ANNUAL REPORT 2020

Planning and Transport Research Centre

March 2021

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.

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1. INTRODUCTION

1.1. Purpose

The primary purpose of this report is to provide an update of activities conducted in 2020 with a focus on outputs and outcomes achieved. While COVID-19 restrictions severely curtailed any face-to-face connection events and conference activities, with only one project needing replanning, research activities proceeded without undue interruption and the publication of journal papers, exceeding targets.

1.2. 2020 in Focus

Key achievements in 2020:

- Identification of new PATREC core research program (2021-2023) comprising 7 projects scheduled to commence July 2021
- PATREC core research program (2019-2021)
  - 6 projects/sub-projects substantially **completed** with Final Reports accepted and dissemination undertaken:
    - Managing transport system investment risk:
      - Sub-project 1: Understanding systematic factors driving patronage shifts
      - Sub-project 2: Determining digital journey planning impacts on patronage
      - Sub-project 3: Adapting strategic asset management practice to account for the uncertainty of CAVs
      - Sub-project 4: Maximising prioritisation of infrastructure investment proposals in the face of uncertainty
    - Increasing older people's acceptance of shared, automated and electric vehicles
    - Land use and freight generation analysis
  - 2 projects delivered key **interim milestones**:
    - Enhanced Vehicle Detection at Traffic Signals and on Smart Freeways – Report accepted: Literature review, technology assessment & experimental design guidelines
    - Enhanced land use inputs to strategic transport models through advanced econometrics – Training and training package delivered
  - Final project of program **commenced**:
    - Modelling perimeter controls based on macroscopic fundamental diagrams
- Five external projects substantially completed with some extended through additional funding allocations and some converted into grant applications to leverage other funding opportunities (eg. ARC Linkage)
- External projects agreed and progressing
  - iMOVE
    - Smart Transport Technology Roadmap Project (RAC, UWA)
    - Working from Home: Changes in Transport Demand (DOT, TNSW, UWA, Curtin)
    - AI-assisted Model Calibration for Real-time Traffic Simulation (Main Roads WA, Aimsun, UWA)
  - AURIN/Uni Melbourne/Australian Research Data Commons
    - Australian Transport Research Cloud
  - ARC Linkage participation

- ▪ Map My Say
  - o Main Roads WA
    - ▪ Extension to Drone Video Analytics (MRWA)
- ARC Linkage proposal submitted: Data driven approach to improve intersection modelling using video content analytics (Main Roads WA, Aimsun)
- 11 peer-reviewed journals published – exceeding 2020 target by just over 100%

2. RESEARCH PROJECT ACTIVITY

2.1. Projects completed

One major, two-year, core PATREC/iMOVE CRC project, Managing transport system investment risk - enhancing patronage predictions and adapting strategic asset management and appraisal processes to account for emerging trends and uncertainty, was **completed**, comprising four substantive sub-components:
- Sub-project 1: Understanding systematic factors driving patronage shifts
- Sub-project 2: Determining digital journey planning impacts on patronage
- Sub-project 3: Adapting strategic asset management practice to account for the uncertainty of CAVs
- Sub-project 4: Maximising prioritisation of infrastructure investment proposals in the face of uncertainty.

Two PATREC core funded projects were completed:
- Increasing older people's acceptance of shared, automated and electric vehicles
- Land use and freight generation analysis.

Five external projects, not using any PATREC core funds, were substantially completed with some extended through additional funding allocations from agency partners (MRWA and DoT) and some converted into grant applications to leverage other funding opportunities (eg. ARC Linkage)
- Main Roads projects
  - o Drone video analytics - extended with additional funding from MRWA
  - o Multi-objective genetic algorithm optimisation for network widening and maintenance scheduling - mostly completed, to be finalised in April 2021 after a stakeholder workshop
  - o SILO agent-based LU simulation – due to problems in accessing ABS micro data, SILO modelling work was replaced by demand sensitivity analysis for the AV simulation work undertaken as part of the previous iMOVE ITS project. The results are being incorporated into the final report
  - o Preliminary investigation of parameter estimation for SIDRA roundabout modelling (pilot) – an ARC Linkage project to undertake a substantive project on the basis of this pilot project, was submitted
- Department of Transport project
  - o Travel Behaviour Change Rapid Economic Appraisal Tool (TREAM) and user guide was completed

The key findings of the completed core-funded projects are summarised next.

Managing transport system investment risk: Enhancing patronage predictions and adapting strategic asset management and appraisal processes to account for emerging trends and uncertainty (Completed)

PATREC-iMOVE CRC Project 3-007 ($328,000; October 2019 – December 2020; UWA, ECU, MRWA, DOT)

To enhance and adapt selected portfolio-wide, strategic transport infrastructure investment planning and management tools, guidelines and frameworks, to account for emerging risks and trends in order to ensure that decision makers have the best possible advice on which to base infrastructure investment decisions, considering the uncertainty of potential changes impacting the transport system.

Understanding systemic factors driving patronage shifts

*To determine the **systemic factors driving patronage shifts** (including long term labour market characteristics, post GFC demographic shifts, increased capacity in road infrastructure, CBD parking costs and transport trends such as: ridesharing, licenses, fuel prices, vehicle ownership), to: (i) enhance the public transport patronage forecasting model for the improved prediction of fare revenues, operating subsidy requirements, levels of service provision and service innovations; and (ii) to facilitate the development of a range of customer centric initiatives to optimise (public transport related) travel behaviour*

Perth patronage trends during the period 2009-2019 follow an S-shape curve with three periods of change: growth, decline, and recovery, consistent with the variation of the economic indicators.

For the metropolitan areas as a whole:
- For **all journeys** fare is a significant contributing factor to patronage numbers, second in importance only to bus service coverage and frequency
- For **all journeys**, bus service frequency and coverage (measured by bus service kilometres) is the most important factor, followed by fare and then economic factors (worker migration rates (worker visas) and employment rates)
- For **commuting journeys**, the most important contributing factors are bus service frequency and coverage followed by fare, then economic conditions (CBD office vacancy rates plays an important role here because it is a strong indicator for the number of jobs in the city)
- Demand elasticities with respect to fares are -0.62 for all fares and -0.78 for commuting
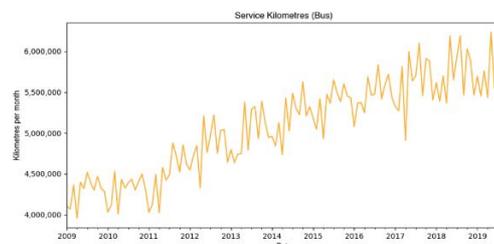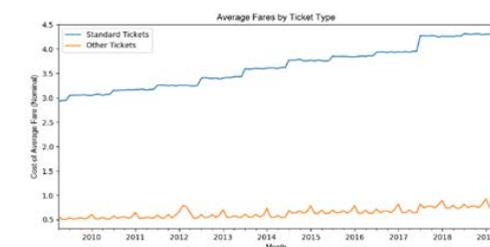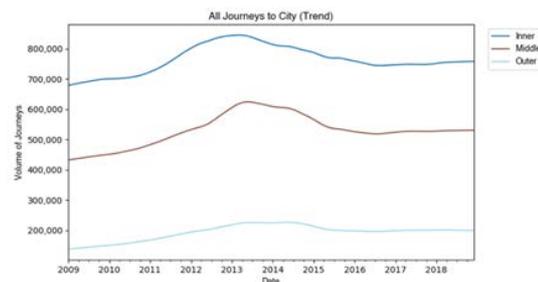
Spatial variation:
- For **commuting journeys**, second to bus service frequency and coverage, fares are most important in outer areas while in inner areas, economic conditions (CBD office vacancy, employment rates) are more important than fares
- Bus service frequency and coverage matters most. For **all fares**, service km (which include local trips) the fare: bus service ratio is smallest for outer suburbs. However, when considering **commuting journeys** to the CBD and inner suburbs, the fare: bus service ratio is lowest for outer suburbs
- For **commuting journeys** from outer areas, fare is twice as important as CBD office vacancy rates
- For **commuting journeys** from inner areas, fare is approximately half as important as office vacancy rates

- Commuting elasticities are higher for outer zones
- Whilst there are statistically significant differences across the three zones it is difficult to argue that the magnitudes are sufficiently different to affect policy
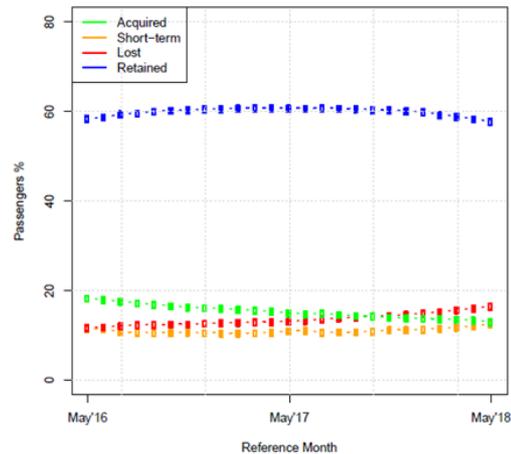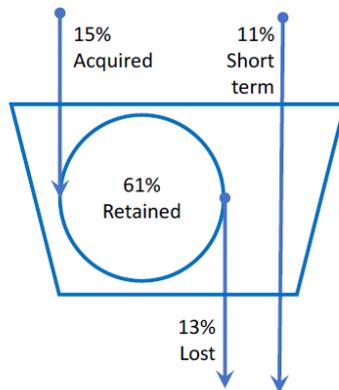
The more refined analysis (for different spatial areas, fare type, and factors) for the more recent period (2014 – 2019) showed that:

- Congestion on the roads is a significant factor some fare types indicating that continuous improvement of road conditions (additional lanes, widening, traffic signalling etc.) can increase driving and decrease public transport patronage
- Park & Ride (PnR) bays at stations play an important part of Perth's public transport network, i.e., the count of bays is a significant explanatory variable for where standard fare travellers commence their journeys
- Level of service as measured by bus service km is significant for all fare types
- Destinations with good public transport accessibility – as measured by the average journey time to reach the destination – are associated with higher demand

Applying the advanced regression analysis results, several forecasting scenarios were used to explore the effects of changing selected internal factors (fare, bus service kilometres) on patronage. The various scenarios produced a range of patronage effects from a decline in number of journeys of -1.5% to an increase of 1.7%.
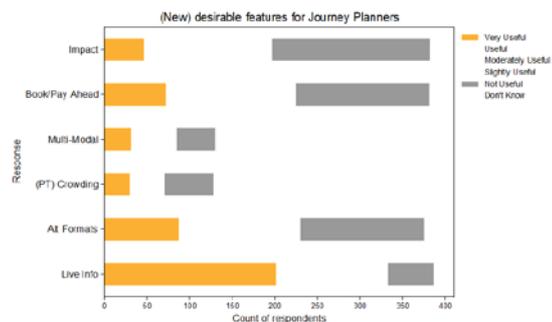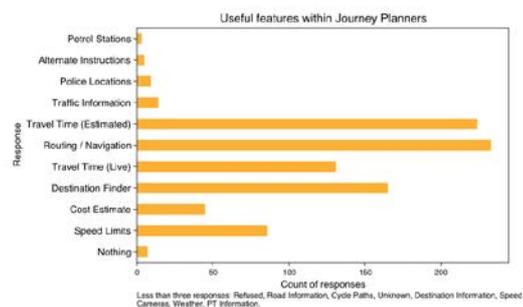
Determining digital journey planning impacts on patronage

*To understand customer experiences of **digital journey planning** services and influence on mode share for all routine trip purposes (work, school, shopping, recreation, etc) and identify potential improvements to journey planning services in order to ultimately inform the development of a range of customer centric initiatives to optimise (non-car based) travel behaviour*

- Two-thirds of respondents used journey planners at least 'occasionally'
- A range of journey planners are used on a variety of devices, with Google Maps and the Transperth apps most common, with many also using Apple Maps and Uber. Primarily, this was on smartphones such as the Apple iPhone
- Many consider journey planners only relevant to shared and active transport modes. The vast majority (88%) used them for car trips as a driver. About one-fifth of respondents who used journey planners used them for journeys including a bus and one-quarter of respondents used journey planners for journeys including a train
- About 90% who used journey planners used them for new journeys they had not undertaken before, approximately three-fifths of these respondents did not use journey planners for regular journeys undertaken. A third indicated using journey planners within multi-modal journeys
- Travel time estimation and routing/navigation were deemed useful by most respondents but importance was also given to live journey information such as live travel time. There was, an unmet need for information regarding the destination within journey planners such as search and discovery of the destination – such as attractions at the destination or 'services' such as food or petrol along the way
- New information such as weather information, environmental impact, booking and paying in advance alongside alternate formats (such as smart speakers) were also of interest to respondents. Many suggested rewards systems, however, the most popular suggestions either involved money or equivalents or were related to discounts on travel
- Most respondents indicated that their behaviour would not be changed by these improvements. However, approximately one-fifth of respondents indicated that there was at least a moderate likelihood that these changes would lead to behaviour change

Recommendations to ensure the continued use and availability of journey planners:

- Ensure the continued supply of accurate and timely transport data in an open format
- Ensure the continued supply of accurate 'secondary' data in an open format eg. number of park and ride bays at railway stations, condition and slope of cycle and walking paths
- Continue development of the Transperth app eg. integration of weather information
- Investigate travel discounts for continued use of public and active transport modes
- Investigate provision of data in new and novel formats eg. integration with 'smart speaker' assistant systems such as Amazon Alexa
- Provision of pre-booking of public transport including integration with Apple Pay and Google Pay

Useful features within Journey Planners

Less than three responses: Refused, Road Information, Cycle Paths, Unknown, Destination Information, Speed Cameras, Weather, PT Information.

(New) desirable features for Journey Planners

Adapting strategic road asset management practice to account for uncertainty relating to CAVs

To identify specific impacts of specifically, CAV, disruptive technologies on road (and road/rail interface) asset management practice as well as response actions and opportunities for innovation in order to adapt templates and guidelines

The findings of the project are that CAV uptake will:

- Affect asset management in many areas including policy, strategy planning, customer and stakeholder expectation, statute and legislation and risk management
- Provide opportunities for improving asset management outcomes including improved road safety, decreased carbon emission, reduced traffic congestion, improve mobility, intermodal integration, optimised supply chains and reduced transport cost
- Present challenges, particularly in relation to managing a rapidly changing transport market with a transition to Mobility as a Service (MaaS) and the rapid increase in micro-mobility, fueled by technology changes and increased customer expectations re: improved mobility
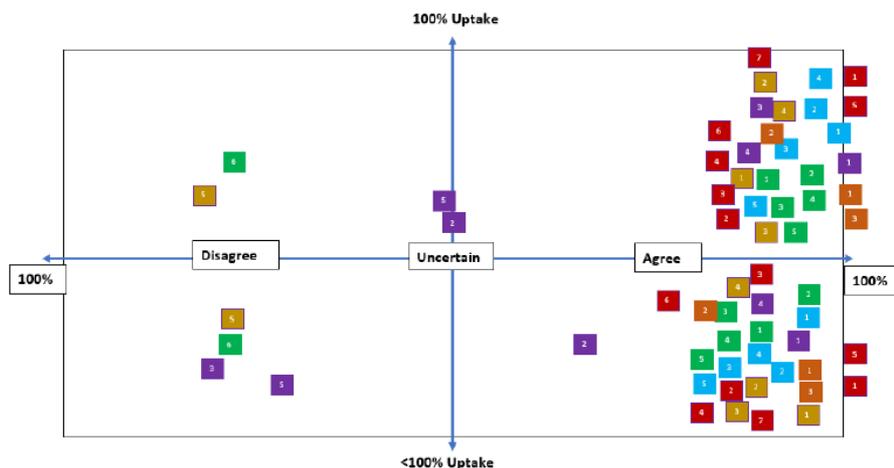

Figure 8: Policy: Purple; Strategy: Green; Planning: Blue; Legislation/Statutory: Orange; Customers/Stakeholders expectations: Yellow; Risk Management: Red: X-axis refers to level of agreement. Y-axis refers to uptake scenarios.

Recommendations for asset managers is that they need to be proactively engaged with:

- Development of a framework for digital infrastructure to support safe, cybercrime protected vehicle-to-vehicle and vehicle-infrastructure communication:
  - Use of data from other sources external to the vehicle must be included
  - Government to introduce protocols to control data related to CAV
  - Legislation and associated regulations should align with the global technology
  - Data could provide key insights for manufacturers, consumers and asset managers
  - CAV technology needs to adapt to the current road infrastructure
- National policies, standards, governance and regulation for CAV uptake and CAV infrastructure decisions:
  - Government should establish competitive grants programs that encourage the trial of CAV technologies that can be adapted to the geographical or climatic conditions
  - Government should plan for and adapt to future changes to Australia's CAV fleet by undertaking consistent policies across all jurisdictions
- Provide mechanisms to improve safety:
  - Evidence on a safe, efficient and equitable transport system by the introduction of CAVs will help government commit to spending funds on CAV infrastructure
  - Computer hacking and terrorism by malicious hackers of both CAV and smart infrastructure are serious concerns which need to be addressed
  - The existence of other policy options such as pricing could ensure people are discouraged from using non-AVs or non-shared private travel.
- Monitoring CAV technology progression, capturing results of trials and any relevant information available, be involved and contribute to national policies and be ready to adapt their practice as required.

Adapting infrastructure project prioritisation to account for uncertainty relating to disruptive technology

To propose adaptation strategies to appraise the uncertainties of emerging technologies within the project assessment and prioritisation framework to ensure that advice to decision makers explicitly considers potential future changes to transport systems

The study recommended scenario testing using a MCA approach, incorporated within the existing Infrastructure Australia framework (Infrastructure Australia, 2018a), as the most suitable tool for assessing the uncertainties of Future Mobility of Transport (FMT) due to technical, practicality and applicability advantages.

Testing the applicability and practicality of the recommended framework in relation to a) existing strategic transport scenarios (Transport Portfolio, WA) and b) three large infrastructure projects found:

- Overall, the following **assumptions** typically used in scenario assessment, are found as the key factors that can influence the assessment outcomes:
  o Changes in demand for PT
  o Electric vehicle and AV uptake
  o Assumption relating to congestion and pollution
  o Strategic objectives/directions
  o Assumptions relating to economic growth
- Assessment outcome is influenced by certain features of **project scope**:
  o The nature of the work, whether the project is a road, PT or active travel project;
  o Integration of technology features, such as better journey planning tools and more efficient operation management systems
  o Being integrated within wider transport optimisation and service integrations, such as being part of the MaaS scheme
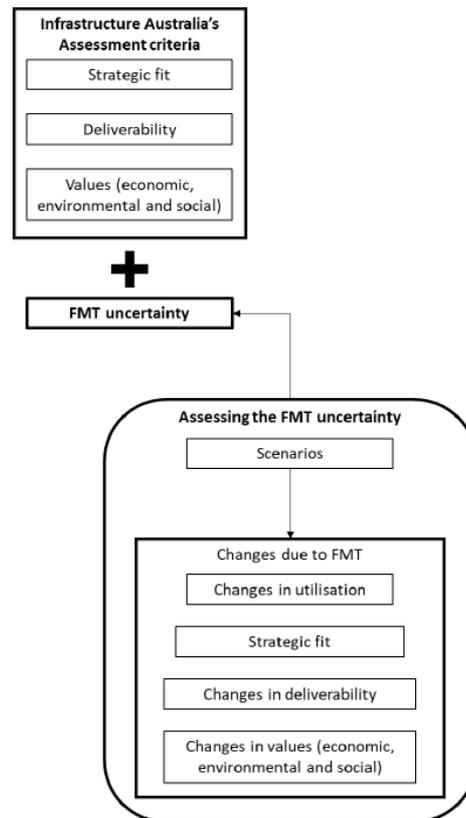
Figure 12 Assessing the FMT uncertainty within the Infrastructure Australia framework

- Uncertainties associated with social value were not fully captured. This can be due to the lack of comprehensiveness of the scenarios, leading to a shortage of assumptions relating to social value in the scenarios used in this study
- Similarly, across all scenarios, changes in the deliverability criterion also suffered from lacking related assumptions
- Additionally, assessment suffers from a key limitation of MCA, which is the risk of subjectivity
- Significant demand uncertainties were evident, which can lead to uncertainty in all benefits and disbenefits. This suggests that all resulting impacts due to changes in demand need to be exclusively assessed under the "changes in utilisation" criterion and that the disruption of FMT needs to be fully understood when undertaking the assessment
- Projects that are inflexible in the way they can be used, are exposed to more uncertainties than others
- Comprehensiveness of the assessment depends on the comprehensiveness of the scenarios
- Identifying "triggers' would be useful as it can flag potential loss of utilisations without any detailed analyses, which can be identified through the assessment of FMT uncertainty

Increasing older people's acceptance of shared, automated and electric vehicles

PATREC Project ($129,993; August 2019 – December 2020; Curtin, DOT)

To assess older people's receptiveness to using SAEVs and determine whether use of an SAEV changes SAEV-related attitudes and intentions to use SAEVs in the future

	Pre-ride scores	Post-ride scores	Change
I am concerned about the safety of self-driving vehicles	6.03	5.13	-0.90
I would feel comfortable riding a self-driving vehicle	5.86	7.41	1.55
I think that self-driving vehicles could be a useful transport option	7.40	7.77	0.37
I can see myself using self-driving vehicles as a means of transport	5.47	6.73	1.27
I would like to have access to a self-driving vehicle	6.27	6.73	0.47

Older adults from retirement complexes adjacent to Curtin University (Bentley, Western Australia) were invited to attend two AV exhibitions. The first exhibition involved residents from SwanCare being invited to view a Shared Autonomous Electric Vehicle (SAEV) at their retirement complex, and the second involved older adults from both SwanCare and Rowethorpe riding an SAEV operating in autonomous mode at the Curtin University campus. Several quantitative and qualitative data collection activities were conducted before and during the exhibitions.

The results of the project suggest that exposing older adults to AVs could be an effective means of fostering positive attitudes to them, potentially resulting in increased likelihood of adoption. After riding the SAEV, the study participants generally felt more positively about AVs and they were more likely to see themselves using one in the future. The view was often expressed by the participants that apprehensive older adults would be more likely to use AVs once they had seen them operating safely in person. In addition, many participants noted that the physical layouts of AVs will need to suit the physical limitations of older adults while providing a safe, and comfortable space. They emphasised that the operating routes of AVs should be practical and accessible for older adults to maximise utilisation.

Land use and freight generation analysis

PATREC Project ($72,000; September 2019 – January 2020; UWA, Tim Hoffman)

To understand the Fremantle container trade and its relationship to freight transport usage across Perth and Western Australia through an analysis of intermodal freight activity to inform government policy aimed at improving intermodal usage into the future.

Future demand for intermodal services in Perth is closely allied to the scale and nature of growth in international container trade through Fremantle:

- outlook for the next 10 years to 2029 appears to be 'low growth'
- since 2013, full import volumes have increased at 1.3% per year, while full exports have increased by 4.6% per year. Empty containers (in total) have remained steady

DPLH's Land Use and Employment Survey database used to estimate the geographic spread throughout Perth of the origins of exports and the ultimate destinations of imported goods.

IMTs need to be developed in locations which offer:

- the ability to connect a new siding(s) to the freight network
- surrounding industrial land suitable for 24/7 logistics operations
- good arterial road links and access
- large lot sizes
- attraction to major export packing operations (such as grain, hay or mineral sands)
- reasonable proximity to the broader manufacturing and distribution economy (ie in existing industrial zones)

The most likely areas offering this set of characteristics are in the arc between Kenwick and Midland, with Perth Airport's northern section seemingly a prime location at this point in time.
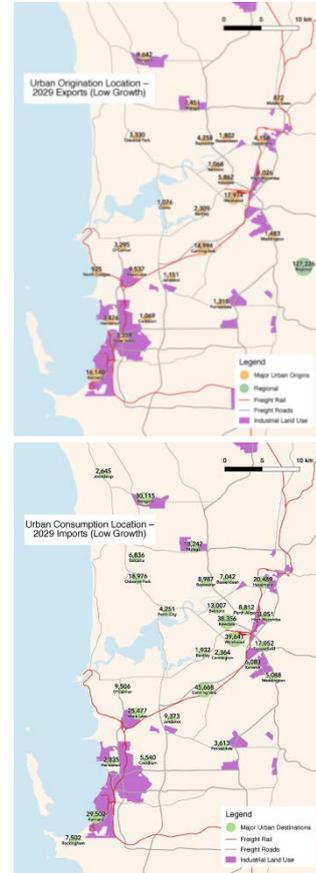
2.2. New PATREC core projects approved

At the Board meeting held on 26 November 2020, the Board approved a package of projects to be conducted in 2021-2023, using core funding, with some (still to be decided) to be run through the iMOVE CRC (Table 1).

Table 1: New core projects approved comprising the 2021-23 program of research

Project title	Aims and Objectives
Working from home travel impacts – funding the DPLH component of an external iMOVE project	The COVID-19 lockdown saw significant changes in activity and mobility patterns with an unprecedented level of individuals' working from home (WFH) with associated drops in public transport patronage and traffic flow. Focusing on Perth, WA, this project aims 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.
Transport Environment and Kids… 10 Years On	This project aims to update some of the metrics from the "TRavel Environment and Kids" study (TREK) conducted in Perth in 2006-2009, including the walkability analysis of Perth metropolitan schools, traffic densities, parental perceptions of neighbourhood safety and latent demand for walking and cycling to school. A key objective of the research is to identify Perth schools and neighbourhoods with the greatest need for connectivity improvements, safety treatments such as children's crossing in high traffic areas, and programs to address parental concerns, as well as any other insights for increasing the rates of walking and riding to school.
Identifying opportunities to address transport disadvantage in Perth	This project aims to explore mobility service opportunities within various sectors (disability support, and other relevant sectors) that can best address transport disadvantage in the Perth metropolitan area. It analyses various measures and data, such as socio-economic indices, SmartRider data, and other transport data, that can measure transport disadvantage from different perspectives (not limited to time and distance), and identifies geographical location/s and groups that can benefit from alternative mobility services. It then conducts interviews to identify the sector/s in Perth that are best placed to respond to the identified disadvantage. It also investigates challenges in providing the alternative service and proposes what roles Government and various sectors can play to overcome the identified challenges.
Integrated freight system optimisation for Western Australian Context	This research project focuses on the integrated freight system within the Western Australian context focusing on Pilbara and Kimberley. It aims to better understand the determinants of a comprehensive set of factors that significantly influence the freight transportation network's efficiency and effectiveness, as per advice from the DoT. Given the substantial increase in the inbound logistics demand, which is estimated to double by 2030, it is of the utmost urgency to carefully plan and manage freight transportation infrastructures in these regions to handle the increased freight flow. Accordingly, this research aims to assist the DoT in understanding the flow of freight, machinery, and resources from their origins to their destinations. This research will analyse and map the freight transportation networks for Pilbara and Kimberley to help policymakers address the roads' infrastructural needs to improve road freight transportation.
Integrating AI and IoT based Bridge Health Monitoring with MRWA BMS for Smart Freight Management	The aim is to develop an IoT and AI based smart decision making tool to enable MRWA to support the freight industry for intelligent route choice as well as enable the assets managers make smart investment choice. This will increase freight productivity as well as enable MRWA to extract move value for money from every Bridge related investment decision. The objectives are to: • Pilot deployment of Internet of Things (IoT) for collecting bridge data from a heavy haulage route • Develop an Artificial Intelligence (AI) based decision support tool based on collected IoT data • Develop a methodology to integrate the AI system with MRWA Bridge Management System for future smart freight movement transport
A Value Driver Model for Traffic Signals	Real-time information, especially delay time, is valuable for traffic operations but it is limited and costly. The existing data sources that Main Roads have access to all have their challenges in availability, cost and accuracy. This project aims at developing a pilot model that utilises secondary datasets within Main Roads (e.g. signal timing data) to estimate overall delay at each intersection in real-time. This could allow Main Roads to measure the delay

	at a network, intersection, or approach level, while not requiring any additional expense in data licensing agreements. It would inform project and operational decisions.
Develop machine learning models for road maintenance investment decision making	Road maintenance investment decisions are conventionally made by experts with decades of experience. Those experts are often occupied by a heavy workload so they often have limited time to train new staff. The main objectives of this project are to: • Develop efficient and robust data driven decision-making model for road maintenance investment planning to improve the transparency and repeatability and minimise the risk. • Capture experts' knowledge using the machine learning models including the implicit decision rules they might use.

3. KNOWLEDGE TRANSFER

3.1. Research Outputs

The focus of PATREC's research outputs in 2020 was on the publication of final reports for the sub-components of the iMOVE CRC Risk management project and the PATREC core-funded projects: Increasing older people's acceptance of shared, automated and electric vehicles and Land use and freight generation analysis - Perth. Eight substantive technical reports were produced amongst them (Table 2).

Due to COVID-19, no conference papers were presented or published. The focus instead, reverted to the publication of academic journal papers. Eleven peer-reviewed journal papers and book chapters were published in 2020, more than double the target (Table 2). Eleven journal papers were progressed (submitted, re-submitted or accepted for publication) (Table 3). Four online presentations as part of industry-organised webinars were given (Table 4). One PATREC Perspective was produced and published on the PATREC website: Impacts of COVID-19 on travel in Perth - Some preliminary insights (Table 2). Some of the material in this publication was used in the application for the successful iMOVE CRC working from home and transport demand impacts project.

Table 2: Research Publication Outputs in 2020

Publication Title	Authors	Date
RESEARCH PROJECT TECHNICAL REPORTS COMPLETED		
Managing Transport System Investment Risk - Factors Influencing Public Transport **Patronage Trends: Perth 2009 to 2019** (iMove Project CRC 3-007; Milestone 2.1)	Brett Smith, Doina Olaru, Tristan Reed, Rachel Cardell-Oliver & Sharon Biermann	20 May 2020
Managing Transport System Investment Risk - Factors Influencing Public Transport **Patronage Trends: Perth 2015 to 2019** (iMove Project CRC 3-007; Milestone 3.1)	Brett Smith, Doina Olaru, Tristan Reed, Rachel Cardell-Oliver & Sharon Biermann	30 Nov 2020
Managing Transport System Investment Risk – **Journey Planner** Usage Analysis (iMove Project 3-007, Milestone 3.2)	Tristan Reed & Sharon Biermann	21 Oct 2020

Managing Transport System Investment Risk - Adapting **Strategic Asset Management Practice** for CAV (iMOVE Project 3-007, Milestone 3.3): • Part 1: Literature Review • Part 2: Impact Assessment Model • Part 3: Recommendations for Asset Managers	Subhadarsini Parida, Kerry Brown, Ferry Jie & Hadrian Djajadikerta	Dec 2020
Managing Transport System Investment Risk: Maximising **Prioritisation of Infrastructure Investment** Proposals in the Face of Uncertainty	Sae Chi & Sharon Biermann	Nov 2020
Managing Transport System Investment Risk - Enhancing patronage predictions and adapting strategic asset management and appraisal processes to account for emerging trends and uncertainty: **Close-out Report** (iMOVE Project 3.007 Milestone 4)	Sharon Biermann, Brett Smith, Tristan Reed, Kerry Brown & Sae Chi	Jan 2021
Increasing older people's acceptance of shared, automated, and electric vehicles	Leon Booth & Simone Pettigrew	27 Jan 2021
Land Use and Freight Generation Analysis - Perth	Tim Hoffman & Sae Chi	Jan 2020

PEER-REVIEWED JOURNAL PAPERS AND BOOK CHAPTERS PUBLISHED 2020

McLeod, S & Curtis, C (2020): Understanding and Planning for Freight Movement in *Cities: Practices and Challenges, Planning Practice & Research*, DOI:10.1080/02697459.2020.1732660

Pettit, C, Biermann, S, Pelizaro, C, Bakelmun, A (2020) A data driven approach to exploring future land use and transport scenarios: the Online What If? Tool. *Journal of Urban Technology*. 27:2, 21-44, DOI: 10.1080/10630732.2020.1739503.

Liu, C, Huynh, D., Sun, Y, Reynolds, M, Atkinson, S (2020), 'A Vision-based Pipeline for Vehicle Counting, Speed Estimation, and Classification', *IEEE Transactions on Intelligent Transportation Systems*. DOI: 10.1109/TITS.2020.3004066

Kiani Mavi, R, Goh, M, Kiani Mavi, N, Jie, F, Brown, K, Biermann, S & Khanfar A (2020) Cross-Docking: A Systematic Literature Review, *Sustainability* 2020, 12(11), 4789. https://doi.org/10.3390/su12114789.

Clements, K. W., Lan, Y. and Liu, H. (2020) Understanding Alcohol Consumption across Countries. *Applied Economics*, pp.1-19. doi.org/10.1080/00036846.2020.1735621

Booth, L., Norman, R., & Pettigrew, S. (2020). The potential effects of autonomous vehicles on alcohol consumption and drink-driving behaviours. *Drug and Alcohol Review*, 39(5), 604-607

Cervigni, E., Renton, M., Haslam-McKenzie, F., Hickling, S., Olaru, D. (2020) Describing and mapping diversity and accessibility of the urban food environment with open data and tools, *Applied Geography*, 102352

Chi, S., & Bunker, J. (2020) An Australian perspective on real-life cost-benefit analysis and assessment frameworks for transport infrastructure investments. *Research in Transportation Economics*. https://doi.org/10.1016/j.retrec.2020.100946.

Pettigrew, S., Nelson, J. D., & Norman, R. (2020). Autonomous vehicles and cycling: policy implications and management issues. *Transportation Research Interdisciplinary Perspectives*, 7, 100188.

Smith, B., Goods, C., Barratt, T., & Veen, A. (2020). Consumer 'app-etite' for workers' rights in the Australian 'gig' economy. *Journal of Choice Modelling*, 100254.

Biermann, S & Martinus, K. (2020) Reducing the need to travel: the challenge of employment self-containment. *Handbook of Sustainable Transport* (ed. Carey Curtis). Edward Elgar Publishing.

PATREC PERSPECTIVES PUBLISHED 2020

Biermann, S, Reed, T & Chi, S (2020) Impacts of COVID-19 on travel in Perth - some preliminary insights https://patrec.org/wp-content/uploads/2020/07/Perspective-COVID-impacts.pdf

Table 3: Journal Papers/Book Chapters In-progress in 2020 (Submitted, Re-submitted or Accepted for Publication)

Paper
Clements, S., Olaru, D., Smith, B., & Boruff, B. Understanding the impact of agglomeration economies on commercial property prices, *Journal of Transport Geography*. Under review
Jie, F, Standing, C, Biermann, S, Standing, S & Robson L. Analysis of the Use and Perception of Transport Sharing in Western Australia, *Asia-Pacific Journal of Business Administration*. Under review
Standing, C, Standing, S, Hoffman, T, Jie, F, Kiani Mavi, R & Biermann, S. Future Trends in Freight Transport and Logistics: A Literature and Expert Analysis. *Transport Reviews.* Under review
Huang, Y., Smith, B., Olaru, D., & Taplin, J.E. On interpreting models of risk in a random utility setting, *Transportation Research B*. **Under review**
Kiani Mavi, R, Kiani Mavi N, Olaru, D, Biermann, S & Chi, S. Innovations in freight transport: A systematic literature evaluation *Transport Policy*, special issue Transport Policy in Post COVID-19 World. **Under review**
Martinus, K & Biermann, S. Tackling the Inherent Structural Inequality of Employment Decentralisation Policy Targets, *Applied Geography*. **Under review**
Olaru, D., Greaves, S., Leighton, C., Smith, B. and Arnold T. Peer-to-Peer (P2P) Carsharing and Driverless Vehicles: Attitudes and Values of Vehicle Owners *Transportation Research A*. **Under review**
Pettigrew, S. The potential effects of autonomous vehicles on physical activity. *Global Health Promotion*. **Under review**
Cummins, L., Sun, Y., & Reynolds, M. (2021) Simulating the effectiveness of wave dissipation by FollowerStopper Autonomous Vehicles, *Transportation Research Part C: Emerging Technologies*. **Published in 2021**
Prior, D., Saberi, M., Janjua, N., Jie, F. (2021), Can I Trust You? Incorporating Supplier Trustworthiness into Supplier Selection Criteria. *Enterprise Information Systems*, 15(3), 1-28, London, DOI: 10.1080/17517575.2021.1878393. **Published in 2021**
Jie, F., Standing, C., Biermann, S., Standing, S., & Le, T. (2021). Factors affecting the adoption of shared mobility systems: Evidence from Australia. Research in *Transportation Business and Management*. **Accepted for publication in 2021**

Table 4: Online webinar presentations

ONLINE WEBINAR PRESENTATIONS
Jie, F (2020) Navigating Your Supply Chain Through 2020, Invited speaker at Webinar: Institute for Supply Management, University of Houston, and the Energy Conference Network, 18 June
Jie, F (2020) Inter-organisational Strategy in The New Normal, Invited speaker at the Webinar: Supply Chain for Global Competitiveness", 18 June
Jie, F (2020) Logistics Management – POST COVID-19, Invited Speaker at Webinar: UNSW ADF, 2 June
Jie, F (2020) Supply Chain Risk and Uncertainties in Mining Sector, Invited speaker at the Webinar: Supply Chain & Procurement in Resources Australia Conference, Perth, 5-6 March

3.2. PATREC Connection Events

Due to COVID-19 restrictions, a number of PATREC connection events, at an advanced planning stage, were cancelled:

- Planned Prof David Hensher events:

- o Meeting with Minister Saffioti (16 March): Stimulating patronage on public transport to support METRONET investment:
  - Achieving a quantum leap in public transport patronage through integration with Demand Responsive Transit (DRT) and more widely, Mobility as a Service (MaaS)
  - Effectiveness of restructuring public transport fares in relation to affordability and patronage stimulation – other, better options?
  - o PATREC Interactive Research Forum: Disruptions in transport – Disaster or Deliverance? (16 March; 60 confirmed) exploring questions relating to:
    - ways in which public transport needs to evolve to respond to significant transport disruptions;
    - the roles of Demand Responsive Transport (DRT), Mobility-as-a-Service (MaaS) and Autonomous Vehicles (AVs) as part of a sustainable mobility future; and
    - the progressive future outlook for WA.
  - o Bus Operator Forum, hosted by PTA: Bus Futures – lessons from Prof David Hensher (17 March, 50 confirmed):
    - Fleet and infrastructure innovation
    - Cost and contracting models
    - Service design and models
    - Trusting partnerships for success
  - o John Taplin Memorial Lecture "What Does Intelligent Mobility Add to Sustainability? Some Top Agenda Issues to Consider (hosted by UWA's Institute for Advanced Studies, PATREC, and UWA Business School; 17 March; 150 confirmed)
- PATREC Seminar: Enhanced Network performance Prediction through Data-driven Analytics and Simulation to disseminate findings of iMOVE ITS project (3 April, 70 confirmed):
  - o Short-term Traffic Speed Prediction for Perth Roads Using Machine Learning
  - o Implementing Multi-Zone Perimeter Controls on Perth's Road Network
  - o Simulating the traffic impact of AVs and CAVs on Perth's freeways and arterial
  - o Showcasing of related technologies

No further connection events were arranged during the year due to ongoing restrictions on gatherings.

3.3. Research Impact

3.3.1. Research Project Outcomes

With the completion of the iMOVE project: Managing Transport System Investment Risk - Enhancing patronage predictions and adapting strategic asset management and appraisal processes to account for emerging trends and uncertainty, steering committee chairs of the four sub-components were asked to provide feedback on the output quality and value for policy formulation:

Understanding systemic factors driving patronage shifts
This research was undertaken in order to inform the enhancement of the public transport patronage forecasting model for the improved prediction of fare revenues, operating subsidy requirements, levels of service provision and service innovations as well as to facilitate the development of a range of customer centric initiatives to optimise (public transport related) travel behaviour.

"Phase 1 provided detailed and novel modelling of patronage updating existing forecasting elasticities estimates for use in operational patronage models. The outputs of this research are feeding into fare review proposals being led by the PTA and Treasury. Phase 2 delved more deeply into the impacts spatially and variations across different user profiles and transport hubs. This approach was justified and provided evidence of significant spatial and temporal variability. Phase

2 outputs will be available on the RailSmart platform to spatially inform transport planning decisions. The research has not resulted in development of customer centric initiatives to optimise public transport use but increased understanding of factors required to influence patronage may be used to feed into customer sentiment and perception market research work being undertaken by the Department" (Jane Millar and Claire Thompson, DoT, email 17 December 2020).

Digital journey planning impacts on patronage

The research was intended to inform planning and decision-making processes throughout the Transport Portfolio, particularly digital journey planning services, MaaS, travel behaviour change, public transport optimisation with associated business case development and project prioritisation.

"The research identified the reach of journey planners into everyday travel decisions for the Perth population, hence the importance of this area of investigation for influencing travel choices. Findings have been shared within the Portfolio to inform ongoing development of the Transperth Journey Planner and provides a base-level understanding of journey planner functionality for the future needs of Mobility as a Service - related policy and initiatives" (Jane Millar and Claire Thompson, Department of Transport, email 17 December 2020).

"Well done on the presentation Tristan. I had a few people come up and say how interesting it was" (Jane Millar, DoT, email 3 December 2020).

Adapting strategic road asset management practice to account for uncertainty relating to CAVs

The findings of this research were intended to offer a strategic perspective on how to rethink the way transport infrastructure assets facilitate the delivery of services into the future; and how to plan for and manage transport infrastructure assets in the future.

"In terms of the 3 reports, from an asset management practitioner's perspective, I consider the reports to be useful. The Literature Review with its findings gives a comprehensive picture of the status of CAV uptake in Australia and overseas and identifies potential impact in the six asset management areas selected. The Impact assessment via the Delphi process followed by focus group discussion was a sound approach to identify the differences, if any, between the two uptake scenarios, and it was also a reflection of people's perception of the future at a point in time. It would had been better if more people were involved in this stage, but we need to also note this happened at the peak of the pandemic in Australia. The final report provides a good summary of the findings, highlighting opportunities in terms of CAV uptake improving asset management outcomes. Considering these reports are for asset managers and not for CAV experts, I do consider they fulfilled their purpose" (Flori Mihai, Main Roads WA, email 22 December 2020).

Prioritisation of infrastructure investment proposals in the face of uncertainty

The research is intended to support the Transport Portfolio in considering future uncertainties within their project assessment and prioritisation framework to ensure that their advice to the decision makers considers potential future changes to the transport systems. This research is intended to complement other initiatives within the Transport Portfolio including the update of the Investment Decision Framework.

"This report has demonstrated to the investment planning teams across the Transport Portfolio that there are ways to improve the prioritisation of investments in the face of unknown outcomes caused by future uncertainty associated with mobility and transport. We need to prepare for and model scenarios into base cases and project cases. Even doing this as a sensitivity test will deliver a greater level of confidence that projects will deliver maximum value given an uncertain transport future. A new Perth Transport demand model is being planned and the work from this research project will identify scenario requirements to build in this new model" (Des Lock, DoT, email 22 January 2021).

The PATREC core-funded project, ***Increasing older people's acceptance of shared, automated and electric vehicles***, was instrumental in the success of a National Health and Medical Research Council grant application.

"Just letting you know that I was fortunate to win one of the just-announced NHMRC Ideas grants to conduct more work on AVs ($736,000 over 3 years). Our track record that included the PATREC project was no doubt part of the reason the project got up, so thank you. Alizanne (Cheetham) is listed as one of the Associate Investigators, so it's great that I'll get to keep working with her in the future" (Simone Pettigrew, formerly Curtin, email 15 December 2020).

In relation to a small external project as a follow-on to the RailSmart project for DoT, ***Travel Behaviour Change Rapid Economic Appraisal Tool:*** "TREAM is intended for use by the Transport Portfolio to complete rapid economic assessment of independent travel behaviour change programs and programs delivered in support of rail and road infrastructure projects. The model has already proven highly effective and user friendly, with the DoT Travel Behaviour Change Team using it to carry out benefit cost analysis for State Budget submissions to deliver behaviour change programs for METRONET and broader community outcomes" (Liam Heitson, DoT, email 9 February 2021).

3.3.2. Stakeholder Satisfaction Survey Results

An on-line survey, comprising nine questions, was developed using Qualtrics to provide feedback to the Director and Board on the level of satisfaction of PATREC partners with the performance of PATREC on an annual basis. The survey for 2020, conducted in March 2021, circulated to over 120 stakeholders directly involved in PATREC research, returned a percentage satisfaction rate of 90.6% (n=18), up 1% on the 2019 score of 89.5%. This is the highest satisfaction rate of the five years in which the survey has been run (Figure 1). Government partners had the highest response rate (50%), with 39% university respondents and "other", 11%. All respondents, except for one, agreed that overall, they are satisfied with PATREC's performance, 78% strongly agreeing and 17% somewhat agreeing. "Strongly agree" dominates replies to questions relating to usefulness of outcomes, value for money, good interactions and extending the knowledge base and networks. As in the past, "Somewhat agree" dominates the responses to two questions: understanding each other's needs and bridging the gap between research and policy.

Figure 1: Trend in overall satisfaction with PATREC's performance (March 2020)
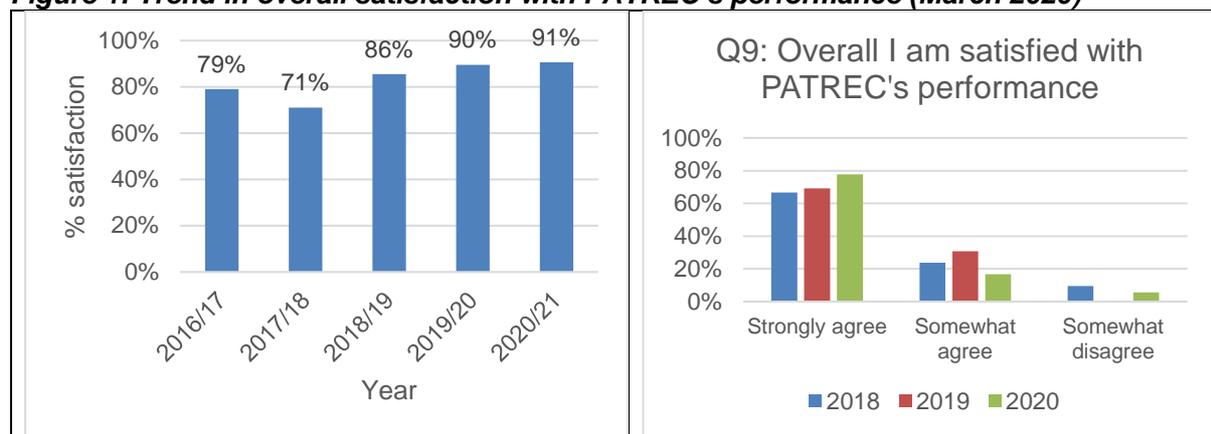
3.3.3. Awards

A PATREC project was shortlisted for an ITS Australia award - an external projects undertaken with Main Roads by Dr Chao Sun, in collaboration with Associate Professor Mark Reynolds, Head

of the School of Computing, Physics and Mathematics, has been for the ITS Australia's Excellence in Research and Development Award 2020, to be announced later in November. The "Video Content Analytics" project, has resulted in software developed to extract traffic data automatically using computer vision, a type of artificial intelligence that helps computers to identify and track objects in videos. This enhances the quality of data used in traffic modelling and could replace conventional manual traffic surveys that are labour intensive and imprecise.

One of PATREC's Research Fellows won an ASPIRE award – Dr Sae Chi has been awarded the UWA Aspire Award for 2020. Funded by Business Events Perth the award is a $5,000 scholarship to assist in personal and professional development through attendance at a relevant international conference in their chosen field of endeavour. Sae has elected to attend an international transportation economics conference once things open up again.

4. PEOPLE AND RESOURCES

4.1. Staffing

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 5). Limited use is also made of consultants where relevant expertise is not available within the partner universities.

Table 5: PATREC Project Researchers

Research Team		
Sharon Biermann	0.6 FTE	Director
Yuchao Sun	1.0 FTE	PATREC Research Fellow (traffic engineering), UWA
Sae Chi	1.0 FTE	PATREC Postdoctoral Research Fellow (transport economics), UWA
Tristan Reed	0.8 FTE	PATREC Research Assistant, Curtin
Haiyan Liu	1.0 FTE	PATREC Postdoctoral Research Fellow (economics), seconded to DOT
Chris Bartlett	0.4 FTE	PATREC Research Assistant, Computer Science
Yan Jie	1.0 FTE	PATREC Research Assistant, Software development
Rachel Cardell-Oliver		Research Associate, UWA Computer Science
Mark Reynolds		Research Associate, UWA Computer Science
Doina Olaru		Research Associate, UWA Business School
Kirsten Martinus		Research Associate, UWA Business School
Brett Smith		Research Associate, UWA Business School
Cate Patterson		Research Assistant, UWA Business School
Tim French		Research Associate, UWA Computer Science
Lyndon Whyle		Research Associate, UWA Computer Science
Thomas Stemler		Research Associate, UWA Mathematics
Farid Boussaid		Research Associate, UWA Electrical, Electronic & Computer Engineering
Mohammed Bennamoun		Research Associate, UWA Electrical, Electronic & Computer Engineering
Tim Hoffman		Consultant
Simone Pettigrew		Research Associate, Curtin
Richard Norman		Research Associate, Curtin
Leon Booth		Research Associate, Curtin

Research Team		
Tele Tan		Research Associate, Curtin
David McMeekin		Research Associate, Curtin
Kerry Brown		Research Associate, ECU
Subha Parida		Research Assistant, ECU
Reza Kiani Mavi		Research Associate, ECU
Ferry Jie		Research Associate, ECU
Hadrian Djajadikerta		Research Associate, ECU
Craig Standing		Research Associate, ECU
Susan Standing		Research Associate, ECU

Table 6: Core Project Steering Committee Participation

Project	Sub-project	Steering Comm. (gov)	Researchers
iMOVE 3: Managing transport system investment risk: enhancing patronage predictions and adapting strategic asset management and appraisal processes to account for emerging trends and uncertainty	Patronage trend drivers	Claire Thompson, DOT (Chair) Martin Keen, DOT (alt Chair) Martin White, PTA Brendan Lumbers, PTA	Brett Smith, UWA (Lead) Doina Olaru, UWA Rachel Cardell-Oliver, UWA Tristan Reed, Curtin
	Journey Planning tools	Claire Thompson (Chair) Martin Keen, DOT Trevor Buckenara, DOT	Tristan Reed, Curtin (Lead)
	Asset management	Flori Mihai, MRWA Graham O'Neil, DOT	Kerry Brown, ECU (Lead) Ferry Jie, ECU Hadrian G Djajadikerta, ECU
	Appraisal	Andrew Wilkinson, DOT Beth Beere, DOT	Sae Chi, UWA (Lead)
iMOVE 4: Enhanced vehicle detection		Kamal Weeratunga, MRWA (Chair) Cory Ross, MRWA Cas Tesnear, MRWA	Mohammed Bennamoun (UWA) Farid Boussaid, UWA Chao Sun, UWA
iMOVE 5: ITS plus modelling	iMOVE ITS phase 2	Steve Atkinson Kamal Weeratunga Graham Jacoby	Chao Sun, UWA (Lead)
	LU-T modelling – CubeLand support	Simon Zheng, DPLH Renlong Han, DOT Ying Huang, DPLH	Doina Olaru, UWA (Lead)
Public confidence in use and roll-out of shared, automated and electric – retirement village shuttle bus trial		Alizanne Cheetham, DOT Simon Grieve, DOT	Simone Pettigrew, Curtin (Lead) Richard Norman, Curtin
Industrial land analysis – freight demand forecasting		Anne-Marie Brits, DOT Chris Sharples, DOT	Tim Hoffman, Consultant (Lead) Rachel Cardell-Oliver Sae Chi, UWA

4.2. Finances

2020 ended with a closing balance of $102,688, including the balance brought forward from 2019 of $113,245. With a YTD balance of $-10k, total expenditure ($1,347,713) slightly exceeded the income of $1,337,156 (Table 7). Actual income was $102k less than budget and actual expenditure, $60k less and with the closing balance of $42k less than budgeted. The primary reason for the discrepancy is the delayed completion of iMOVE project deliverables which were delivered and paid in early 2021.

Table 7: Financial Summary for 2020

PATREC Income and Expenditure 2020	YTD Actual 31 Dec 2020	Budget 2020 (Revised)
INCOME		
WA Government Grants	280,000	280,000
Universities Sponsorship	202,000	202,000
iMOVE Commonwealth	424,756	433,440
iMOVE UWA	70,000	70,000
iMOVE additional gov/industry	100,000	104,000
Other Research Grants & Contracts	260,400	350,000
Total Income	**1,337,156**	**1,439,440**
EXPENDITURE		
PATREC OFFICE	**119,415**	**209,086**
RESEARCH PROJECTS	**1,228,298**	**1,198,974**
Total Expenditure	**1,347,713**	**1,408,061**
YTD BALANCE	-10,557	31,379
Balance Brought Forward from 2019	**113,245**	**113,245**
CLOSING BALANCE (incl Balance B/F)	**102,688**	**144,624**

5. GOVERNANCE

5.1. Board Members

The PATREC Advisory 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. Prof Nathaniel Belcher replaced Prof Alan Dench as the member for Curtin University while Prof Andrew Page replaced Prof Tim Colmer as the UWA member (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 8: PATREC Board Members

2019	*2020*
Adjunct Prof Reece Waldock, Independent Chair	Adjunct Prof Reece Waldock, Independent Chair
Mr David Caddy, Chair, Western Australian Planning Commission	Mr David Caddy, Chair, Western Australian Planning Commission
Mr Peter Woronzow, Managing Director, Main Roads Western Australia	Mr Peter Woronzow, acting Director General Transport, Western Australia
Mr Steve Beyer, Director, Portfolio Strategic Projects Office, Department of Transport	Mr Steve Beyer, Director, Portfolio Strategic Projects Office, Department of Transport
Prof Alan Dench, Pro Vice-Chancellor Humanities, Curtin University	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 Kerry Brown, Director of the Centre for Innovative Practice, Edith Cowan University
Prof Tim Colmer, Acting Pro Vice-Chancellor (Research), The University of Western Australia	Prof Andrew Page, Pro Vice-Chancellor (Research), The University of Western Australia
Mr Ian Duncan, Executive Manager, Infrastructure, WALGA	Mr Ian Duncan, Executive Manager, Infrastructure, WALGA

5.2. PATREC Research Advisory Committee Members

Comprising one to 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:

- introduce 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 took over as Chair of the PRAC on the retirement of Brett Hughes and Damien Martin, elected during 2018, continued as Deputy Chair in 2019 (Table 10).

Table 9: PATREC Research Advisory Committee Members

Name	Organisation
Steve Atkinson (Chair)	Main Roads WA
Anne-Marie Brits	Department of Transport
Justin McKirdy	Department of Transport
Douglas Morgan	Main Roads WA
Steven Phillips	Main Roads WA
Damien Martin (Deputy Chair)	Department of Planning, Land & Heritage
John Chortis	Department of Planning, Land & Heritage
Martin White	Public Transport Authority
Rebecca Lange	Curtin University
David McMeekin	Curtin University
Hadrian Djajadikerta	Edith Cowan University
Ferry Jie	Edith Cowan University
Doina Olaru	The University of Western Australia
Brett Smith	The University of Western Australia
Sharon Biermann	PATREC

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 to date against 2020 targets as set in the Annual Business Plan 2020, is summarised in Table 10.

Table 10: Key Performance Indicator Targets (2020) and Achievements as at 31 December 2020

Performance Indicator	Target 2020	Achieved 2020
Academic Performance Indicators		
Number of journal papers published	5	10
Number of peer-reviewed book chapters published	2	1
Number of peer-reviewed conference papers published in proceedings	7	0
Number of peer-reviewed books published	0	0
Number of PhD and Masters students attracted (and graduated)	1	0
Value ($) of [direct] external research funding secured (through PATREC account)	$957,440	$855,156
Policy Impact Performance Indicators		
Number of high impact, policy-informing projects/sub-projects completed	6	6
Number of substantive Technical Reports/Working Papers accepted/published	6	8
Number of PATREC Perspectives published on PATREC website/other factsheets	6	1
Number of presentations at PATREC and other connection events/webinars	10	4
Number of connection events arranged and held	5	5 (arranged, but cancelled due to COVID)
Number of short courses, unit contributions presented	5	2 Transport Eng. Unit (CS); Resilient transport unit contribution (SB)
Stakeholder (academic and policy) satisfaction indicator (qualitative)	80%	91%