility tool (ADAPT) in Cloud; use cases with local stakeholders – cycling, transport disadvantage

Improved Roundabout Modelling using Drone Video analytics (Lead: Chao Sun; iMOVE, MRWA, UWA, Aimsun) ($392k)	Agreement executed on 26 April 2022. 20% complete
Innovation Connection (Metrocount) – Video analytics application (Lead: Chao Sun) ($100k)	Agreement signed 11 January 2022. 20% complete
AI-assisted Model Calibration for Real-time Traffic Simulation (Lead; Chao Sun; iMOVE, MRWA, Aimsun, UWA, $400k)	Agreement executed 17 September 2021. Delayed commencement waiting for Aimsun software supply. 20% complete.
Optimising video analytics for traffic data collection and calibration incorporating fixed camera videos (Lead: Chao Sun; MRWA, iMOVE, UWA, $200k)	Agreement executed on 6 September 2022; project commenced
Freight route priority trial evaluation (Lead: Tele Tan; iMOVE, MRWA, Curtin, $140k)	Agreement executed on 14 October 2022. Services Agreement with Curtin in process
Application of Biochar Waste in Pavement Design ($200)	Agreement under negotiation (MRWA, iMOVE, UWA)
A comparative assessment of C-ITS technologies to inform decisions on deployment in Australia ($140k)	iMOVE EOI submitted 20 July 2022 (ECU, Curtin) - unsuccessful
National Cycling Data and Analytics Platform (NCDAP) – ARC LIEF	Grant application with UNSW lead (Curtin, UWA) – unsuccessful; re-submission commenced as part of new round
ARC Industry Fellowship - Mid-career – Chao Sun (with MRWA in-kind support and UWA cash): Evidence Based Road Design using Video Analytics Data ($1 million, 4 years)	Grant application submitted 20 October 2022. Anticipated outcome - 24 April to 8 May 2023
Methodology advice and review for the Westport Supply Chain Integrated Design Modelling project (Invited review - Chao Sun, Brett Smith, Doina Olaru, $59k)	Agreement in process (Deloitte Access Economics, UWA)

2.4. New research program (2023-25) agreed

Seven priority projects were approved by the Board to commence in mid-2023, continuing through to late 2024/early 2025 (Table 3).

Table 3: New core projects (2023-25 program of research)

Title	Sponsor	University/s
Automated intersection parameter measurement using aerial photography and computer vision - pilot	MRWA	UWA
Evaluate the efficiency and economic benefit of spray injection pothole repair	MRWA	UWA
Evaluation of road safety treatments - road safety trial design and evaluation	MRWA	UWA
Evaluation of road safety treatments - video analytics		
Impacts of e-rideables on the transport task in WA	DoT	UWA/Curtin
Micromobility and freight – exploring opportunities in WA	DoT	Curtin
Transport mode choice development using PATHS data	DoT	UWA/Curtin

Designing a sustainable last km freight and parcel delivery system for Perth and Peel - retail and parcel delivery	DPLH	ECU
Designing a sustainable last km freight and parcel delivery system for Perth and Peel - comparative insights across a range of sectors/supply chains		UWA

2.5. New climate action program agreed

A new program of research: Climate Action in Transport and Land use Planning was agreed by the Board, to run in parallel, ultimately interacting, with the current PATREC research program.

The development of three project proposals commenced:

- Feasibility of battery-electric buses for regional school bus services (UWA)
- Mapping the circular economy of WA: Monitoring the contributions of circularity towards achieving Net Zero (Curtin)
- Accounting for carbon in the planning for new residential suburbs (Australian Urban Design Research Centre (AUDRC), UWA.

More details of this new program of research can be found in the PATREC Strategic Plan 2023-25.

3. KNOWLEDGE TRANSFER

3.1. Research outputs

The focus of PATREC's research outputs in 2022 was on the publication of technical reports for completed projects – eight reports were produced (Table 4).

Nine peer-reviewed journal papers were published in 2022 (Table 3) with 12 journal papers progressed (submitted, re-submitted or accepted for publication) (Table 5). Twelve seminar/webinar presentations were given by PATREC associates at PATREC and other industry-organised events (Table 6). Three news articles and a webinar video based on PATREC-research were published on the iMOVE website with links provided from the PATREC website (Table 4).

Table 4: Research publication outputs in 2022

Publication Title	Authors	Date
RESEARCH PROJECT TECHNICAL REPORTS COMPLETED		
Working from Home: Changes in Transport Demand – the Case of Greater Perth: Overview Report	Carey Curtis, Sharon Biermann, Doina Olaru, Caroline Knight, Julie Lee, Brett Smith, Tristan Reed, Kirsten Martinus	Nov 22
Working from Home: Employee Perspectives - Travel and Values	Doina Olaru, Tristan Reed, Sharon Biermann	Sept 22
Working from Home: Employee Perspectives – Work	Caroline Knight	Sept 22
Working from Home: Changes in Productivity	Kirsten Martinus, Brett Smith	Sept 22

Working from Home: Transport infrastructure demand - scenario evaluation	Brett Smith, Tristan Reed, Sharon Biermann	May 22
Working from Home: Policy Response	Carey Curtis, Jan Scheurer	Sept 22
A Smart Transport Technology Roadmap for Perth	Sae Chi, Sharon Biermann, Farid Boussaid, Tristan Reed, Doina Olaru	Oct 22
South Perth Foreshore Bike Path Video Surveys	Chao Sun, Sergio Banchero, Daniel Demiris	Sept 22

PEER-REVIEWED JOURNAL PAPERS PUBLISHED

Booth, L., Tan, T., Norman, R., Anund, A. and Pettigrew, S., 2022. Experiences of older adults interacting with a shared autonomous vehicle and recommendations for future implementation. *Transportation Research Part F: Traffic Psychology and Behaviour*, 90, pp.100-108.

Cardell-Oliver, R. and Olaru, D., 2022. CIAM: A data-driven approach for classifying long-term engagement of public transport riders at multiple temporal scales. *Transportation Research Part A: Policy and Practice*, 165, pp.321-336.

Chi, S., & Mazzer, S. (2022). Identifying MaaS schemes that maximise economic benefits through an economic appraisal. *European Journal of Transport and Infrastructure Research*, 22(4), 1-24.

Goudarzi, F.S., Olaru, D. and Bergey, P. (2022). Beyond risk attitude: Unpacking behavioural drivers of supply chain contracts. *International Journal of Production Economics*, 255, p.108678.

Kiani Mavi, R, Kiani Mavi N, Olaru, D, Biermann, S & Chi, S. (2022) Innovations in freight transport: A systematic literature evaluation. *International Journal of Logistics Management, Special Issue: Bridging the Research Practice Gaps in Supply Chain Management: Lessons from COVID 19*.

Martinus, K and Biermann, S. (2022) Addressing Structural Inequality of Employment Redistribution Policy Targets, *Land Use Policy*.

Cervigni, E., Olaru, D., Hickling, S. & Haslam-Mckenzie, F. (2022) Using aggregated mobile phone location data to measure foodscape exposure in the activity spaces of different socio-economic groups, *Health and Place.*

Knight, C, Olaru, D, Lee, J & Parker, S (2022). Office support is more important than home support for hybrid workers. *MIT Sloan Management Review*.

Zaitounya, A., Fragkou, A., Stemler, T., Walker, D., Sun, Y., Karakasidis, T., Nathanail, T. & Small, M. (2022) Multiple sensors data integration for traffic incident detection using the Quadrant Scan, *Sensors*.

PATREC PERSPECTIVES, BULLETINS, ARTICLES, VIDEOS PUBLISHED

iMOVE: Smart bridge health monitoring and maintenance prediction, 15 February 2022 https://imoveaustralia.com/project/smart-bridge-health-monitoring-and-maintenance-prediction/

iMOVE: A model for estimating delays at traffic signals, 3 March 2022 https://imoveaustralia.com/project/real-time-model-for-estimating-delays-at-traffic-signals/

iMOVE: Improving roundabout modelling using drone video analytics, 11 May 2022 https://imoveaustralia.com/project/improving-roundabout-modelling-using-drone-video-analytics/

iMOVE: Data and simulation: Improving Perth's road network performance, 9 June 2022 https://imoveaustralia.com/project/project-outcomes/data-and-simulation-improving-perths-road-network-performance/

iMOVE: Better video analytics for traffic data collection via fixed cameras, 30 November 2022 https://imoveaustralia.com/project/better-video-analytics-for-traffic-data-collection-via-fixed-cameras/

Table 5: Journal papers in-progress in 2022 (Submitted, Re-submitted, Under Review or Accepted for Publication)

Paper
Banchero, S., Sun, Y., Stemler, T. Multi-objective graph partitioning for the MFD-based perimeter control of an urban network, *IEEE Access*. **Resubmitted**
Cummins, L., Sun, Y., & Reynolds, M. Intelligent Pick-up and Drop-off System for Passenger Vehicles. *Transportation*. **Resubmitted**
Sun, Y., Cummins, L., Ji, Y. & Pritchard, N. Modelling Uncertainties for Automated and Connected Vehicles in Mixed Traffic, *Transportation*. **Resubmitted**
Vo, L, Martinus, K and Smith B. A Demand Systems Approach to Understanding Medium-Term Post-Pandemic Consumption Trends, *Economic Papers*. **Resubmitted**

Table 6: Seminars, online webinar and conference presentations

SEMINAR/WEBINAR/CONFERENCE PRESENTATIONS
Chao Sun presented on his research into the application of video analytics for PSP at a forum at Main Roads: Knowledge Sharing-Automated Intelligence (AI) for Video Analysis held on Tuesday, 8 February 2022
Invited presentation to the ATS (Active Travel to School) Working Group on 2 February 2022 on the iMOVE TRavel Environment and Kids (TREK) project by Anna Gannett
Presentation at AITPM virtual event on active transport, 21 April 2022 - 'Automated Intelligence for Analysing Cyclist and Pedestrian Video Surveillance' (Chao Sun, Craig Wooldridge)
iMOVE Working from home Collaboration Forum – 2 invited presentations: • Scenario travel demand evaluation, by Tristan Reed and Brett Smith on 29 March 2022 • Project Overview by Sharon Biermann and Doina Olaru on 2 August 2022
Sun, Y., Banchero, Pearse, J., Demiris, D. & Wooldridge, C., Use of Automated Video Surveys on Shared Paths, *2022 Australasian Road Safety Conference* (28 – 30 Setember).
Chao Sun and Craig Wooldridge gave an online video presentation: Video analytics and cycling, at the AITPM 2022 Technical Conference Series, Automation Session, 7 – 25 November with Q&A session on 24 November 2022.
Chao Sun presented at an AITPM online event - Transport modelling research across Australia, 27 October 2022 on the iMOVE project: Applying perimeter controls to larger urban regions to regulate traffic at a system-wide level by optimizing flow in each region
Olaru, D., Kiffin-Petersen, S., Purchase, S., and Smith, B. (2022) Using Natural Language Processing to Analyse Trust in Autonomous Vehicles (AV), Paper presented at the *1st Asia-Pacific Business Analytics Conference*, Perth, October 21, Australia.
Smith, B., Reed T. and Biermann, S. (2022) Economic Appraisal of increased incidents of Working from Home: A Road Transport Scenario Evaluation for Perth Metropolitan Area, Paper presented at the *1st Asia-Pacific Business Analytics Conference*, Perth, October 21, Australia.
iMOVE Working from home project online dissemination seminar held on 14 November 2022, with **presentations**: ○ Carey Curtis — Project Overview and Employer Perspectives ○ Doina Olaru — Employee Perspectives: Travel ○ Caroline Knight — Employee Perspectives: Work ○ Tristan Reed, Brett Smith — Travel Demand Trends and Scenarios ○ Kirsten Martinus — Productivity Impacts ○ Carey Curtis — Recommendations and Results in Wider Context
Gannett A, Mandzufas J, Hooper P, Saunders J, Trapp G, (2022). Investigating the walkability of primary, secondary and K-12 schools across metropolitan Perth, Western Australia, *Asia-Pacific Society for Physical Activity Annual Conference*, Nov 28-29, Melbourne**.** Poster presentation

CONFERENCE PAPERS PRESENTED AND PUBLISHED
Kamal, M. and Mansoor, A., 2022. Structural Health Monitoring and IoT: Opportunities and Challenges. In International Conference on Intelligence of Things (pp. 3-15). Springer, Cham. **Presented and published**
Chi, S., & Mazzer, S. (2022). Identifying MaaS schemes that maximise benefits to society through an economic appraisal framework. In Australasian Transport Research Forum 2022 Proceedings Australasian Transport Research Forum. **Presented and published**
Chi, S., Golbabaei, F., Biermann, S., & Reed, T. (2022). Defining transport disadvantage in Perth: early findings. In Australasian Transport Research Forum 2022 Proceedings Australasian Transport Research Forum. **Presented and published**
Tang, X. (2022) Autonomous Vehicles and Ride-pooling: Insights from a qualitative study, *Australasian Transport Research Forum 2022* Proceedings, September, Adelaide, Australia. **Presented and published**
Gannett A, Mandzufas J, Hooper P, Saunders J, Trapp G, (2022). Investigating the walkability of primary, secondary and K-12 schools across metropolitan Perth, Western Australia, *Asia-Pacific Society for Physical Activity Annual Conference*, Nov 28-29, Melbourne**. Presented**
Olaru, D., Kiffin-Petersen, S., Purchase, S., and Smith, B. (2022) Using Natural Language Processing to Analyse Trust in Autonomous Vehicles (AV), Paper presented at the *1st Asia-Pacific Business Analytics Conference*, Perth, October 21, Australia. **Presented**
Smith, B., Reed T. and Biermann, S. (2022) Economic Appraisal of increased incidents of Working from Home: A Road Transport Scenario Evaluation for Perth Metropolitan Area, Paper presented at the *1st Asia-Pacific Business Analytics Conference*, Perth, October 21, Australia. **Presented**
Sun, Y., Banchero, Pearse, J., Demiris, D. & Wooldridge, C., Use of Automated Video Surveys on Shared Paths, *2022 Australasian Road Safety Conference* (28 – 30 September). **Presented**

3.2. PATREC connection opportunities and events

PATREC research seminar held on 9 September 2022: Contemporary planning and emergent futures: a comparative study of five capital city-regions on four continents by Professor Alan Mabin, School of Architecture and Planning, University of the Witwatersrand, Johannesburg.

A working from home project online dissemination seminar held on 14 November 2022.

3.3. Teaching and training

- PhD student supervision: PATREC co-supervised 4 PhD students (Chao Sun, Sharon Biermann):
    - Samson Ting (PhD) co-supervised with Thomas Stemler - data-driven approach to improve intersection modelling (PATREC and iMOVE top-up scholarship)
    - 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
    - Xiaolin Tang (PhD) co-supervised with Brett Smith from Business School – submitted for examination (November 2022). Title: Riding into the Future: People's Willingness to Rideshare in Autonomous Vehicles.
- Masters supervision: PATREC co-supervised 2 Masters students (Sharon Biermann, Sae Chi)
    - Tianqi Xiao (Master of Urban Planning – Practicum), co-supervised by Sharon Biermann and Sae Chi
    - Marcus Jih Jie Lim (Master of Urban Planning – Practicum), co-supervised by Sharon Biermann and Sae Chi
- Director repeated two Transport Geography lectures at UWA on 10 May 2022 and 17 May 2022 – recordings from last year updated and re-used.

3.4. Research impact

3.4.1. Research project outcomes

For completed projects, steering committee chairs/representatives provided feedback on the output quality and value for policy formulation.

Smart Transport Technologies Roadmap - the RAC advised that a key outcome of the project is to inform RAC's future budget submissions. "Many thanks to the team for the work done on the project. It has been an interesting one and we have enjoyed building stakeholder relationships and gaining a stronger understanding of how these technologies may be deployed in Perth. At this stage we are not planning to publish the report in its existing format and will instead look to apply the findings within other submissions, as well as utilise them on other projects. In particular, we will be continuing to explore the need for ITS architecture in WA (a critical barrier to deploying any smart tech in Perth and a priority item being addressed as part of MRWA's ITS Master Plan)" (Fiona Goodbody, Manager Transport Policy, Social and Community Impact, RAC, email dated 24 January 2023)

Working from home: Changes in Transport Demand – the Case of Greater Perth

- PATREC research was incorporated into a published iMOVE Report - Prospects for Working from Home: Assessing the evidence https://imoveaustralia.com/wp-content/uploads/2022/05/Prospects-for-Working-from-Home-Assessing-the-evidence-FINAL.pdf
- "This project was a great example of how PATREC have responded to a pressing issue significantly impacting Australian transport systems. The original request through iMove meant that there could be coordination of similar research being conducted across the country. PATREC provided a local perspective to the Western Australian agencies involved and responded comprehensively to the scope providing insights relating to community behaviour, travel demand, modelling scenarios and policy recommendations. The work is being used to inform understanding of the impacts of the COVID-19 pandemic

on the urban transport system with a particular emphasis on how strategic modelling reflects significant and unanticipated change" (email from Claire Thompson dated 24 Dec 23).

RAC Air pollution monitor independent review – "Many thanks to the team for the work done on the project. It has been an interesting one and we have enjoyed building stakeholder relationships and gaining a stronger understanding of how these technologies may be deployed in Perth. Until the report is published the findings are being applied within other submissions, as well as utilised on other projects. In particular, we will be continuing to explore the need for ITS architecture in WA (a critical barrier to deploying any smart tech in Perth and a priority item being addressed as part of MRWA's ITS Master Plan)".
https://rac.com.au/about-rac/advocating-change/initiatives/air-health-monitor/faqs

Principal Shared Path (PSP) application of video analytics to cyclists and pedestrians. Chao Sun presented his research on the application of video analytics to a AITMP virtual event on active transport, held on 21 April 2022 - 'Automated Intelligence for Analysing Cyclist and Pedestrian Video Surveillance'. Positive feedback was obtained from the AITPM organisers:

- "It's an impressive piece of research and we had plenty of interest in the Q&A session, so it's clearly striking a chord"
- "…impressed with the capability that you're building over there, and …surprised at what was possible".

3.4.2. Awards

- PATREC Video Analytics Team was awarded the School of Social Sciences Award in Research Impact and Innovation (2022) 5 September 2022
- iMOVE video competition – one of four awards was given to the video about the PATREC/iMOVE project: Transport Environment and Kinds – 15 year on (Lead: Anna Gannett, Telethon Kids Institute, UWA) https://imoveaustralia.com/news-articles/intelligent-transport-systems/2022-best-project-video-competition/

3.4.3. Media

Caroline Knight conducted radio interviews arising from the MIT Management Review article on **working from home** and loneliness:

- ABC RN Drive 05.05.22
- https://www.abc.net.au/radionational/programs/drive/hybrid-workers-balancing-convenience-with-lonliness/13868650
- RTR FM 05.05.22
- 6PR Perth 04.05.22
- ABC Perth 04.05.22
- Curtin FM 13.05.22
- ABC RN Your Working Life episode - aired 5 May 2022:

https://www.abc.net.au/radionational/programs/this-working-life/feeling-lonely-when-working-from-home-you%E2%80%99re-not-alone.-here%E2%80%99s/13922008

3.4.4. Stakeholder satisfaction survey results

The satisfaction survey for 2022, was conducted in February/March 2023, circulated to 153 stakeholders directly involved in PATREC research during 2022, with a response rate of 24% (n=37). University partners comprised 43% of respondents (down from 52% in 2021), with 49% government respondents (up from 32%) and 8% "other" (down from 16%) (Figure 1a). A percentage satisfaction rate of 85% was achieved (n=35; 2 university "grudge" responses excluded as no evidence of considered distinction between responses to question). This is down 7% on the 2021 score of 92% and the lowest since 2018 (Figure 1a). The difference

from 2021 is largely due to a shift of around 40% of government responses from 'strongly agree' to 'somewhat agree' (Figure 1b).

Despite the downward trend, 2022 satisfaction levels retain 'strongly agree' as the largest category with 89% agreeing (strongly or somewhat) to satisfactory performance (Figure 2a). 57% of respondents 'strongly agreed' to overall satisfaction with PATREC's performance, 32% 'somewhat agreed', 5% (two government respondents) 'somewhat disagreed' and 5% (two university respondents) disagreed. Highest satisfaction was in relation to questions of good interactions amongst partners, extending the knowledge base and networks (Figure 2b). As in past surveys, lowest levels of 'strongly agree' relate to understanding each other's needs and bridging the gap between research and policy. More detailed results for each question are provided in Figure 3.

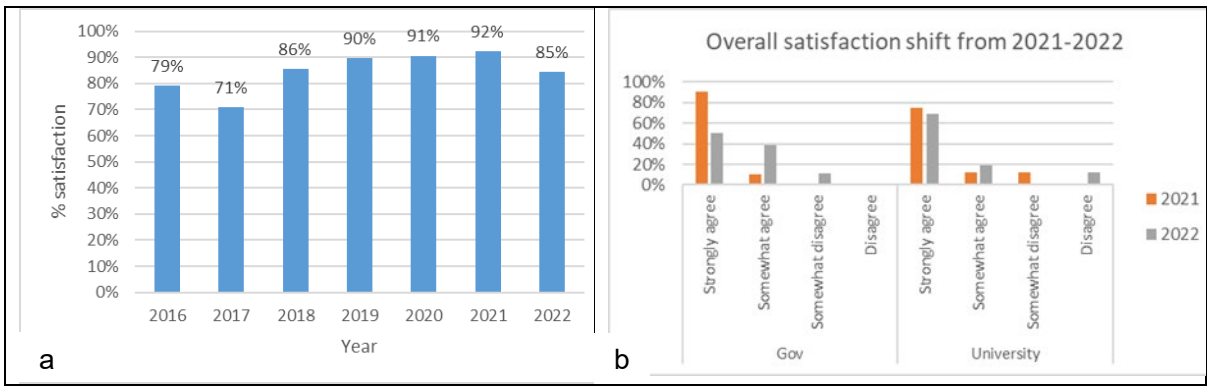


Figure 1: Trends in overall satisfaction with PATREC's performance

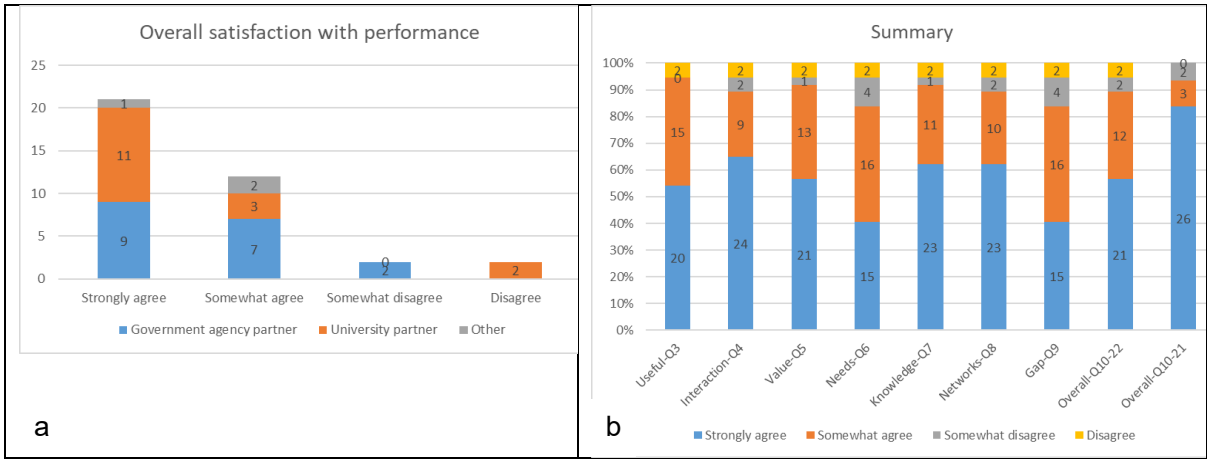


Figure 2: 2022 PATREC satisfaction survey response numbers and results (at Feb/March 2023)

Suggestions provided by respondents:

- PATREC has been very helpful in bridging the gap between government and the University. The only complaint is not really about PATREC, but about the extra paperwork involved with iMOVE (i.e. quarterly reporting, communicating about all presentations/publications, etc.). These requirements may be simple, but do add an extra step in the process
- Project based funding has its merits but it creates difficulties in building a strong team in the long run
- Internships would be another avenue to strengthen the link between government and universities

- There have been some delays in the projects due to researchers leaving the university and then takes time to recruit new people. It will be good to have a back-up plan by having more people involve in the research at the same time if possible
- Greater willingness to take on ideas/feedback, interpret results and consider application of insights.
- Research projects should be disseminated timely between all partners and researchers so all people have equal opportunity
- More collaboration
- Look at potential to draw on other sources of expertise within participating universities, e.g. Centre for Social Impact, for relevant proposals/projects
- An understanding of the level of involvement of the associates would be useful. Perhaps a question capturing the amount of time dedicated to interactions with the PATREC partners outside the organisation would be useful

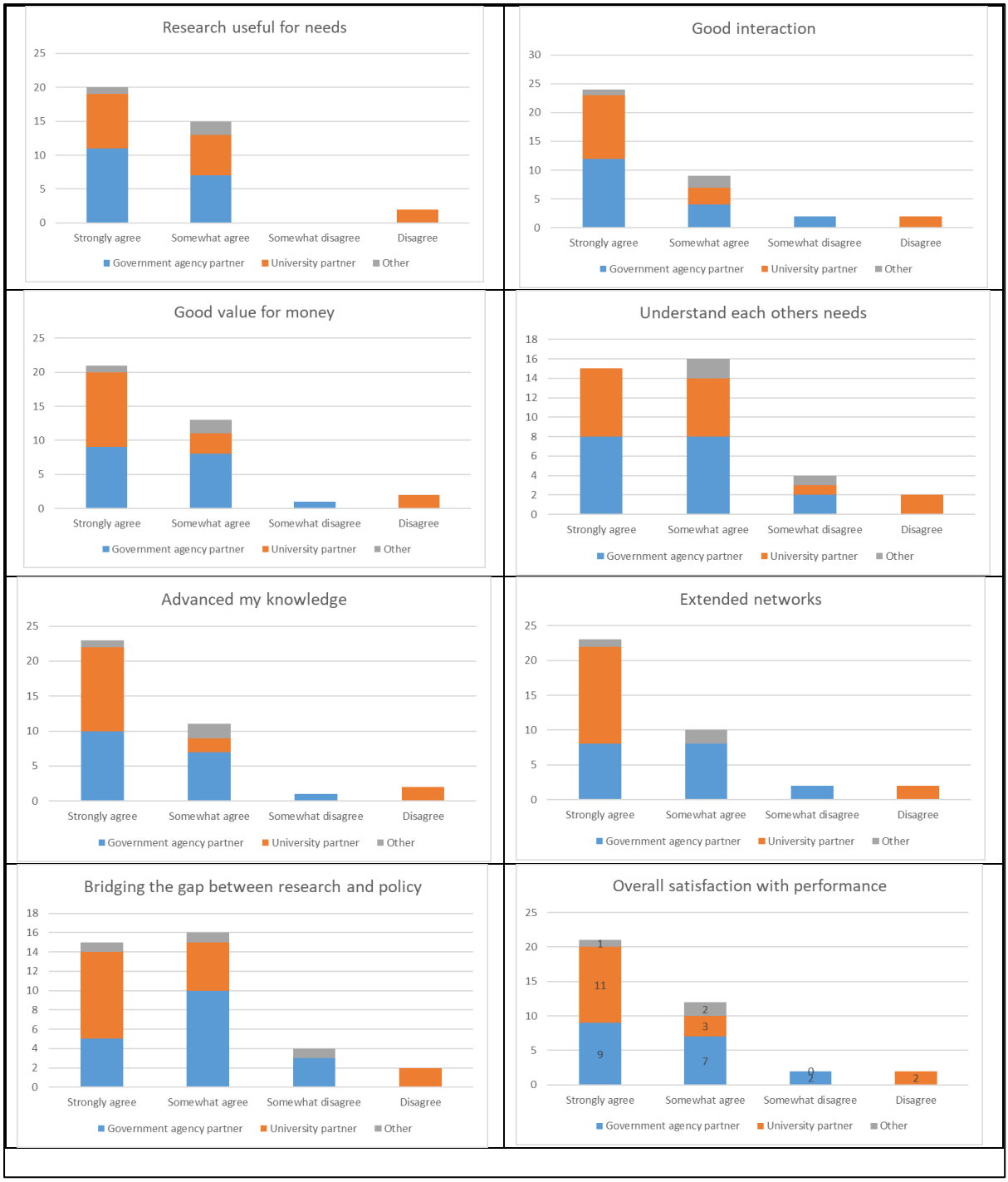


Figure 3: Individual question results

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, are called upon to conduct policy-informing, applied research.

The research team is broadly consistent with that presented in the Strategic Plan with extensions to expiring fixed-term and casual contracts taking place in late 2022 to ensure resourcing is secured to deliver on concluding and commencing core projects and external projects (Table 7). The new climate action program has broadend 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 (0.4 FTE)
Charise Baker	PATREC office - Senior Administrative Officer (0.6 FTE)
Sharon Biermann	Research - Director – 0.6 FTE
Yuchao Sun	PATREC Senior Research Fellow (traffic engineering); 1.0 FTE
Sae Chi	PATREC Research Fellow (transport economics); 1.0 FTE
Tristan Reed	PATREC Research Fellow (spatial analytics), Curtin (0.8 FTE)
Sergio Matias	PATREC Research Assistant (1.0 FTE)
Nicholas Pritchard	PATREC Research Assistant (part time)
Demiris Daniel	PATREC Research Assistant (part time)
Liam Cummins	PATREC Research Assistant (part time)
Tom Lymburn	PATREC Research Assistant (part time)
Max Davidson	PATREC Research Assistant (part time)
Samson Ting	PATREC PhD scholarship, research assistant (part time)
Finn Edgar	PATREC Research Assistant (part time)
Padraig Lamont	PATREC Research Assistant (part time)
Doina Olaru	Research Associate, UWA Business School
Kirsten Martinus	Research Associate, UWA Geography
Brett Smith	Research Associate, UWA Business School
Julie Lee	Research Associate, UWA Business School
Thomas Stemler	Research Associate, UWA Mathematics
Michael Small	Research Associate, UWA Mathematics and Statistics
Shannon Dee Algar	Research Associate, UWA Forrest Prospect Fellow, Maths and Statistics
Atif Mansoor	Research Associate, UWA Computer Science and Software Engineering
Robert Lee	Research Assistant, UWA Computer Science and Software Engineering
Mark Reynolds	Research Associate, UWA Physics, Mathematics, Computing
Farid Boussaid	Research Associate, UWA Electrical, Electronic & Computer Engineering

Mohammed Bennamoun	Research Associate, UWA Electrical, Electronic & Computer Engineering
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 Albrechts	Research Associate, WA Centre for Road Safety Research, UWA
Laura Fruhen	Research Associate, School of Psychological Science, UWA
Gina Trapp	Research Associate, Telethon Kids, UWA
Anna Gannett	Research Assistant and PhD candidate, Population and Global Health, UWA
Paula Hooper	Research Associate, AUDRC, 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
Jun Li	Research Associate, Civil and Mechanical Engineering, Curtin
Wensu Chen	Research Associate, Civil and Mechanical Engineering, Curtin
Zhen Peng	Research Assistant, Civil and Mechanical Engineering, Curtin
Ritu Gupta	Research Associate, Electrical Engineering, Computing and Mathematical Sciences, Curtin
Himanshu Agrawal	Research Associate, Electrical Engineering, Computing and Mathematical Sciences, Curtin
Carey Curtis	Research Associate, Adjunct, UWA
Courtney Babb	Research Associate, Urban Planning, 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
Kerry Brown	Research Associate, Employment and Industry, Business and Law ECU
Tony Marceddo	Research Associate, Securing Digital Futures, ECU
Flavio Macau	Research Associate, Employment and Industry, Business and Law ECU
Navjot Bhullar	Research Associate, Psychology, ECU
Shihao Yan	Research Associate, Science, ECU
Kat O'Mara	Research Associate, Science, ECU
Reza Kiani Mavi	Research Associate, Supply Chain and Project Management, Business and Law, ECU
Ferry Jie	Research Associate, Supply Chain and Logistics Management, Business and Law, ECU

Hadrian Djajadikerta	Research Associate, Strategic Management Accounting, Business and Law, ECU
Zhaoyong Zhang	Research Associate, Finance and Economics, Business and Law, ECU
Mohammad Iranmanesh	Research Associate, Vice-Chancellor's Research Fellow, Business and Law, ECU

4.2. Finances

The year ended with a closing balance of $377k, $131k more than budget, mainly due to the balance brought forward from 2021 having been adjusted (Table 8). Income ended at $1.86 million, $68k behind budget with expenditure $53k ahead of budget at $1.97 million. Core project income was slightly behind budget due to delays in milestone completion however, external project income was $79k over budget ending at $970k.

Table 8: Financial summary for 2022

PATREC Income and Expenditure 2022	Year end – 31 Dec 22	Budget 2022	Variance Budget vs YTD Actual
INCOME			
WA Government Grants (core subscriptions)	290,170	290,170	0
Universities Sponsorship (core subscriptions)	209,337	209,337	0
iMOVE/PATREC core project	388,833	400,000	-11,167
External Research Grants & Contracts	969,216	890,000	79,216
Total Income	**1,857,556**	**1,789,507**	68,049
EXPENDITURE			
PATREC office	**134,633**	**129,126**	**5,507**
Research projects	**1,833,612**	**1,786,095**	**47,517**
Total Expenditure	**1,968,245**	**1,915,221**	**53,024**
YTD BALANCE	-110,689	-125,714	
Balance Brought Forward from 2021	**487,517**	**371,512**	
CLOSING BALANCE (incl Balance B/F)	**376,828**	**245,798**	**131,030**

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 2022 remained stable with no change in membership until late in the year (Table 8). The PATREC Director is an ex officio member of the Board. The PRAC Chair and PTA are also invited to Board meetings.

Table 9: PATREC Board members 2022

2022
Adjunct Prof Reece Waldock AM, Independent Chair
Mr David Caddy, Chair, Western Australian Planning Commission
Mr Peter Woronzow, acting Director General Transport, Western Australia
Mr Steve Beyer, Director, Portfolio Strategic Projects Office, Department of Transport
Prof Nathaniel Belcher, Professor of Architecture, Head of School, School of Design and the Built Environment, Curtin University
Prof Kerry Brown, Director of the Centre for Innovative Practice, Edith Cowan University
Prof Andrew Page, Pro Vice-Chancellor (Research), The University of Western Australia
Mr Ian Duncan, Executive Manager, Infrastructure, WALGA

5.2. PATREC Research Advisory Committee (PRAC)

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 PRAC 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.

Steve Atkinson (Main Roads) continued as Chair and Ryan Falconer took over from Damien Martin as Deputy Chair in 2022 (Table 10). The PRAC meetings are held three times a year, two weeks in advance of Board meetings.

Table 10: PATREC Research Advisory Committee (PRAC) members

Name	Organisation
Steve Atkinson (Chair)	Main Roads WA
Vicky McAllister	Department of Transport
Ryan Falconer (Deputy Chair)	Department of Transport
Cory Ross	Main Roads WA
Damien Martin	Department of Planning, Land & Heritage
John Chortis	Department of Planning, Land & Heritage

Martin White	Public Transport Authority
Tele Tan	Curtin University
Courtney Babb	Curtin University
Ferry Jie	Edith Cowan University
Tony Marceddo	Edith Cowan University
Doina Olaru	The University of Western Australia
Brett Smith	The University of Western Australia
Sebastian Davies-Slate	WALGA

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 11). 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 11: Project steering committee participation in 2022

Project title	Government	Research
Transport environment and kids… 15 years on	Chair: Michelle Prior, Liam Heitson, Zarin Salter, David Wake (DOT); Damien Martin (DPLH); Sebastian Davies-Slate (WALGA)	Gina Trapp, Anna Gannett (Telethon kids, UWA)
Identifying opportunities to address transport disadvantage in Perth	Chair: Claire Thompson, Leonie Gibbons (DOT)	Sae Chi (PATREC); Tristan Reed (Curtin)
Integrated IoT, computer vision and machine learning technologies for smarter bridge health monitoring and prediction	Chair: Raquib Hossain, Steve Atkinson, Jewely Parvin (Main Roads); Sebastian Davies-Slate (WALGA)	Wensu Chen, Jun Li (Curtin); Atif Mansoor (UWA); Chao Sun (PATREC)
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: Johann Brits, Chris Scholte, Graham Jacoby (Main Roads)	Chao Sun (PATREC)
Adequacy of the road freight transport network to support the freight task in Australia's North West now and into the future	Chair: Vicky McAllister (DOT); Flori Mihai (Main Roads; Damien Martin (DPLG); Sebastian Davies-Slate (WALGA)	Kerry Brown, Ferry Jie, Reza Kiani Mavi, Hadrian Djajadikerta (ECU)
Enhanced vehicle detection at traffic signals and smart freeways	Chair: Cory Ross, Kingsley Pettit (Main Roads)	Farid Boussaid, Mohammed Bennemoun (UWA)
Working from home - changes in transport demand – Perth	Chair: Claire Thompson (DoT) Wes Soet (MRWA), Renlong Han (DoT), Damien Martin (DPLH), John Chortis (DPLH)	Sharon Biermann (PATREC); Doina Olaru, Brett Smith, Julie Lee, Kirsten Martinus (UWA); Caroline Knight,

		Tristan Reed (Curtin); Carey Curtis (PATREC adjunct)
Improved Roundabout Modelling using Drone Video analytics	Scott Aitken (Aimsun), Rafael Carvajal, Johan Brits, Hector Lee (Main Roads),	Chao Sun
AI-assisted Model Calibration for Real-time Traffic Simulation	Scott Aitken, Mohammad Saifuzzaman (Aimsun), Rafael Carvajal, Raj Shah, Miaad Khayatian, Steve Atkinson, Johann Brits (Main Roads)	Chao Sun
Optimising video analytics for traffic data collection and calibration incorporating fixed camera videos	Rafael Carvajal, Raj Shah, Miaad Khayatian, Steve Atkinson, Johann Brits (Main Roads)	Chao Sun
Freight route priority trial evaluation	Cory Ross, Tim Keane (Main Roads)	Tele Tan, Tristan Reed, Ritu Gupta

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. The number of performance indicators has been reduced to essential academic and policy impact indicators with a focus on outputs and outcomes rather than inputs. Performance for the year against 2022 targets as set in the Annual Business Plan 2022, is summarised in Table 12.

Table 12: Key performance indicator targets (2022) and achievements as at 31 December 2022

Performance Indicator	Target 2022	Achieved as at 31 December 2022
Academic Performance Indicators		
Number of journal papers published	8	9
Number of peer-reviewed book chapters published	0	0
Number of peer-reviewed conference papers published in proceedings	5	4
Number of peer-reviewed books published	0	0
Number of post graduate research students attracted (and graduated) – Section 3.3	2	6
Value ($) of [non-core] research funding secured (through PATREC account)	$1,290,000	$1,358,049
Policy Impact Performance Indicators		

Number of high impact, policy-informing projects/sub-projects completed:
• Working from home – changes in transport demand – Perth
  ○ Overview
  ○ Working from Home: Employee Perspectives - Travel and Values
  ○ Working from Home: Employee Perspectives – Work
  ○ Working from Home – Changes in Productivity
  ○ Working from Home: Policy Response
  ○ Working from home: Transport infrastructure demand - Scenario evaluation
• Smart Transport Technology Roadmap (external)
• RAC Air Health Monitor – Independent review (external)
• Application of video analytics on Principal Shared Paths (external project) – Stage 2 – South Perth foreshore
	3	9

Number of substantive Technical Reports/Working Papers accepted/published: • As above	3	9
Number of PATREC Perspectives/iMOVE news articles published on PATREC website: • iMOVE: Bridge health monitoring published on 15 February 2022 • iMOVE: Real Time Model for Estimating Delays at Traffic Signals published on 3 March 2022 • iMOVE: Improved network performance prediction through data-driven analytics and simulation published 9 June 2022	0	3
Number of presentations at PATREC and other connection events (including conference presentations not published) – Table 5	10	16
Number of connection events arranged and held • Research seminar, 9 September 2022: Professor Alan Mabin • Working from home project online dissemination seminar held on 14 November 2022	3	2
Number of short courses, unit contributions presented	3	1
Stakeholder (academic and policy) satisfaction indicator	85%	85%