

Queensland Department of Transport and Main Roads

Submission to the Queensland Parliament Transport and Public Works Committee Inquiry: *Transport Technology—the challenges and opportunities which technology will bring to the transport sector in coming years*

OVERVIEW

Key points:

- There is uncertainty associated with the future - including the form, impact and implications of transport technologies.
- The Department of Transport and Main Roads is developing the Queensland Transport Strategy to provide a strategic approach that will prepare our policy, technical, infrastructure and customer service capabilities for the future. The Strategy will be a 30-year future-focused, whole-of-system transport strategy to position Queensland to maximise the benefits of current and future emerging trends and technologies.
- Queensland, through the department, is part of a nationally consistent and coordinated policy framework and action plan to address the challenges and opportunities associated with transport technologies.

The Queensland Department of Transport and Main Roads (TMR) welcomes the opportunity to provide a submission to the inquiry into *Transport technology – the challenges and opportunities which technology will bring to the transport sector in coming years*, being undertaken by the Transport and Public Works Committee of the Queensland Parliament.

Emerging technologies continue to revolutionise industry and the way that people engage with the transport system and view mobility. Such change presents significant challenges and opportunities for how Queenslanders travel, and how goods and services are moved. This submission discusses the challenges and opportunities technology will bring to Queensland's transport system in response to each of the terms of reference.

SUMMARY

Global and local trends are creating new opportunities for transport in Queensland and changing the transport task. Around the world, there is an increasing need to make better use of resources, manage environmental impacts and respond to significant changes in the global economy. In Queensland, our economy is growing and more people are choosing to call our state home. Collectively, these trends are resulting in new transport services, such as urban food delivery and parcel delivery, and demand for more trips, alongside a range of other impacts.

Through smart use of new and emerging technologies, we can position the transport system to meet the future needs of Queenslanders – creating an integrated system that anticipates, rather than just responds to, customers' needs. Technology is already improving how people and goods move, whether through on-demand transport, cooperative and automated vehicle technology or using drones to deliver parcels or food.

It is also providing improved transport access options for people with disabilities, older Queenslanders and people who may not have a driver's licence. Further changes will improve safety, efficiency and convenience, ultimately saving people and businesses time and money.

TMR in collaboration with research partner Data61, have identified five overarching 'megatrends' that are predicated to significantly influence Queensland's transport system over the coming decades. The megatrends are:

- **On the move.** Demand for transport has grown, with people travelling more and increasingly likely to consume goods and services purchased online. Future technological, demographic and consumer shifts will continue to drive this growth in transport demand.
- **Digital dividends.** Emerging technologies look to become increasingly capable, affordable and widespread. Automated vehicles, connected infrastructure, drones and big data analytics all have the potential to make the transport system more efficient, cheaper and more responsive to demand.
- **Virtually there.** Advances in technology are enabling more processes to be automated or completed online, transforming the way we work, shop and access services. This will impact how much, when and why people travel, and the infrastructure needed to support the transport task.
- **A lighter footprint.** Geopolitical pushes towards electric vehicles, shifts in consumer preferences and emerging shared mobility models offer significant opportunities to reduce the environmental and safety burden of transport. However, Queensland lags behind global trends in some of these areas.
- **Empowered consumers.** Transport users increasingly expect personalised, on-demand services that cater to their specific needs. The evolution of more individualised transport services could encourage new models of freight distribution and pay-as-you-go charging models for transport users.

TMR is exploring a range of technologies and new business models that could improve transport outcomes for Queensland and increase transport affordability for Queenslanders. Future-focused projects currently underway in TMR include:

- Connected and automated vehicle trials, including the Cooperative and Automated Vehicle Initiative (CAVI) – Australia's largest trial at Ipswich.
- Actively exploring viability of Mobility as a Service in Queensland. TMR is currently running a demand responsive transport trial in partnership with Yellow Cabs in Logan.
- Queensland has Australia's only comprehensive electric vehicle strategy which includes actions to investigate the electrification of light, heavy and public transport fleets.
- Queensland is home to the world's longest electric vehicle charging super highway in a single state. TMR is actively monitoring new vehicle charging technologies and fuel types such as induction charging and hydrogen fuel.
- TMR is using drones to enhance maintenance and operations on the state's road, rail and maritime system.
- TMR is improving its capability in data analytics, machine learning and artificial intelligence to create the transport system of the future, for example through implementation of building information management systems.
- TMR is creating an agile and responsive workforce that is developing a range of innovative new tools and services to improve operations and reduce costs, for example through the department's Innovation Council and improved digital capability and online services.
- TMR's Data and Business Analytics Strategy sets a vision and imperative for transforming the way decisions are made by putting data and business analytics at their centre. A dedicated project is supported by a senior leaders advisory group and wider TMR collaboration through technical working groups and a Community of Practice.

- With over 250 datasets published on the Queensland Government Open Data portal, TMR is the third most published agency in Queensland Government and is committed to continuing to mature its Open Data practices.
- Significant research and development in road materials technology and asset management for improved infrastructure resilience, environmental sustainability and reduced whole of life costs

QUEENSLAND CONTEXT

Over the next 30 years, Queensland will experience significant change. Alongside demographic growth and shifts, emerging technologies and trends are likely to cause profound transformations to Queensland's transport system.

While the extent of change in transport is unprecedented, potentially more significant is the unknown nature of many of these changes. Determining which technological developments will transform our lives over the next 30 years is challenging.

Despite this uncertainty – or perhaps because of it - fundamental choices will need to be made on how the future transport system is delivered, for example:

- the cost of different transport modes will change significantly as automation, technology and sharing economy business models emerge, resulting in changes to transport markets, changes for consumer choice, and choices for government about where best to invest
- depending on what choices consumers make in this new era, the future need for additional infrastructure supply may be quite different to past trends
- growth in traditional revenue sources for transport (such as registration, licensing and fuel excise) are already slowing when compared to population growth, and will require government to develop options for the sustainable long-term funding of the transport system.

When making decisions about the transport system today, we need to do so with the knowledge that we cannot predict what the future will look like with any confidence. It is therefore important that the decisions being made today do not limit how we can respond in the future, for example:

- innovation within the transport sector should be enabled to ensure that access, safety, efficiency and sustainability is retained and improved so that the best possible outcomes are achieved for Queensland
- the benefits of transport technology should be maximised for passenger and freight transport throughout rural, regional, and urban Queensland.

TMR STRATEGIC APPROACH FOR FUTURE TRANSPORT

To maximise the benefits of transport technology and ensure that the safety, accessibility, efficiency and sustainability of the transport system is retained and improved, TMR is currently developing a Queensland Transport Strategy (QTS). The QTS will be a 30-year, future-focused, whole-of-system transport strategy that will position TMR to maximise the benefits of current and future emerging trends and technologies for our customers and the community.

TMR's strategic approach to preparing Queensland's transport system and managing the impact of transport technologies aims to provide a high degree of confidence that TMR is:

- aware of key emerging transport technologies
- understands the implications of potentially disruptive technologies, both for the transport system and the community

- effectively coordinating and aligning TMR policies and programs in response to transport technologies with national, state and local policy agendas
- prepares for and manages the risks associated with disruptive technology.

The QTS will help to guide and inform transport decision-makers to better prepare our policy, technical, infrastructure and customer service capabilities for the future.

NATIONAL POLICY FRAMEWORK ON TRANSPORT TECHNOLOGIES

Many of the issues associated with transport technologies are also being addressed through a comprehensive and integrated national program overseen by the Transport and Infrastructure Council.

The key policy framework for delivering this coordinated, national action on transport technologies is the *National Policy Framework for Land Transport Technology* and associated *Action Plan: 2016-2016* (Action Plan)¹. All transport jurisdictions in Australia and New Zealand, including Queensland, have endorsed the approach outlined in the Framework and committed to implementation of the 14 national actions.

Queensland has invested significant resources in either leading or contributing to actions under the Action Plan and is committed to an ongoing, engaged role in delivering nationally coordinated action to address the challenges and opportunities associated with transport technologies.

TERMS OF REFERENCE

A) identifying trends and changes in fuel type usage in the sectors of personal transport, freight transport and public transport, such as the increasing uptake of hybrid and electric vehicles

Key points:

- Queensland's registered vehicle fleet has shifted towards smaller cylinder vehicles, which is being driven by increased market availability, improved vehicle performance, and lower operating costs.
- Queensland registration figures indicated that the State's electric vehicle fleet increased by over 70 per cent between mid-2016 and mid-2018.
- Further research into the development of renewable energy, including alternative fuel types such as hydrogen should be a priority.

CONTEXT

Changing regulatory requirements across the globe, fluctuating fuel prices and consumer preferences for smaller and more fuel-efficient vehicles are pushing vehicle manufacturers to produce more environmentally friendly vehicles. Vehicles powered by a variety of fuel types are currently being developed and supported by the motor industry across the globe, and include:

- electric vehicles (predominantly powered by electricity, with some models also equipped with fossil fuel/biofuel range extenders)
- hybrid-internal combustion engine vehicles (powered by fossil fuels and/or biofuels)

¹http://transportinfrastructurecouncil.gov.au/publications/files/National_Policy_Framework_for_Land_Transport_Technology.pdf

- fuel-cell vehicles (powered by hydrogen or biofuels converted into hydrogen).

In addition to promoting a wider range of vehicles with different fuel types, major manufacturers are now producing vehicles that are very different to those produced 10-15 years ago. This reflects a trend towards motorists' preference for smaller, more fuel-efficient vehicles. These vehicles generally have smaller engines compared to many of the vehicles manufactured in the early 2000s and have similar, if not better, performance characteristics.

TRENDS IN VEHICLE AND FUEL TYPES

Queensland's vehicle fleet

In the nine years from 2011 to 2018, Queensland motor vehicle registration data across light commercial and passenger cars indicates that Queenslanders' preference cars with smaller, more fuel-efficient engines. **Table 1** shows that over the period from 30 June 2011 to 30 June 2018, registrations for smaller 4-cylinder cars have been increasing at a steady rate, while larger 6-cylinder cars have been declining. The increase in registrations of 8-cylinder vehicles may be attributable to larger luxury cars, some 4WD models and enthusiast vehicles.

Table 2 outlines the number of vehicles in TMR's Queensland motor vehicle registration database by fuel type, as at 30 June 2018. This database captures a wide variety of motorised vehicles from motorcycles, cars and buses, to heavy vehicles (trucks) including farm vehicles and mobile machinery.

| As at June | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Total light Commercial and Passenger cars by cylinder size | | | | | | | | |
| 4 Cyl | 2,043,600 | 2,147,058 | 2,260,897 | 2,361,892 | 2,452,202 | 2,559,307 | 2,661,745 | 2,758,556 |
| 6 Cyl | 1,008,165 | 990,231 | 970,335 | 943,614 | 913,414 | 888,863 | 861,400 | 834,333 |
| 8 Cyl | 132,161 | 137,306 | 143,226 | 148,263 | 151,771 | 155,889 | 161,187 | 164,076 |
| Increase/Decrease in Number | | | | | | | | |
| 4 Cyl | | 103,458 | 113,839 | 100,995 | 90,310 | 107,105 | 102,438 | 96,811 |
| 6 Cyl | | - 17,934 | - 19,896 | - 26,721 | - 30,200 | - 24,551 | - 27,463 | - 27,067 |
| 8 Cyl | | 5,145 | 5,920 | 5,037 | 3,508 | 4,118 | 5,298 | 2,889 |
| Increase/Decrease % | | | | | | | | |
| 4 Cyl | | 5.1% | 5.3% | 4.5% | 3.8% | 4.4% | 4.0% | 3.6% |
| 6 Cyl | | -1.8% | -2.0% | -2.8% | -3.2% | -2.7% | -3.1% | -3.1% |
| 8 Cyl | | 3.9% | 4.3% | 3.5% | 2.4% | 2.7% | 3.4% | 1.8% |

Table 1 - Number of light vehicles registered at 30 June each year by the main cylinder groupings, 4, 6 and 8.

Currently, petrol and diesel fuelled vehicles still make up the majority of Queensland registered motor vehicles. While hybrid and fully electric vehicles still make up a small proportion of the overall fleet, it is expected that growth will increase as vehicle manufacturers move away from petrol and diesel fuelled vehicles resulting in more options being available within the Queensland market.

| Queensland's vehicle fleet by fuel type | |
|--|----------------------------------|
| Fuel type | # of vehicles in category |
| Petrol | 2,945,725 |
| Hybrid electric vehicles (Diesel /electric or petrol / electric) | 19,873 |
| Gas | 7,868 |
| Fully electric vehicle | 798 |
| Diesel | 1,238,203 |
| Bi-Fuel (Petrol / gas or Diesel / gas) | 28,280 |

Table 2: Queensland's vehicle fleet by fuel type (data is current as at 30 June 2018)

Table 3 outlines Queensland's vehicle fleet based on different fuel types within different transport categories and shows that electric vehicles are now evident in the heavy vehicle, personalised transport, private and public transport categories. It also indicates that hybrid vehicles consisting of either a petrol/electric and diesel/electric engine, are also becoming more visible across the fleet.

| Category | Fuel Type | | | | | | | |
|------------------------|-----------|--------|----------------|----------------|---------------------|---------------------|-------|----------|
| | | | | | Hybrid Vehicles | | | |
| | Petrol | Diesel | Petrol/ Gas | Diesel/ Gas | Petrol/ Electric | Diesel/ Electric | Gas | Electric |
| Emergency | 3.93% | 95.64% | 0.09% | 0.35% | 0.00% | 0.00% | 0.00% | 0.00% |
| Heavy Vehicle | 2.36% | 97.54% | 0.02% | 0.03% | 0.00% | 0.04% | 0.01% | 0.01% |
| Personalised Transport | 67.03% | 14.83% | 2.39% | 0.01% | 15.28% | 0.01% | 0.41% | 0.04% |
| Private | 71.92% | 26.79% | 0.64% | 0.03% | 0.41% | 0.00% | 0.18% | 0.02% |
| Public Transport | 16.75% | 80.14% | 0.97% | 0.04% | 0.00% | 0.00% | 2.04% | 0.05% |

Table 3: Queensland's vehicle fleet by purpose of use (data is current as at 30 June 2018)

Heavy vehicles are critical to the freight task and are widely used to move essential goods and services across Queensland. Within the current motor vehicle fleet, heavy vehicles are predominately powered by diesel fuel (97.54 per cent), as diesel provides greater fuel economy to vehicles travelling long distances.

As of 30 June 2018, electric vehicle technology is visible as a fuel type within the heavy vehicle segment (0.01 per cent). Similarly, hybrid diesel/electric fuelled vehicles represent 0.04 per cent of the heavy vehicle industry. A small portion of Queensland's heavy vehicles are now also being powered by other fuel types such as petrol/gas at 0.02 per cent, diesel/gas at 0.03 per cent and gas at 0.01 per cent.

If Queenslanders continue to preference increasingly fuel efficient vehicles, this will support growth in the take up of vehicles powered by more economical fuel sources as they become available. It is anticipated that electric vehicles will continue to grow as a portion of Queensland's vehicle fleet as they reach cost parity with internal combustion engine vehicles, and current models enter the second-hand market.

UPTAKE OF ELECTRIC VEHICLES (EVs)

In recognition of the global support for EV technology and the need to encourage local uptake, the Queensland Government launched *The Future is Electric – Queensland's Electric Vehicle Strategy* in 2017. The Strategy consists of 16 initiatives aimed at:

- empowering consumers to learn more about EVs.
- enabling EV charging infrastructure.
- exploring cost-effective programs to support the uptake of EVs.
- envisaging what future actions may be required to adjust to changes in the market.

For the purpose of the *Queensland Electric Vehicle Strategy*, EVs are defined as any vehicle that can be propelled by one or more electric motors, and that can be plugged-in to charge.

There are two main categories of EVs:

- battery-electric vehicles (BEVs) - fully electric vehicles, such as the Nissan Leaf or Tesla Model S.

- plug-in hybrid electric vehicles (PHEVs) - electric vehicles that can be plugged-in to charge and drive shorter distances on electricity, and also have a liquid fuel range extender/internal combustion engine that provides additional range for longer trips.

EVs are a promising technology for transport emission reductions given their high energy efficiency, low operating costs, reduced oil dependency, and their potential for providing wider electricity grid benefits through bi-directional, smart vehicle-to-grid systems².

As of the 30 June 2018, there were 1562 plug-in electric vehicles registered in Queensland, comprising of 798 BEVs and 764 PHEVs (PHEVs are included in the total of hybrid electric vehicles in **Table 2**). Overall, EVs represented 0.04 per cent of the Queensland fleet. Additionally, there were 11 battery-electric heavy vehicles and 76 battery-electric motorcycles/mopeds registered in Queensland.

Queensland registration figures indicate that the state's EV fleet increased by over 70% between mid-2016 and mid-2018.

Based on these registration figures, 249 EVs were sold in Queensland in the financial year (FY) 2016/17 (95 BEVs; 154 PHEVs) and 406 EVs were sold in Queensland in FY2017/18 (251 BEVs; 155 PHEVs). This translates to a 164 per cent increase in BEV sales but only a 1% increase PHEV sales, in part due to the runout sale of an older PHEV model in 2016, leading to an inflation in FY2016/17 PHEV figures. Overall, there was a 63 per cent increase in EV sales in Queensland between FY2016/17 and FY2017/18.

In comparison, national sales figures provided by the University of Queensland show that BEV sales increased by 113 per cent (887 to 1889 BEV sales), and PHEV sales increased by 118 per cent (652 to 1423 PHEV sales), over the same period (overall, 115 per cent increase in EV sales; 1539 to 3312 EV sales).

These figures demonstrate that since the launch of the first QESH sites in the second half of 2017, the sale of BEVs—which are dependent on fast-charging infrastructure for long distance travel—have increased at a faster rate in Queensland than across nation as a whole (164 per cent vs. 113 per cent).

EV uptake trends in Queensland, and across Australia, support findings from a recent study commissioned by the Australian Renewable Energy Agency and the Clean Energy Finance Corporation (the corporation). The corporation predicted that with moderate policy intervention, EVs could represent 49 per cent of Australian new vehicle sales by 2030, climbing to 100 per cent of sales by 2040³. Even under a nil policy intervention scenario, the study predicted that EV sales would make up approximately 25 per cent of Australian new vehicle sales by 2030, largely due to: falling battery prices, increased EV model availability, and an increasing difference between electricity and petrol prices.

OTHER FUEL SOURCES

Hydrogen

Another emerging fuel type that is less advanced than others is hydrogen fuel cell vehicles. When used to power electric motors, hydrogen fuel cells provide vehicles with greater driving range and opportunities for faster refuelling. Various vehicle manufacturers are developing hydrogen fuel cell technology, with several models available for sale overseas. Fuel cell technology uses hydrogen (or another fuel source such as pure ethanol) to power the vehicle engine.

As an example, unlike battery powered buses, fuel cell buses do not require lengthy recharge cycles, and store energy in tanks and therefore the maximum range is determined

² Electric vehicle-to-grid systems involve demand management of charging, so that EVs are predominantly charged during peak renewable and/or low grid demand periods i.e. overnight. These systems are also bidirectional, and can export electricity back to the grid during peak grid demand periods, effectively acting as mobility battery systems.

³ <https://arena.gov.au/assets/2018/06/australian-ev-market-study-report.pdf>

by 'load carrying capacity' rather than charging a static battery. However, consideration needs to be given to design, production facility and maintenance to deliver a fuel cell bus service.

Queensland supports further research into hydrogen as a renewable fuel source. On 31 May 2018, the Queensland Government announced a commitment of \$750,000 to support the investigation of producing and supplying hydrogen at a competitive price to alternative energy sources such as natural gas and other sources⁴.

B) examining the readiness of the transport network for increasing electrification of vehicles in coming years

Key points:

- Queensland is the only jurisdiction to have a dedicated strategy designed to increase the use of electric vehicles (EVs): *The Future is Electric – Queensland's Electric Vehicle Strategy*. Queensland is supporting the uptake of electric vehicles through the delivery of the Queensland Electric Super Highway (QESH).
- The QESH is a network of fast charging stations from the Gold Coast to Cairns and from Brisbane to Toowoomba.
- TMR is working closely with Energy Queensland to understand the impact of EVs on the electrical network to ensure both transport and the electrical networks are prepared for an increasing number of EVs and chargers.

CONTEXT

Queensland has made progress towards transitioning the transport network for the increase in EVs in the coming years. Queensland is the only jurisdiction to have a dedicated strategy designed to increase the use of electric vehicles through *The Future is Electric – Queensland's Electric Vehicle Strategy* launched in 2017. The strategy includes an initiative to develop the Queensland Electric Super Highway (QESH), the world's longest EV super highway in a single state.

The QESH is designed to allow Queenslanders and tourists to travel by EV from the Gold Coast to Cairns and from Brisbane to Toowoomba. The highway features a network of fast EV charging stations which support the majority of EV models currently in Australia and are recognised as an industry standard around the world. Existing QESH sites will be complimented by a second phase of fast charging sites, and slower regional destination chargers to be completed over the coming years.

EV CHARGING STATIONS AND ENERGY PROVISION

There are two main types of EV charging stations in Queensland:

- alternating current (AC) chargers: 3-22 kW (20 to 130 kilometres per hour)
- direct current (DC) fast-chargers: >50 kW (>300 kilometres per hour).

Between mid-2016 and mid-2018, the number of publicly accessible EV charging stations in Queensland increased by 264 per cent (from 78 to 284 charging stations). This has predominantly been in the form of AC charging stations (257 charging stations) and through the rollout of the QESH DC fast-chargers (27 fast-charging stations). Queensland currently

⁴ <http://statements.qld.gov.au/Statement/2018/5/31/palaszczuk-government-backs-hydrogen-research-for-renewable-fuel-source>

leads Australia with the highest number of DC fast-charging stations⁵, in large part due to the QESH.

With the majority of EV charging expected to be carried out at home and work, it will be important to closely monitor the clustering of EVs to ensure any local grid capacity constraints can be managed and/or addressed. TMR is working closely with Energy Queensland to understand the impact of EVs, and inform future planning activities to ensure both transport and electricity networks are prepared for an increase in EVs and chargers.

Studies from overseas show that the charging of EVs can be integrated into the existing grid with minimal additional costs using demand management strategies, including time-of-use tariffs⁶. Further improvements in battery technology will also decrease charging infrastructure requirements.

Many energy providers see EVs as an opportunity for increasing the utilisation of the electricity grid, at a time when many households and businesses are becoming less dependent on the grid through the uptake of rooftop solar systems.

Heavy vehicles, such as buses and trucks used for freight, may have different charging profiles to passenger vehicles depending on their typical route length and operating times. Overnight AC charging is likely to be sufficient to provide enough charge to facilitate typical daily routes for short-haul and urban electric heavy vehicles. Long-haul heavy vehicles are likely to be more dependent on fast-charging infrastructure, at least initially, in combination with internal combustion engine and fuel cell range-extendors.

⁵https://climateworks.com.au/sites/default/files/documents/publications/climateworks_australia_state_of_electric_vehicles2_june_2018.pdf

⁶http://www.synapse-energy.com/sites/default/files/EVs-Not-Crashing-Grid-17-025_0.pdf

C) identifying other emerging technological factors which will impact on transport networks into the future, such as driver aid technology and 'driverless car' technologies**Key points:**

- The *National Policy Framework for Land Transport Technology* (the NPF), developed and overseen by the Transport Infrastructure Council, provides a nationally consistent, agreed framework to guide research, development and deployment of transport technologies. National transport bodies (such as the National Transport Commission and Austroads) and state jurisdictions (including Queensland) are contributing to the coordinated delivery of transport technology actions identified in the NPF.
- Technological factors most likely to impact transport networks involve: increasing automation (automated vehicles); increasingly connected/cooperative systems; changes to service delivery models (shared mobility); and associated data privacy and data access issues.
- The introduction of CAVs and other emerging technologies will have implications for transport infrastructure, transport revenue/funding models, land use and the urban environment more broadly.
- In addition to small scale, localised trials on CAVs, Queensland is also delivering nationally significant trials of connected and automated vehicles under the NPF Action Plan. These trials will help Queensland (and other jurisdictions) prepare for, and accelerate, the deployment of advanced vehicle technologies with improved safety, mobility and environmental benefits.

CONTEXT

Around the world, including in Queensland, technology is driving innovation, opportunity and transformation. New emerging technologies and shared transport services have the potential to profoundly benefit Queensland's transport system and its customers. However, these developments also present challenges that will test the ability of government to effectively respond to change and satisfy customer needs and expectations, now and into the future.

Conversely, technology can disrupt and adversely impact existing systems. Significant changes in transport technology and service models could potentially result in increased travel demand, more road congestion, declining government revenues, rising costs and employment impacts. Technology developments can also present challenges that test the ability of government to effectively respond to change and satisfy customer needs and expectations, now and into the future.

By planning for the long-term and developing evidence-based options for responding to changes in the transport system, governments and the private sector can help to minimise any potential negative impacts associated with the introduction of new transport technologies.

NATIONAL FRAMEWORK AND ACTION ON TRANSPORT TECHNOLOGIES

The NPF provides a nationally integrated and consistent policy approach to the deployment of transport technologies. The NPF identifies four main roles for government in relation to the deployment of technology: deliver policy leadership; enable innovation; create a supportive regulatory environment; and invest in research, development and real-world trials. The NPF also includes seven policy principles for government action. These principles provide guidance to Queensland, and other jurisdictions, to manage disruption, encourage innovation and respond to transport technology.

The NPF and accompanying Action Plan outlines Australia's national priorities for implementing new technologies. It is underpinned by an extensive program of policy, regulatory and technical work involving a range of national transport bodies including the National Transport Commission (NTC)⁷ and Austroads, in partnership with Commonwealth and state and territory jurisdictions. Many industry organisations have partnered with agencies to deliver project-level NPF activities. Several of Queensland's flagship projects to trial new transport technologies are being delivered as part of the NPF Action Plan.

The NPF Action Plan is currently being updated and will be considered by the Transport and Infrastructure Council in November 2018.

EMERGING CUSTOMER DRIVEN TRENDS AND TECHNOLOGICAL FACTORS

Vehicle ownership

The introduction of connected and automated vehicles (CAVs) to the Australian market is expected to further drive an increase in shared mobility and as a result impact existing vehicle ownership models. Ownership and service delivery models that are expected to experience growth are:

- car sharing - where people rent a vehicle for a short period, often only a few hours. This model differs from traditional car rental where the car is hired for one day or longer. It is useful for people not wanting to own a car or those with only occasional need for a car. Car sharing offers the opportunity to reduce the number of cars in use, particularly in urban areas, and is primarily focused in higher density areas where people can walk to and from the vehicle when they need it
- ride sharing - where shared rides are pre-booked via a smartphone, such as Uber, Lyft, Via and Haxi. Some ride sharing models also allow users to split the cost of a fare with other passengers in the vehicle

Mobility as a Service (MaaS)

The transportation landscape is changing, customer expectations are growing and there is an increase in sharing assets.

MaaS embodies a shift away from personally owned modes of transportation and towards aggregated mobility solutions that are consumed as a service. Aggregation looks at bringing together infrastructure, services, technology and information to suit the travel and lifestyle needs of the individual.

MaaS has a range of benefits, including:

- Personalised mobility solutions
- Improved liveability and accessibility of cities
- Improved sustainability with efficient use of infrastructure and assets
- More opportunities for utilisation of transport and
- Improved services based on demand and preferences

MaaS opportunities exist across the whole network. Not only in the South East, but also for regional and remote Queensland. Public transport is an important part of MaaS, however it also describes the whole ecosystem from public transport, to ride-share and bike share, to flexible payment options with subscription and bundled services, to personalised journey planning with an integrated planning, booking and payment platform.

⁷ [http://www.ntc.gov.au/Media/Reports/\(C681665C-A838-3A47-EB1B-BC1F925285C6\).pdf](http://www.ntc.gov.au/Media/Reports/(C681665C-A838-3A47-EB1B-BC1F925285C6).pdf)

Automated heavy vehicles

Heavy vehicles are an attractive application for automated technologies and the heavy vehicle industry are likely to be early adopters. This is because the driver currently represents one of the most expensive links in the road freight haulage task. The ability for trucks to 'platoon' (drive cooperatively at less than one second apart over long distances) will provide significant benefits to owners with lower staffing costs. However, the application of truck platooning is likely to be restricted to multi-lane freeway standard roads which will have limited application on South East Queensland motorways. The interaction of different vehicles such as platooning heavy vehicles and motorcycles and cars is yet to be properly understood and their effects on safety.

Connected Vehicles

'Connected vehicles' is the term used to describe vehicles with a direct communications link (usually through wireless Internet connectivity) to other vehicles, roadside infrastructure (like traffic signals and signs) and/or service providers and devices. It covers passenger vehicle, buses and heavy vehicle satellite-based communication systems as well as Cooperative Intelligent Transport Systems (C-ITS) technologies, and digital short-range communications systems. The benefits of connected vehicles are likely to be wider than those delivered by autonomous vehicles, and encompass the areas of safety, traveller information, mobility, infotainment and remote diagnostics, as well as maintenance and software updates⁸. Through research and trials of vehicle technology being undertaken across the globe, it is being increasingly apparent that automated vehicles will require connected vehicle technologies to realise their full range of benefits.

Drones

Drones are a rapidly developing technology with significant industry growth expected over the coming decades. Aerial drones in particular have a range of current applications on Queensland's transport system that can provide operational efficiency, safety and productivity benefits.

Drone is the common term used to describe a variety of remotely operated and/or autonomous vehicles. TMR's primary focus is currently on the use of aerial drones called Remotely Piloted Aircraft Systems (RPAS).

RPAS are being used extensively by TMR to support and enhance technical activities such as geographic survey, asset management, structural inspections, road corridor surveys, traffic monitoring, disaster response and aerial photography/videography.

Depending on the function it is performing, RPAS can be equipped with a range of different cameras and sensor technology including, thermo-scanner, LiDAR (Light Detection and Ranging) sensors, infrared and hyperspectral cameras, chemical delivery systems, weed spraying and meteorological sensors.

Drones are also being developed to perform traditional transport functions including freight and passenger movement. While there is some variation in the level of maturity of passenger and freight drones, trials of both have occurred in the last two years. There is considerable debate about the extent of impact that drones may have on the movement of passengers and goods in the future.

While mainstream passenger transport applications develop over the long term, small parcel and first and last mile freight delivery are a more realistic prospect for the transport system in the medium term.

⁸ Main Roads Western Australia, 2015, *Connected Vehicles: Are We Ready?* Available at: <https://www.mainroads.wa.gov.au/Documents/Connect%20Vehicles%20Web.RCN-D15%5E23413758.PDF>

Aerial drones or RPAS will continue to play an increasing role in performing technical tasks such as geographic survey, asset management, structural inspections, road corridor surveys, traffic monitoring, disaster response, aerial photography and video.

The Civil Aviation Safety Authority (CASA) is currently developing a roadmap to provide the future direction of RPAS integration into the Australian aviation system.

Data

Cooperative and automated transport technologies require and generate significant amounts of data in real time. With improved technology and information flow, there is potential for operation of the transport system as a whole, and specific components of the system, to be optimised (for example, integrating mobility across all modes for individual travellers and enhanced visibility of product movement along a single supply chain).

However, balancing the privacy of individuals' data against the system wide benefits of effective data sharing regimes is a significant challenge.

The iMOVE Cooperative Research Centre (CRC) is a consortium of 44 industry, government, and research partners engaged in a concerted 10-year effort to improve Australia's transport systems through collaborative R&D projects. The Queensland Government is one of the consortium partners. The primary objective of the iMOVE CRC is to improve mobility of people and freight through the better use of data.

TMR has developed a Data and Business Analytics Strategy sets a vision and imperative for transforming the way decisions are made by putting data and business analytics at their centre. A dedicated project is supported by a senior leaders advisory group and wider TMR collaboration through technical working groups and a Community of Practice.

With over 250 datasets published on the Queensland Government Open Data portal, TMR is the third most published agency in Queensland Government and is committed to continuing to mature its Open Data practices.

Materials Technology

A transport network that is resilient to the effects of climate change, particularly more extreme weather events, contributes to sustainable communities. Resilience enables fast recovery following a problem or interruption to resume regular operations or services. This reduces disruption to the broader transport network and allows people and freight to keep moving.

The transport network will be able to withstand natural disasters and be safe to use as soon as practically possible after such events. Better planning and design of infrastructure, early warning sensors and connective vehicle-infrastructure technologies will improve network resilience.

For the last five years, TMR has been funding the Australian Road Research Board (TMR) to conduct research under the National Asset Management Centre of Excellence (NACoE) program.

The program aims to develop and implement innovative technology which will:

- reduce the cost of infrastructure in Queensland
- improve sustainability outcomes
- apply best practice from interstate and overseas.

High Modulus Asphalt (a French innovation) is now being applied on an increasing scale. Approximately 10,000 tonnes was used on the Deagan Deviation on the Gateway Upgrade Project; 50,000 tonnes was used on the Port Road project, and currently 200,000 tonnes is under construction on the Logan Enhancement Project. TMR is now assessing how to allow Enrobés à Module Élevé Class 2 (EME2) as an option for Section D of the Cooroy Curra link.

It allows the asphalt base thickness to be reduced by about 20%, while offering superior performance, sustainability and productivity. Compared to conventional asphalt bases, EME2 has higher stiffness, better durability and improved rut and fatigue resistance. With lower emissions during production, fewer non-renewable resources (aggregates) used, and fewer trucks are needed to transport the asphalt, EME2 has a lower environmental impact than conventional heavy duty pavements.

As a direct result of NACoE research, crumbed rubber is increasingly being used in seals in several parts of Queensland's road network. TMR has amended its specification to increase the use of crumbed rubber seals. Crumbed rubber seals are believed to be more resilient in cold weather. TMR has now trialled crumbed rubber open grade asphalt which should deliver a more durable quieter and safer surfacing, and crumbed rubber gap graded asphalt, which provides an economical solution for rehabilitating cracked pavements.

Millions of tyres are discarded in Queensland each year, with most finding their way into landfill or overseas for destruction. Increased use of crumbed rubber binder provides a potential long-term alternative to this wastage. Aside from reducing landfill, it also has other environment benefits, including noise reduction, energy savings in construction, and a reduction in CO2 emissions compared to other methods of tyre disposal.

TMR is also using increasing quantities of foamed bitumen with the major Houghton Bridge approaches project south of Townsville to include this pavement to increase its flood resilience. Foamed bitumen results in finer particles being coated in bitumen, delivering a pavement more resilient to flooding. In the wake of Ex-Tropical Cyclone Debbie, roads that had used foamed bitumen stabilisation were able to withstand the severe flooding and survive largely intact, avoiding rehabilitation costs and enabling faster re-opening of the roads.

IMPACTS ON TRANSPORT

Infrastructure investment

The introduction of CAVs and other emerging technologies is likely to have significant impacts on transport infrastructure, land use and the urban environment more broadly. However, it is not yet clear what level of government support will be required to facilitate the adoption of CAVs. At a minimum, it is likely that some level of investment will be required in C-ITS, including infrastructure that communicates with vehicles.

The eventual adoption of CAVs will drive a significant change in transport demand and therefore the nature of future investment in the network. TMR is currently investigating potential future scenarios and how best to respond.

Connected and automated vehicles and network utilisation

It is possible that new vehicle technology will result in higher demands on the road network, as CAVs can operate without a driver, passengers, or with disabled or underage passengers. This increased accessibility could place an increase in the volume of trips (transport demand) made on the road.

Effective transport policies could be implemented in the future to encourage increased levels of shared-use CAVs, and their integration with public transport services, to ensure benefits are maximised.

It would be expected that when there are high levels of shared-use and where CAVs are used to complement high-capacity public transport services, there would be significant benefits in terms of network cost, utilisation and optimisation.

Government revenue

Road revenues will be impacted with the increasing uptake of CAVs and EVs. Currently, all levels of government receive revenue from road and other transport users which contributes to the provision of transport infrastructure. For example, local governments collect revenues from parking infringements, whereas state and territory governments are responsible for licensing, registration and traffic infringements and the Commonwealth receives revenue from fuel excise.

Fuel tax revenue, which accounts for 45 per cent of road related revenues, is continuing to decline due to improvements in fuel efficiency of light vehicles, changes in travel preferences and the introduction of EVs. Other road related revenue such as registration and licensing remain the only significant source of growth but are highly likely to be impacted in the future with the adoption of CAVs.

Current and future changes in the transport sector and in technology will require all levels of government to reconsider how transport users are charged for their use and how these charges are linked to investments in the network, so that funding remains equitable and sustainable into the future.

There have been numerous independent calls for a move towards cost reflective road user charging in recent years, including the Productivity Commission Inquiry into Public Infrastructure in 2014, the Competition Policy (Harper) Review of 2015 and Infrastructure Australia in 2016.

Given this interest in cost reflective road user charging, at the end of 2015 the Council of Australian Governments (COAG) asked the Transport and Infrastructure Council to lead efforts to improve the efficiency of road services by accelerating heavy vehicle road reform and investigating high-level benefits, costs and options to introduce cost reflective road pricing for all vehicles.

To progress this agenda a Land Transport Market Reform (LTMR) Steering Committee (the Committee) has been established with officer-level representatives across the federal, state and territory governments, the Australian Local Government Association and the National Transport Commission. Queensland is actively engaged in this work including relevant committees and working groups.

In late 2017 the Australian Government indicated its intention to undertake a study into the potential benefits and impacts of cost reflective pricing for light vehicles on road users. The details for the study are yet to be announced.

QUEENSLAND ACTION

National regulatory framework for automated vehicles

The introduction of driverless or CAVs into the Australian market will significantly change the way our roads are used and how they are managed. The challenge for governments is to provide a regulatory framework that focusses on the safety of all road users. Mechanisms that currently control road access and vehicle safety are not adequate to deal with CAVs. As such, there is a need to design a regulatory approach that does not present a barrier to innovation, vehicle importation and commercial deployment of the new technology.

TMR is engaged in a national program of work, led by the NTC to establish a regulatory framework for CAVs. This framework will address the implications for vehicle supply to market, vehicle safety, driving laws, registration, insurance and enforcement. Australian jurisdictions have agreed that this end-to-end framework should be in place by 2020. This work is part of the NPF Action Plan.

Cooperative and highly automated vehicles

The car industry is in a heavy research and development phase, where most manufacturers are working toward a highly automated vehicle (level 4), and a driverless vehicle (level 5). While still in their research and development phase, it is difficult for the car industry to provide decisive information about their infrastructure requirements or when vehicles may be commercially available. Many have indicated that they are trying to build the vehicles to use existing infrastructure.

A contract between TMR, Queensland University of Technology (QUT) and the iMOVE CRC to look at the readiness of Queensland's infrastructure assets for CAVs (today and into the future), was signed in June 2018. A further contract between TMR, QUT and the CRC, to test and demonstrate a level 4 cooperative and automated vehicle across a number of safety scenarios, has also been reached.

The contracts are part of the Cooperative and Automated Vehicle Initiative (CAVI) project. CAVI is a nationally significant, Queensland-led project designed to help TMR prepare for, and accelerate, the emergence of advanced vehicle technologies with safety, mobility and environmental benefits onto Queensland roads. CAVI is being delivered as part of the NPF Action Plan.

Cooperative vehicle pilot

Cooperative Intelligent Transport Systems allow road users and roadside infrastructure (such as traffic signals and signs) to communicate real-time information to other road users. A range of applications utilising wireless communications are emerging for vehicle-to-vehicle and vehicle-to-infrastructure communication. These applications typically provide the driver (who remains in control of the vehicle) with safety warnings. It is estimated that connectivity between vehicles and infrastructure alone could reduce crashes by over 20% and when combined with automation even higher reductions and as much as 90%.

A connected vehicle pilot was announced jointly by TMR with the Motor Accident Insurance Commission and Ipswich City Council in November 2016. Pilot will include a public on-road test in Ipswich involving around 500 fleet and public participants. The pilot will enhance Queensland readiness, grow industry partnerships, demonstrate the benefits and build public confidence in the technology.

Automated vehicle (AV) trials

TMR has previously issued four permits to trial AVs in Queensland. These trials involved the EasyMile EZ10 shuttle vehicle, with the trials being conducted on closed road environments at low speed. A permit is required if the trial involves a vehicle that does not comply with Australian Design Rules (ADRs) or if road rules need to be exempted.

Permits issued by TMR to facilitate AV trials are provided for under existing legislation and enable TMR to exempt the proponent from vehicle standard requirements, registration requirements and road rules. The permits have been issued on an ad hoc basis, specific to the circumstances of each trial.

TMR has established the AV Trial Permit Framework to enable trials of automated vehicles. The NTC have also prepared a national regulatory impact statement for the safety assurance of CAVs, currently under review.

D) examining how technology is affecting employment arrangements in the transport industry, particularly in the food delivery area.**Key points:**

- The transport industry has been impacted by a range of economic and technological changes in recent years. The growth of Queensland's economy and population has likely supported additional employment within the industry, particularly around road transport and for truck drivers.
- Certain technological advancements may have facilitated employment growth in a number of areas (for example on-demand transport services like Uber, food delivery services).

CONTEXT

The recent emergence of 'Delivery on Demand' distribution models has disrupted the traditional supply chain dynamic in urban areas around the world, including Australia. Service providers such as Foodora, Deliveroo and Uber-eats are establishing themselves as key players in the food delivery market. Technology enabled geolocation, ordering and payment systems are the foundation of these peer-to-peer type services.

TECHNOLOGY AND TRANSPORT EMPLOYMENT TRENDSTransport Technology and the 'Gig' Economy

The gig economy is an employment trend where organisations contract with independent workers for short term engagements. It connects customers to individual traders who have products or services to sell, hire or lease, often via an online platform or mobile app.

In recent years the gig economy has extended to the food delivery industry which relies on a variety of transport methods including cars, bicycles and motorcycles presenting challenges in road safety and regulation. International visitors, including students, who are taking up employment as delivery drivers/riders may be at greater risk due to a lack of familiarity with our road rules.

Transport industry employment in Queensland

The Transport, Postal and Warehousing (TPW) industry is the ninth largest employer in Queensland, accounting for 140,650 jobs or 5.7 per cent of total employment in 2017-2018⁹.

Figure 1 shows that within the TPW industry, road transport is the largest employer accounting for 49 per cent of total TPW employment in 2017-18. Road transport includes services like furniture removal, log haulage (road), road freight transport, road vehicle towing, taxi truck services (with driver), truck hire (with driver), bus services, car hire (with driver), and taxi cab management (operation on behalf of owner).

⁹ ABS data series, 4-quarter mid points average to June 2018

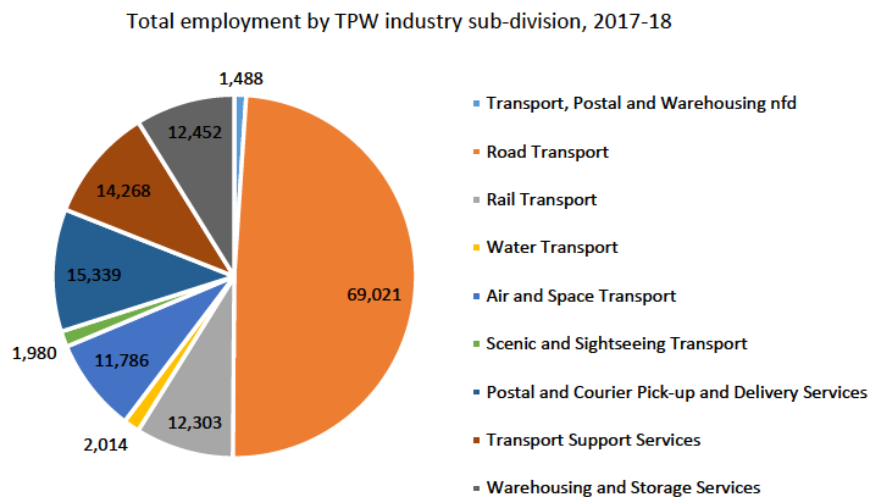


Figure 1: Australian Bureau of Statistics (ABS) information on employment in the TPW industry, by transport type.

Over the decade to 2017-18, the TPW industry saw moderate growth, recording a net increase of 3,725 workers (or 2.7 per cent).

Employment by occupation

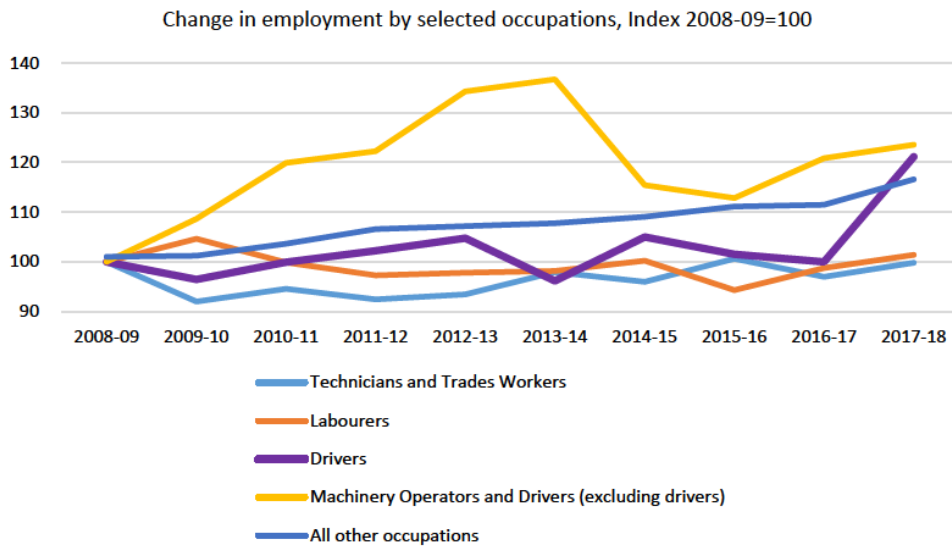
A number of occupations are closely associated with the transport industry and employ a significant number of Queenslanders. While there are several different occupations within the TPW industry including managers, professionals, clerical and administrative workers, the industry has a significantly higher concentration of drivers than other industries.

TMR received ABS detailed employment data to assess the change in the employment of driver-related occupations over time. ABS collects data on nine different ‘driver’ occupations - Couriers and Postal Deliverers; Machinery Operators and Drivers nfd¹⁰; Train and Tram Drivers; Road and Rail Drivers nfd; Bus and Coach Drivers; Forklift Drivers; Delivery Drivers; Automobile Drivers; and Truck Drivers. For the purposes of this analysis, occupations within this group were aggregated into a single group called ‘drivers’.

Drivers accounted for around 4.4 per cent of total Queensland employment in 2017-18. Truck drivers are the largest occupation within this group, accounting for 46.7 per cent of total employment.

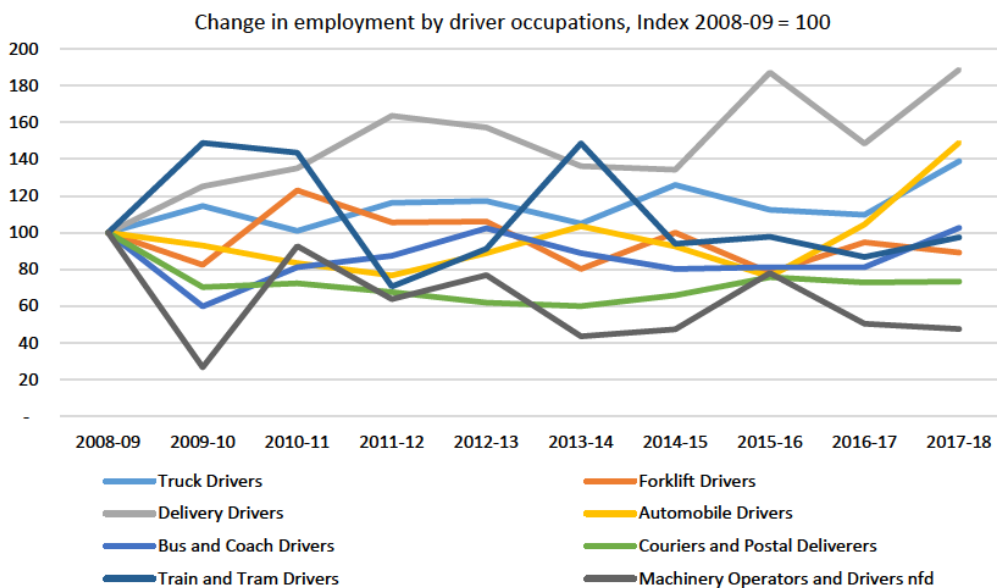
Employment of drivers grew by around 19,036 workers, or 21.1 per cent, over the decade to 2017-18. Notably, almost all of this growth occurred in the last year. Aside from this recent increase, there was relatively low growth in employment of drivers over the past decade, in line with technicians and trade workers and labourers, but lower than machinery operators and all other occupations. It is not clear whether this significant rise will persist in coming years.

¹⁰ nfd = not further defined.



Within the group of driver occupations, the largest absolute increase in employment since 2008-09 was for Truck Drivers (+14,258), followed by Delivery Drivers (+5,577) and Automobile Drivers (+3,698) while there was declining employment for Couriers and Postal Deliverers (-3,460), Machinery Operators and Drivers nfd (-1,159) and Forklift Drivers (-1,244).

In terms of relative changes, Delivery Drivers saw the largest increase with growth of 88.7 per cent. Automobile and Truck Drivers also saw large relative increases of 49 per cent and 38.9 per cent, respectively.



Drivers of transport employment

The changes outlined in the previous section reflects a range of factors, including population and economic growth as well as technological change.

Transport is a derived demand: unlike final goods and services, the demand for transport services is determined through the demand for other goods and services. Transport industry output tends to follow overall economic and population growth more closely than traded industries such as: agriculture, forestry and fishing, mining, and manufacturing industries.

While the transport industry has been supported by relatively high levels of economic and population growth, growth has not been uniformly distributed. Within the group of driver occupations, Truck, Delivery and Automobile Drivers have seen large increases in employment while Couriers and Postal Deliverers and Forklift Drivers have seen declining employment.

This may partially be explained by technological changes impacting on the industry. In recent years, the growth of online retailing, app-based delivery services for food delivery and ridesharing as well as traditional bricks-and-mortar retailers increasingly offering delivery services, has likely resulted in significant increases in employment in some industry sub-divisions and occupations. Conversely, increasingly sophisticated logistics technologies may be reducing labour requirements within parts of the industry.

The transport industry and driver occupations are likely to continue to be impacted by technological change.

The Commonwealth Department of Infrastructure and Regional Development submission to the House of Representatives Standing Committee on Industry, Innovation, Science and Resources on the Social Impacts of Automation in Transport (February 2017) suggests that automation will also create new business and job opportunities that could offset possible losses. This may include new roles in supplying, maintaining and operating automated vehicles, or other roles that use automated vehicles as a platform to deliver new kinds of services to the market. As with other disruptive technologies, it difficult to anticipate the opportunities that may arise with automated vehicles¹¹.

Drones

Drones, including robots are a rapidly developing technology with significant industry growth expected over the coming decades.

Drone is the common term used to describe a variety of remotely operated and/or autonomous vehicles and includes robots. Drones are being developed to perform traditional transport functions including freight and passenger movement.

Trials have occurred in the last few years regarding the use of drones for delivery of small items, including food.

Small parcel and first and last mile freight delivery are a realistic prospect for the transport system in the medium term.

¹¹ Commonwealth Department of Infrastructure and Regional Development, February 2017, Social Impacts of Automation in Transport. Available at: file:///C:/Users/jvlangr/Downloads/Sub26%20-%20Dept%20of%20Infrastructure.pdf